

EMPIRICAL STUDY



Determining the Effectiveness of Visual Input Enhancement Across Multiple Linguistic Cues

Ian Comeaux  and Janet L. McDonald

Louisiana State University

Visual input enhancement (VIE) increases the salience of grammatical forms, potentially facilitating acquisition through attention mechanisms. Native English speakers were exposed to an artificial language containing four linguistic cues (verb agreement, case marking, animacy, word order), with morphological cues either unmarked, marked in the same color, or marked in different colors. Cue validity (how often a cue was present and correct) and dominance were also manipulated. In Experiment 1, where the morphological cues were low in validity but highly dominant, VIE helped participants to acquire and strengthen one morphological cue (case marking) but not the other (verb agreement). In Experiment 2, where animacy was highly dominant, there was no benefit of VIE; indeed, the same color VIE condition impeded the acquisition of the marked cues. Thus, VIE may only be beneficial in certain circumstances and this may depend on the type of cue as well as its validity and dominance.

Keywords visual input enhancement; second language learning; Competition Model; cue validity

This manuscript is based on the master's thesis of the first author. We would like to thank Catherine Pinas, Jeanette Rimmer, Yedam Jo, and Stephen Doerfler for their help with data collection. Preliminary versions of these data were presented at Psychonomics 2015 and 2016.



This article has been awarded Open Materials and Open Data badges. All materials are publicly accessible in the IRIS digital repository at <http://www.iris-database.org>. All data are publicly accessible via the Open Science Framework at <https://osf.io/re48w>. Learn more about the Open Practices badges from the

Center for Open Science: <https://osf.io/tyyxz/wiki>.

Correspondence concerning this article should be addressed to Janet McDonald, Department of Psychology, Louisiana State University, Baton Rouge, LA 70803. E-mail: psmcdo@lsu.edu

Introduction

One of the many challenges second language (L2) learners face is acquiring the grammar and morphology of their new language. Not only must they learn new grammatical features, they must also come to understand how various linguistic factors interact within the new language to convey intended meaning. For example, to assign the actor role in a sentence (who or what carries out the action of the verb), learners may draw upon cues from the domains of syntax, morphology, and semantics. To master a language, learners must first acquire the relevant L2 cues and then additionally learn to appropriately weight them for that language. Here we explored visual input enhancement (VIE) as a potential pedagogical technique for facilitating the acquisition and appropriate weighting of multiple linguistic cues when learners must determine the actor role in a new language.

Visual Input Enhancement

Attention plays a central role in theories of L2 acquisition, such as the noticing hypothesis of Schmidt (1990, 1992, 2001; see also Robinson, 1995, and Tomlin & Villa, 1994). Noticing is differentiated from metalinguistic awareness and only requires that a learner detect a feature at a low level of awareness so that it is included in the intake that is used for acquisition. This implies that acquisition could improve if noticing could be enhanced through methods, such as explicit instruction, focus on form, or, as examined here, manipulation of the input itself. VIE is one method of making elements of visually presented linguistic stimuli more salient (i.e., more noticeable) through the use of typographical alterations. For instance, VIE may make use of bold font, italics, or different color patterns to highlight key linguistic features, such as plural, verb tense, or gender markings. According to the noticing hypothesis, these features should then capture attention and in turn be more readily acquired.

The results of studies using VIE have been mixed. There is some evidence that VIE is effective in facilitating the acquisition of grammatical structures (Cintrón-Valentín & Ellis, 2015; Ellis & Sagarra, 2010; Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995; Lee, 2007; Leeman, Arteagoitia, Fridman, & Doughty, 1995; Tolentino & Tokowicz, 2014). For example, Lee had Korean students read L2 English texts containing passive voice forms that were either presented in bold font or without any enhancement. Participants in the bolded condition performed better on a form correction task than those in the unenhanced condition. However, despite this better mastery of the passive grammatical form—or perhaps because of it—the bolded group showed poorer comprehension of the passages that they had read. Cintrón-Valentín and

Ellis had English-speaking participants learn Latin phrases that contained both an adverb and verb tense morphology. While the control group based comprehension and production on the adverb, the group that had enhanced verb morphology looked at this information more during study and used it more strongly in their subsequent comprehension and production.

Several other studies (Alanen, 1995; Izumi, 2002; Jourdenais, 1998; Kubota, 2000; Leow, 2001; Leow, Egi, Nuevo, & Tsai, 2003; Loewen & Inceoglu, 2016; Lyddon, 2011; Park, Choi, & Lee, 2012; Park & Nassif, 2014; Winke, 2013; Wong, 2003) failed to find beneficial effects of VIE alone on acquisition of grammatical forms. For example, Izumi found that L2 learners who were exposed to texts in which relative clause structures were underlined were more likely to use this structure while taking notes but failed to show an improvement in performance on a battery of grammatical tests. Thus, VIE appeared to facilitate noticing of the enhanced structure, but it did not ultimately help acquisition. Park et al. had native Korean speakers read English texts containing gerunds and *to*-infinitive phrases. These constructions were unenhanced, bolded and underlined, or bolded and underlined with instructions to attend to the highlighted phrases. While both visual enhancement groups looked at these phrases longer, only the group with both enhancement and instructions had better command of these grammatical forms; VIE alone did not differ from the control condition. In addition, both groups with enhancement showed poorer comprehension of the texts that they had read.

The noticing hypothesis claims that better acquisition is the result of noticing. However, only some VIE studies have contained an explicit measure of noticing, such as participants' use of target forms in protocols or participants' notes (Izumi, 2002; Jourdenais et al., 1995; Leow, 2001), or participants' eye-gaze durations on enhanced sections (e.g., Cintrón-Valentín & Ellis, 2015; Loewen & Inceoglu, 2016; Park et al., 2012; Winke, 2013). Some studies have confirmed that VIE increased attention to the highlighted information either in the presence (Cintrón-Valentín & Ellis, 2015; Jourdenais et al., 1995) or in the absence of better acquisition (Izumi, 2002; Park et al., 2012; Winke, 2013) while others have not found statistically significant evidence of heightened noticing (Leow, 2001; Loewen & Inceoglu, 2016).

The manner in which VIE has been actualized might also have an effect. Simard (2009) examined different ways of visually highlighting English plural forms for native French-speaking children. These included single alterations (bolded, all capitals, underlined, italicized, or colored), a combination of the first three methods listed, and a combination of all five. Results showed that both the three-cue combination and the all-capitals groups outperformed the control

group on a posttest.¹ Thus, certain typographical alterations may be more effective than others and, while multiple alterations may be useful, having too many (i.e., the five-cue combination) may be detrimental.

Two meta-analyses (Alsadhan, 2011; Lee & Huang, 2008) have both concluded that VIE has shown an overall positive albeit small effect size. However, fundamental differences across studies have made it difficult to make comparisons (Han, Park, & Combs, 2008)—studies have varied widely in target languages, target grammatical forms, dependent measures, and methodologies. Further, there have been contradictions even within replications—for example, while Lee (2007) found a positive effect of VIE, Winke (2013), in a direct replication, failed to find any benefit of VIE. Thus, the circumstances under which VIE is effective are not clear. The design of the present study allowed us to examine how the type of cue and its statistical properties influence whether or not VIE is effective.

Relative Weighting of Multiple Cues: The Competition Model

In acquiring a L2, it is not enough for learners to simply acquire single grammatical features in isolation as has often been done in VIE studies. Rather, they must acquire and coordinate multiple linguistic cues. In particular, they must correctly weight each cue appropriately in order to determine the intended meaning of a sentence in the language. For example, if a person is trying to determine the actor in an English sentence, such as *He poisons the potatoes*, there are a variety of cues that could be used—the syntactic cue of word order (favors the preverbal noun); the morphological cue of verb agreement (favors the noun that agrees in number with the verb marking) or case marking (favors the nominative case noun or nonaccusative case noun); and the semantically based cue, animacy (favors the animate noun). For the above sentence, each of these cues favors *he* as the actor. However, in a sentence such as *The potatoes poison the man*, two cues favor *the potatoes* (preverbal word order and verb agreement), one cue favors *the man* (animacy), and one cue (case marking) is absent. In such cases, the relative strength of the available cues determines which noun is the actor—in this case, *the potatoes*, because English strongly relies upon word order, which favors the preverbal noun as the actor over the postverbal noun (Bates & MacWhinney, 1989). In English, word order dominates subject–verb agreement, case marking, and noun animacy (MacWhinney, Bates, & Kliegl, 1984; McDonald, 1987a). While morphological cues, such as verb agreement and case marking, tend to be correct when present (as in the above examples), this is not always so, particularly in nonmainstream dialects of English. In such cases, word order, because of its high dominance in English,

gives the correct interpretation over the conflicting morphological cues. Consider, for example, this grammatical sentence in a dialect of English spoken in Belfast: *The girls likes pizza* (Tortora & den Dikken, 2010, p. 1091). Here verb agreement favors *pizza* as the actor, while preverbal word order and animacy favor the actual actor, *the girls*. Similarly, the grammatical African American English sentence *Me and him do it sometimes* (Oetting & McDonald, 2001, p. 223) has case inflection favoring *it*, while word order, animacy, and verb agreement correctly favor *me and him*. Yet even mainstream English speakers have no trouble understanding the intended meaning of these nonmainstream dialect sentences because of the dominance of the word-order cue.

Different languages have different cue dominance hierarchies. For example, German adults rely more on verb agreement and case marking than on word order or animacy (Lindner, 2003; MacWhinney et al., 1984). Thus, in a sentence such as *Den Mann vergiften die Kartoffeln* (*The-accusative man-singular poison-plural the potatoes-plural*) where preverbal word order and noun animacy favor the first noun while verb agreement and case marking favor the second, native German speakers interpret this sentence to mean *The potatoes poison the man*. Thus, native English speakers learning German would not only have to acquire the way German marks verb agreement and case, they would also have to learn a new set of relative cue strengths.

The Competition Model (Bates & MacWhinney, 1989; MacWhinney, 2005) is a framework that proposes how properties of individual cues drive interpretation within a language. One property, *overall cue validity*—how often a cue is present and correct across all sentences of a language—predicts the order in which cues are originally acquired during language learning by native-speaking children (Bates & MacWhinney, 1989; Bates et al., 1984; McDonald, 1986; but see Sokolov, 1989, who finds *availability*—how often the cue is present—to be a better predictor for Hebrew-speaking children). Another property, *the dominance hierarchy*, determines the relative importance of the cues in adult sentence interpretation. Hierarchies emerge from situations in which there is conflict between cues, that is, from sentences like *The potatoes poison the man* but not *The man poisons the potatoes*. Computing how often cues give the correct answer when they are in conflict determines the strength of cues relative to one another, and this dominance hierarchy reflects cue use among adult native speakers (McDonald, 1986, 1987a; McDonald & MacWhinney, 1991).

Other factors may influence order of acquisition or strength of cue use. These include *cue detectability* and *cue cost* (Bates & MacWhinney, 1989; Kail, 1989; Kail & Charvillat, 1988; MacWhinney, 2012). A cue low in detectability, for example, due to low phonological contrast, may be acquired later than

predicted (MacWhinney, Pléh, & Bates, 1985; McDonald & MacWhinney, 1991). Cues high in cost, for example, due to high cognitive demands, may be acquired later or used less strongly than predicted (Devescovi, D'Amico, & Gentile, 1999; Kail, 1989; Kail & Charvillat, 1988). The design of the current experiment allowed for inquiry into both of these factors. First, we examined cue detectability by manipulating the salience of linguistic cues via VIE to see how this influences the order of cue acquisition and final cue use. Second, we examined cue cost by comparing the acquisition of the local case-marking cue (i.e., a single ending on the direct object) to the more complex subject–verb-agreement cue, which involves integrating information across elements (i.e., learners must note and keep in mind the marker on the verb while processing those on the nouns).

The Competition Model has also been applied to L2 learning (Bates & MacWhinney, 1981; MacWhinney, 1997). While outcomes may differ depending on the two languages involved and the age of L2 acquisition, several studies have shown that the cue strengths applied to a learner's L2 often begin close to those of their first language (L1) and may gradually adjust with continued exposure toward those of native speakers of the L2 (Heilenman & McDonald, 1993; Liu, Bates, & Li, 1992; McDonald, 1987b; McDonald & Heilenman, 1991; Morett & MacWhinney, 2013), with learners sometimes using an amalgamation of strategies from both their languages (Hernandez, Bates, & Avila, 1994). Some evidence has suggested that animacy may be an easier cue to transfer or use than syntactic or morphological cues (Gass, 1987; Sasaki, 1991), and evidence from studies measuring event-related potentials has suggested that animacy is processed similarly across languages (Bornkessel-Schlesewsky & Schlewsky, 2009).

The Present Study

Competition Model studies typically use an actor-assignment comprehension task consisting of simple transitive sentences, each containing a verb and two nouns. After being presented with a sentence, participants choose which noun they believe to be responsible for carrying out the action described. In this paradigm, participants are presented with all sentence types that can be formed by a total crossing of each of the three levels of each cue: (a) the cue is not present or applicable, (b) the cue favors the first noun, or (c) the cue favors the second noun. Using this design, it is possible to determine (a) if a participant is using a particular cue and (b) how strongly the participant uses a cue relative to other cues by looking at the percent variance accounted for by each cue in every possible context—thus revealing the cue dominance hierarchy.

In this study, we used an artificial language in order to ensure that all stimuli would be unfamiliar to participants. In addition, this allowed us to manipulate each cue's overall validity as well as its position within the dominance hierarchy. Participants took part in an actor-assignment task in this artificial language in which the cues of verb agreement, case marking, and noun animacy were systematically crossed. Word order was always VNN (verb, noun, noun), and, in the absence of other cues, a VSO (verb, subject, object) interpretation was correct. This pattern was chosen as it was the opposite of the VOS (verb, object, subject) interpretation favored by native English speakers for sentences with a VNN word order (MacWhinney et al., 1984; McDonald, 1987a). Thus, if there was any initial transfer of the strongly favored word-order cue from English, this would not have proven useful in this artificial language. The overall validity and the dominance hierarchy of the cues were established by varying the frequency with which certain types of sentences were seen during learning trials that contained feedback as to which noun was the actor. These learning trials were alternated with test trials that equally sampled all sentence types and were provided without feedback. Analysis of how nouns were chosen during the test trials allowed us to see which cues were being used and their relative strength. By alternating learning and test trials, we were able to examine how cue use and relative strength changed over the course of learning.

VIE was present only in the learning trials. The morphological markers of verb agreement and case appeared with a color contrast relative to the otherwise black text. Because most VIE studies only highlight one type of feature within a sentence, we were interested in how VIE would work when applied to multiple features simultaneously. Along with a no-contrast control group, we examined two instantiations of VIE: a one-color group, where the same color (red) was applied to both verb agreement and case markers, and a two-color group, where one color (red) was applied to the verb agreement marker and another color (green) to case marker. While previous studies have applied more than one way of enhancing a single structure (e.g., Simard, 2009), we know of no study that has used differential marking of different structures. Because both morphological cues appeared in word-final position, we thought that participants should be better able to distinguish two separate cues if these were differentially marked.

We made the following predictions based on the Competition Model: (a) initial acquisition of the cues should be determined by overall validity, with the cues highest in overall validity being the first acquired, and (b) the relative strength of cue use should shift to reflect the cue dominance hierarchy later in learning. However, VIE might modify this learning trajectory, as

the VIE-marked cues were expected to draw attention toward themselves and away from the unmarked cues. Therefore, during initial learning VIE might aid in quicker acquisition of a cue that would typically be delayed due to its low overall validity, but might not facilitate acquisition of a cue already high in overall validity. Further, later in learning, VIE might aid in appropriately strengthening a cue when it was high in the dominance hierarchy, while it might inappropriately strengthen a cue that was low in the dominance hierarchy. These predictions were tested in Experiment 1, where the VIE-marked cues had low overall validities but were high in the dominance hierarchy, and Experiment 2, where one of the VIE-marked cues had high overall validity but was low in the dominance hierarchy. We also examined the effect of cue cost by comparing how VIE affected the low-cost cue of case marking versus the more demanding cue of verb agreement, which required integration across sentence elements.

Experiment 1

In Experiment 1, the cues of word order and animacy had high overall validity, while the cues of verb agreement and case marking were high in the dominance hierarchy. Thus, participants were expected to use word order and animacy early on but later to rely on the cues of verb agreement and case marking more strongly. VIE was applied to the cues of verb agreement and case marking. We hypothesized that this might cause these cues to be acquired earlier than in the no-VIE condition and might cause them to be weighted more strongly (appropriately so) later in learning.

Method

Participants

The data from 107 native English-speaking young adults were analyzed in the experiment. Participants were initially divided into three groups with 37 participants assigned to the no-VIE group, 36 to the one-color VIE group, and 37 to the two-color VIE group. One participant in the one-color VIE group and two participants in the two-color VIE group were dropped due to experimenter errors during the data collection process, leaving 37 participants in the no-VIE group and 35 participants each in the one-color VIE and two-color VIE groups.

The groups did not differ in age ($M = 20.06$ years, $range = 17-24$, $SD = 1.50$), $F(2, 104) = 0.73$, $p = .49$. Participants were mostly female, with each group having 9–14 males. All but three of the participants reported classroom exposure to a language other than English. All of these participants had

exposure to one or more Romance languages (Spanish = 79, French = 39, Latin = 9, Italian = 3), and a few, distributed across the conditions, had additional classroom exposure to other languages (German = 5, Hebrew = 1). Total years of reported classroom exposure to a foreign language regardless of grade ranged from 0.5 to 11 years ($M = 3.93$, $SD = 2.22$); groups did not differ by years of exposure, $F(2, 99) = 0.24$, $p = .79$. Finally, a few participants reported meaningful exposure to a language outside of the classroom either through family members or environment (Arabic = 1, Kannada = 1, Spanish = 1).

Materials

Stimuli consisted of sentences containing a verb and two nouns in the VNN word order, and vocabulary was similar to that previously used in studies involving the actor-assignment paradigm (Li, Bates, & MacWhinney, 1993; MacWhinney et al., 1984, 1985; Su, 2004). Eight verbs (*bite, chase, eat, hit, kick, push, wash, watch*), eight animate nouns (*bird, tiger, camel, elephant, lion, lizard, mouse, zebra*), and eight inanimate nouns (*balloon, broom, glass, kite, lamp, rock, window, radish*) were used. Verbs were arbitrary two-syllable nonsense words, with no obvious relationship to their English counterparts (*greheck, hils, ponta, crahid, dawro, verug, tajeh, inpa*, respective to the order listed above). To lessen memory load, the lexical forms of the nouns in the artificial language were generated by shortening the English words to their first two or three phonemes but with some alteration to their spelling to give the feel of a different language (*ber, tyg, kam, ela, lai, lyz, mao, zee* for the animate nouns listed above; *bul, bru, glu, kyt, luh, rok, wen, rah* for the inanimate nouns). Pictures for the vocabulary items were taken from the International Picturing Naming Project (Szekely et al., 2004).

The verb-agreement cue was instantiated by a suffix on the verb (either *-na* or *-ye*) and a different set of suffixes to mark the nouns in the sentence (either *-ji* or *-gu*). The noun ending *-ji* agreed with the verb ending *-na*, while the noun ending *-gu* agreed with the verb ending *-ye*.² Case marking was an accusative marker on the noun that was not the actor, indicated by attaching *-pa* to this noun after the agreement marker. An example sentence (with suffixes underlined) would be *inpana zebji rokgupa* (*watch-singular zebra-singular rock-plural-accusative*), which translates to *The zebra watches the rocks*.

Sentences were created based on the experimental design in McDonald and MacWhinney (1991). With three different cues (verb agreement, case marking, and animacy) that could vary in three different ways (not applicable, favored first noun, or favored second noun), a complete crossing led to

27 different potential arrangements of cues. Specifically, verb agreement markers were always present, but if both noun endings agreed with the verb, it was not applicable, otherwise the verb ending agreed with either the first or second noun. Case marking was sometimes not present and therefore not applicable, otherwise it indicated that the first or second noun was the subject (i.e., not the direct object). Animacy was not applicable when the nouns were either both animate or both inanimate. When one noun was animate and one inanimate, the position of the animate noun indicated the actor. Word order was always VNN, and in the absence of other cues, the VSO interpretation was correct.

This design is illustrated in brief in Figure 1 and in more detail in Appendix S1 in the Supporting Information online, with example sentences translated into English. In eight of the cells, there were no conflicts between the cues as to which noun was favored as the actor; conflict occurred in the other 19 cells, indicated with shading. A cue dominance hierarchy that indicated which cue would yield the correct answer when conflict occurred was established, such that verb agreement was the most dominant cue, followed by (from most to least dominant) case marking, animacy, and word order. The noun that was the correct actor in each cell according to this hierarchy is indicated by bold face. During learning blocks, sentences were presented with the frequencies shown in each cell, followed by feedback. This yielded overall validities of 27% for verb agreement, 36% for case marking, 45% for animacy, and 59% for word order. This is the opposite order of the dominance hierarchy, so any transition from use of overall validity to the dominance hierarchy should be readily apparent. For example, if participants used the two high overall validity cues of VSO word order and animacy to a greater extent than case marking and verb agreement, they should tend to pick the first noun *zebras* in a sentence like *Hits the zebras-accusative the lamp*. If participants later transitioned to using the cues of verb agreement and case marking more strongly than animacy or word order, they should tend to pick *lamp* in that sentence. Thus, by examining the pattern of behavior across all 27 sentence types, we were able to discover the cues that participants were using and their relative strengths.

Sentences used in the learning blocks were randomly generated by selecting a verb and two nouns for each sentence, with the restriction that sentences could not contain the same two nouns in the same position. In total, 198 sentences (3 blocks \times 66 sentences per block) were created for the learning blocks. Sentences in the test blocks were formed by taking noun pairs from sentences from a different learning block, pairing them with a different verb, and altering the morphological markers—thus creating a new sentence in a different cell

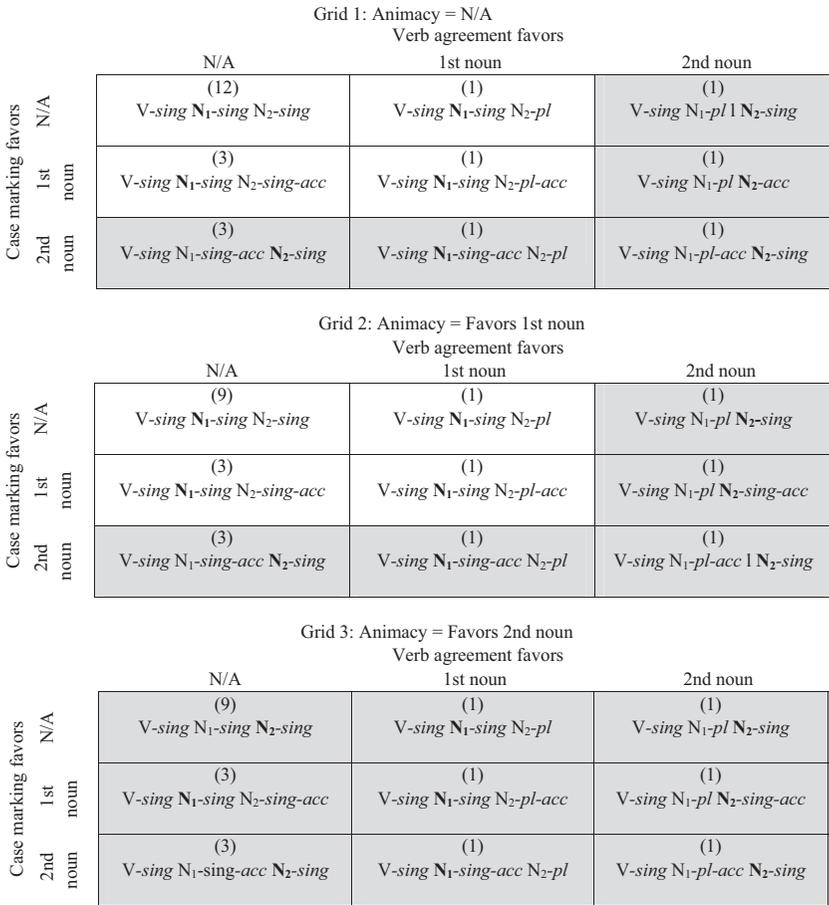


Figure 1 Schematic of the experimental design in Experiment 1, along with the number of times each cue combination was shown within each learning block (in parenthesis). The bolded noun is the correct actor in each context. Shaded cells represent conflict cases. Cues could be: not available (N/A) (e.g., for animacy, both nouns of equal animacy); favor the first noun in the sentence as the actor (e.g., for animacy, the first noun was animate and second inanimate); or favor the second noun in the sentence as the actor (e.g., for animacy, the first noun was inanimate and second animate). V = verb, N = noun, sing = singular, pl = plural, acc = accusative.

of the design. The correct response for a test sentence matched the correct response to its learning block counterpart roughly half of the time. In total, 162 test sentences (3 blocks × 54 sentences per block) were formed. Each cell in the 3 × 3 × 3 design was tested twice in each test block.

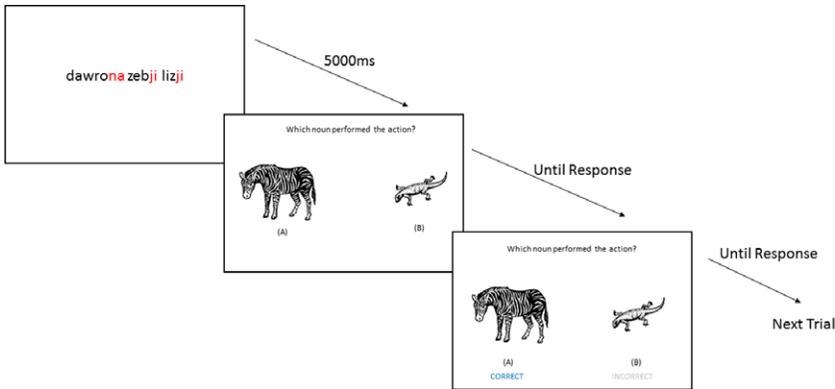


Figure 2 A depiction of the actor-assignment task used in this study. Pictured is a trial from a learning block in the one-color VIE condition. The suffixes indicating verb agreement (*-na* and *-ji*) were presented in red text. The test trials omitted the third screen; participants did not receive feedback, and the next sentence was immediately presented after a response was given. [Color figure can be viewed at wileyonlinelibrary.com]

VIE was manipulated between subjects. In the no-VIE condition, all text was presented in black font. In the one-color VIE condition, the morphemes indicating verb agreement and case marking were all presented in red font during the learning blocks. In the two-color VIE condition, the suffixes that indicated verb agreement were presented in red, and the markers that indicated case marking were presented in green. All text in the test blocks was presented in black font, regardless of group.

Design and Procedure

After filling out a demographic and language background questionnaire, participants were exposed to the vocabulary of the artificial language. Individual items were shown on the computer screen for 3,000 milliseconds and consisted of an image with the corresponding word (noun or verb) in the artificial language, along with the English translation presented beneath it. Two passes were made through the entire vocabulary; items were presented in a different randomized order on each pass.

After the vocabulary exposure, participants were exposed to individual sentences in the artificial language. Three learning blocks were interspersed with three test blocks to examine learning over time. Learning blocks consisted of 66 sentences presented in a random order with the frequency in each cell of the design as given in Figure 1. As shown in Figure 2, each sentence was

displayed for five seconds and was then replaced with a screen containing unlabeled pictures of the two nouns in the sentence with a prompt above them, asking participants to select which noun served as the actor. Half the time the order of the pictures on this screen matched the order in which the nouns appeared in the sentence, and half the time it was flipped. Participants responded via keypress by selecting “1” for the picture on the left and “0” for picture on the right. Feedback was then provided by displaying the words *Correct* in blue text under the picture corresponding to the actor and *Incorrect* in grey text beneath the other picture. Participants then proceeded to the next sentence by pressing the spacebar.

Test blocks consisted of 54 sentences, two exemplars from each of the 27 cells of the design. This phase was identical to the learning phase except that no feedback was provided as to which answer was correct and incorrect. The experiment moved directly to the next test sentence once the participant made a response. Additionally, VIE was not instantiated in any test block. Instructions informing the participants whether they would or would not be provided feedback were presented at the start of each learning or test block.

Data Analysis

We conducted three different analyses. First, we examined how often participants picked the correct noun in the test blocks using a 3×3 mixed factorial analysis of variance (ANOVA), with group (no-VIE, one-color VIE, and two-color VIE) as a between-subjects factor and block (1, 2, or 3) as a within-subjects factor. This established if groups were performing above chance, if they differed from each other, and if performance improved across blocks. This analysis was not a focus of any of our hypotheses and was done to establish that participants had indeed learned something.

Second, to determine if participants were utilizing the individual cues, we analyzed percent choice of the first noun in a $3 \times 3 \times 3$ repeated-measures design. The first repeated measure was verb agreement (not applicable, favors first noun, favors second noun); the second was case marking (not applicable, favors first noun, favors second noun); and the third was animacy (not applicable, favors first noun, favors second noun). Because word order was fixed throughout the experiment and favored the first noun, we checked for this by testing if the intercept was significantly different from chance (50%). When a cue showed statistically significant use, we followed up with a Bonferroni corrected post hoc test to see which levels differed. In general, if a cue was significantly used, a greater preference for the first noun should be seen when the cue favored the first noun than when it favored the second; when the cue

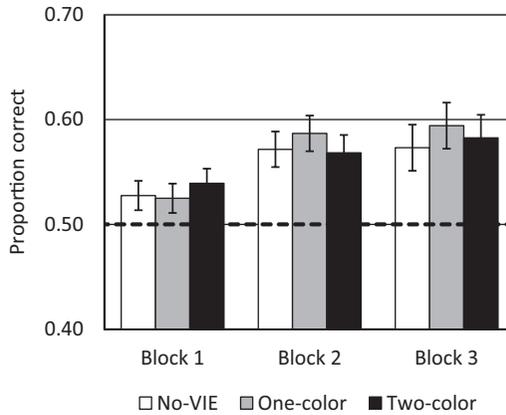


Figure 3 Participants' correct responses as a proportion for the test trials in Experiment 1 using visual input enhancement. Error bars indicate standard error. The dotted line indicates chance performance (50%).

was inapplicable, the rate of first noun choice should fall somewhere in between. We also encountered multiple violations of sphericity in the course of our analyses. When this was the case, we report the results of the ANOVA using the Greenhouse-Geisser correction, designated by the statistic, F_{G-G} . We performed separate ANOVAs for each test block and VIE group.

Finally, in order to get a measure regarding the strength of cue use, we calculated eta-squared values from the ANOVAs for first noun choice. Eta-squared values indicate the proportion of variance accounted for by each cue.³

Results

Correct Responses

Figure 3 shows the percent correct performance for each group for each block. A series of one-sample t tests indicated that each group performed significantly above chance (50%) across all blocks (all $ps < .05$), except for the no-VIE group in Block 1 ($M = .53$, $SD = .09$), which approached significance, $t(36) = 1.86$, $p = .07$ (two-tailed). There was a significant main effect of block, $F_{G-G}(1.60, 166.55) = 16.83$, $p < .001$, $\eta_p^2 = .14$. Bonferroni corrected post hoc comparisons revealed that participants scored significantly worse on Block 1 ($M = .53$, $SD = .09$) than either Blocks 2 or 3 ($M = .58$, $SD = .07$, and $M = .58$, $SD = .09$, respectively), both $ps < .001$. There was no main effect of group, $F(2, 104) = .14$, $p = .87$, $\eta_p^2 = .003$, or interaction between group and block, $F_{G-G}(3.20, 166.55) = .59$, $p = .63$, $\eta_p^2 = .01$.

Use of Cues

Table 1 gives an overview of the analyses reported below by indicating if a cue was significantly used, and when it was, which of the levels of that cue were significantly different from each other by a Bonferroni corrected post hoc test. To avoid redundancy, effect sizes are not reported here, as they are provided in the eta-squared analysis section.

In the early stages of the learning process, we expected to see learners picking up on the cues highest in overall validity—in this case, word order and animacy. Indeed, in the first block all groups showed significant use of these cues, while the two conditions involving VIE also showed use of the enhanced case-marking cue. Specifically, for the no-VIE group, there were main effects of word order, $F(1, 36) = 5.15, p = .029$, and animacy, $F_{G-G}(1.25, 45.05) = 9.72, p = .002$, and no main effect for either case marking, $F_{G-G}(1.45, 52.17) = 0.91, p = .38$, or verb agreement, $F(2, 72) = 1.83, p = .17$. For the one-color group, there were main effects of word order, $F(1, 34) = 17.69, p < .001$, and animacy, $F_{G-G}(1.46, 49.50) = 12.80, p < .001$, as well as the case-marking cue, $F_{G-G}(1.48, 50.16) = 4.21, p = .031$, but no main effect of verb agreement, $F(2, 68) = 0.76, p = .47$. Similarly for the two-color group, there were significant main effects of word order, $F(1, 34) = 5.08, p = .031$, and animacy, $F_{G-G}(1.37, 46.63) = 15.60, p < .001$, as well as case marking, $F_{G-G}(1.62, 55.15) = 5.27, p = .012$, but no main effect of verb agreement, $F_{G-G}(1.70, 57.69) = 0.21, p = .78$.

In the second block, we expected more cues to be acquired given the greater length of exposure to the language. Indeed, all four cues were used by the no-VIE and one-color group and three of the four cues by the two-color group. Interactions involving verb agreement and case marking occurred in the no-VIE and one-color group, showing that these cues were only used in certain circumstances. Specifically, for the no-VIE group, there was a significant main effect for all four cues, verb agreement, $F_{G-G}(1.49, 53.52) = 5.08, p = .016$, case marking, $F_{G-G}(1.66, 59.62) = 6.08, p = .004$, animacy, $F_{G-G}(1.29, 46.33) = 11.34, p = .001$, and word order, $F(1, 36) = 7.13, p = .011$. There was also a two-way interaction qualified by a three-way interaction. The interaction between verb agreement and case marking, $F(4, 144) = 3.24, p = .014$, arose because case marking ($CM_2 < CM_1 = CM_0$) was only significant when verb agreement was not applicable. The three-way interaction between verb agreement, case marking, and animacy, $F(8, 288) = 2.37, p = .017$, came about because case marking was only significantly used when animacy was not applicable regardless of verb agreement level or when verb agreement was not applicable regardless of animacy level (i.e., case marking was not used when both verb

Table 1 Summary of the significant effects in the analyses of variance, with post hoc tests for the Experiment 1 test blocks using visual input enhancement (VIE)

No VIE			
Cue	Block 1	Block 2	Block 3
Verb agreement	—	VA ₂ < VA ₀ 51% < 60%	marginal (<i>p</i> = .056)
Case marking	—	CM ₂ < CM ₀ = CM ₁ 48% < 51% = 51%	CM ₂ < CM ₀ = CM ₁ 49% < 64% = 63%
Animacy	A ₂ < A ₀ = A ₁ 47% < 59% = 65%	A ₂ < A ₀ < A ₁ 47% < 56% < 67%	A ₂ < A ₀ = A ₁ 45% < 62% = 69%
Word order	favors N ₁ 57%	favors N ₁ 57%	favors N ₁ 59%
VA × CM	—	significant	significant
VA × CM × A	—	significant	—
One-color VIE			
Cue	Block 1	Block 2	Block 3
Verb agreement	—	VA ₂ < VA ₀ 52% < 62%	VA ₂ < VA ₀ = VA ₁ ^a 49% < 57% = 63%
Case marking	CM ₂ < CM ₁ ^a 50% < 63%	CM ₂ < CM ₀ = CM ₁ 44% < 63% = 67%	CM ₂ < CM ₀ = CM ₁ 43% < 61% = 64%
Animacy	A ₂ < A ₀ < A ₁ 45% < 59% < 67%	A ₂ < A ₀ < A ₁ 48% < 58% < 68%	A ₂ < A ₀ = A ₁ 47% < 57% = 64%
Word order	favors N ₁ 57%	favors N ₁ 58%	favors N ₁ 56%
VA × CM	—	significant	significant
Two-color VIE			
Cue	Block 1	Block 2	Block 3
Verb agreement	—	VA ₂ < VA ₀ = VA ₁ ^a 50% < 56% = 57%	—
Case marking	CM ₂ < CM ₀ = CM ₁ 50% < 60% = 61%	CM ₂ < CM ₀ = CM ₁ 38% < 58% = 67%	CM ₂ < CM ₀ < CM ₁ 35% < 63% < 76%
Animacy	A ₂ < A ₀ < A ₁ 46% < 58% < 67%	A ₂ < A ₀ = A ₁ 47% < 55% = 60%	A ₂ < A ₀ = A ₁ 51% < 59% = 63%
Word order	favors N ₁ 57%	—	favors N ₁ 58%
CM × A	—	—	significant

Note. ^aSignificant by a least significant difference post hoc test, while the more conservative Bonferroni adjusted tests failed to find any differences within a significant main effect. Cues in the order of the dominance hierarchy are verb agreement (VA), case marking (CM), animacy (A), and word order (WO). Subscripts denote which noun the cue favored: 0 = not available; 1 = first noun; 2 = second noun. Percentage values indicate the proportion of first noun selection.

agreement and animacy favored one of the nouns). Thus, case marking only appeared to be used in situations where there was minimal input from the other two cues. For the one-color group, there were again significant main effects for all four cues, verb agreement, $F_{G-G}(1.57, 53.30) = 4.40, p = .025$, case marking, $F_{G-G}(1.37, 46.48) = 19.57, p < .001$, animacy, $F_{G-G}(1.35, 45.82) = 11.05, p = .001$, and word order, $F(1, 34) = 14.48, p = .001$. The interaction between verb agreement and case marking was also significant, $F(4, 136) = 4.78, p = .001$. Tests of simple effects showed that this interaction was due to participants using verb agreement only when case marking was absent ($VA_2 < VA_0$) or favored the first noun ($VA_2 < VA_0 = VA_1$), while they were able to at least make some use of case marking at each level of verb agreement (for VA_0 : $CM_2 < CM_0 = CM_1$; for VA_1 : $CM_0 = CM_2 < CM_1$; and for VA_2 : $CM_2 < CM_0$). Thus, participants did not consistently adhere to a hierarchy of case marking over verb agreement or vice versa. For the two-color group, there was a main effect of verb agreement, $F(2, 68) = 3.95, p = .024$, case marking, $F_{G-G}(1.68, 57.25) = 12.18, p < .001$, and animacy, $F_{G-G}(1.42, 48.37) = 8.53, p = .002$, but no main effect of word order, $F(1, 34) = 1.75, p = .20$, and no interactions.

We had hypothesized that participants would be reliant on the verb agreement and case marking cues by the third test block due to their high status in the cue dominance hierarchy. However, not all groups were using verb agreement, and interactions between cues in all groups indicated they were still working out the dominance hierarchy. For the no-VIE group, there were significant main effects of case marking, $F_{G-G}(1.55, 55.96) = 8.65, p = .001$, animacy, $F_{G-G}(1.55, 55.99) = 11.90, p < .001$, and word order, $F(1, 36) = 14.46, p = .001$, along with a marginal main effect of verb agreement, $F_{G-G}(1.39, 50.07) = 3.45, p = .056$. In addition, the verb agreement \times case marking interaction was significant, $F_{G-G}(2.88, 103.55) = 4.18, p = .009$. Tests of simple effects showed that participants were able to use verb agreement when case marking was absent or favored the first noun but not when case marking favored the second noun. Viewed from the other perspective, they were able to use case marking when verb agreement was absent ($CM_2 < CM_0$) or when verb agreement favored the first noun ($CM_2 < CM_0 = CM_1$), but there were no differences between the levels of case marking when verb agreement favored the second noun. Thus, they had not fully worked out the hierarchy between these two cues. For the one-color group, there were significant main effects for all four cues: verb agreement, $F_{G-G}(1.44, 48.82) = 4.80, p = .022$, case marking, $F_{G-G}(1.56, 53.18) = 12.26, p < .001$, animacy, $F_{G-G}(1.30, 44.07) = 10.55, p = .001$, and word order, $F(1, 34) = 7.35, p = .01$. There was also a significant

interaction between the verb agreement and case-marking cues, $F_{G-G}(2.90, 98.60) = 3.57, p = .018$. Tests of simple effects showed that this was due to the use of case marking ($CM_2 < CM_1 = CM_0$) when verb agreement was absent or favored the first noun but not when it favored the second noun. Thus again, this group knew verb agreement and case marking were important cues but still struggled with their relative rankings. For the two-color group, there was a significant main effect of case marking, $F_{G-G}(1.29, 43.93) = 23.23, p < .001$, animacy, $F_{G-G}(1.64, 55.60) = 10.29, p < .001$, and word order, $F(1, 34) = 7.40, p = .01$. There was no significant main effect of verb agreement, $F_{G-G}(1.56, 52.94) = 2.06, p = .15$, nor did it participate in any interaction. There was a significant interaction of case marking and animacy, $F(4, 136) = 3.03, p = .02$. Tests of simple effects showed that this was due to use of animacy ($A_2 < A_1 = A_0$) only when case marking was absent. Animacy was not used when case marking was available. Thus, this group had correctly noted that animacy should only be used when the stronger cue of case marking was absent.

Strength of Cue Use

Using the data from the ANOVAs, we calculated eta-squared values, which give the proportion of variance accounted for by each cue. These values give a picture of the strength of relative cue use and provide a way to examine descriptively how cue strength changed over test blocks as well as differences in patterns of cue use across groups (see Figure 4). These values relate directly to the cue(s) that tended to win whenever cues were in conflict and thus are a good reflection of how strongly the different groups used each cue. For example, consider the relative strengths of the cues of case marking and animacy in Block 3. For the no-VIE group, the eta-squared for animacy was slightly higher than that for case marking. When verb agreement was not available and animacy favored the first noun while case marking favored the second (i.e., $VA_0A_1CM_2$), the animate noun was chosen 53% of the time. For the one-color VIE group, the eta-squared for case marking was slightly higher than that for animacy. For the same $VA_0A_1CM_2$ sentence type, the animate noun was chosen 43% of the time (i.e., the noun favored by case marking was chosen 57% of the time). Finally, for the two-color VIE group, the eta-squared for case marking was a great deal higher than that for animacy. For the $VA_0A_1CM_2$ sentence type, the animate noun was chosen only 37% of the time (i.e., the noun favored by case marking was chosen 63% of the time). Examining the eta-squared values thus allowed us to test our predictions about cue weights.

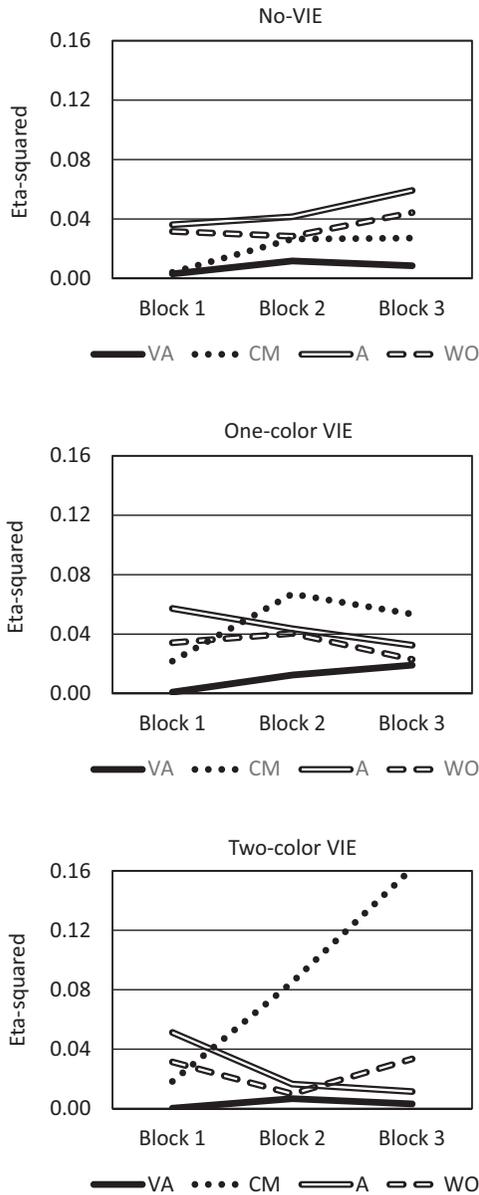


Figure 4 Eta-squared values for each cue in the test trials across blocks in Experiment 1 for each visual input enhancement condition. Cues are ordered in the legend from high to low in the dominance hierarchy for this experiment: verb agreement (VA), case marking (CM), animacy (A), and word order (WO).

We predicted that initial cue acquisition should follow overall validities, but strength of cue use should evolve with learning to reflect the cue dominance hierarchy. Thus, we expected to see initial reliance on word order and animacy cues change over time to reflect the cue dominance hierarchy of verb agreement over case marking over noun animacy over word order. Indeed, in Block 1 the cues of word order and animacy were used most strongly in all three conditions. However, as learning continued, little change occurred in the relative strengths of the cues in the no-VIE group. Even though this group showed significant use of all four cues in Blocks 2 and 3 (although verb agreement was marginal in Block 3, it did participate in a significant interaction), they still relied on word order and animacy as the dominant cues. Thus, they were failing to learn the dominance hierarchy. For the one-color VIE group, an adjustment in cue strengths occurred with learning. Both the cues highest in the dominance hierarchy (verb agreement and case marking) strengthened over time. By Block 3, case marking dominated the other three cues, which were used with approximately equal strength. Thus, this group was following the predicted trends although verb agreement had yet to overtake case marking in strength. In the two-color VIE group, very strong growth of strength of the case-marking cue was observed. However, this might have been to the detriment of the verb-agreement cue, which was not being used at all in the third block. Of the three learning conditions, it appeared that the one-color VIE was the closest to acquiring the cue dominance hierarchy. It remains an open question if, with further learning, this condition would be the first to adjust verb agreement to have the highest cue strength.

Discussion

Participants improved on the actor-assignment task over the course of the experiment as the percent of correct responses increased after the first block. While the different VIE groups did not differ from each other in terms of percent correct responses, the results of the cue-use analyses showed that the groups did indeed employ different cue-use strategies. Early on in learning, all groups were relying on the two cues with the highest overall validities—word order and noun animacy, as predicted by our first hypothesis. This was confirmed by significant main effects of these cues in the ANOVA and by their higher weights as reflected in their eta-squared values. However, both the one-color and two-color VIE groups also showed significant use of the case-marking cue as early as the first block of testing, albeit weighted less heavily than that of word order and case marking. Thus, the contrastive marking on this cue allowed it to be acquired earlier than it was in the no-VIE control group.

However, the other VIE-marked cue, verb agreement, was not acquired until the second block, where it was significantly used in all three learning conditions—thus, the enhancement of this cue did not help participants to acquire it earlier than in the control condition. This is most likely due to verb agreement possessing a higher cue cost than case marking. Previous research has shown that agreement cues may be harder to acquire and use because they involve processing information across a sentence, while case marking is a more local cue (cf. Kail & Charvillat, 1988; Lindner, 2003). Thus, we have evidence that VIE may be more effective for some kinds of cues than others.

With continued exposure, learners adjusted how strongly they relied on the cues. We predicted that the weights of the two cues highest in the dominance hierarchy—verb agreement and case marking—should increase throughout learning, relative to word order and animacy cues, with verb agreement ultimately being the strongest cue. The least adjustment of cue weights in this predicted manner occurred in the no-VIE group. While this group was able to use all four cues later in learning (as all cues showed either significant main effects or participated in a significant interaction in Blocks 2 and 3), participants in this group continued weighting animacy and word order above verb agreement and case marking. The one-color VIE group showed the closest performance to the predicted pattern—they used all four cues in Blocks 2 and 3, and also adjusted the relative weight of the case-marking cue to be above that of animacy and word order. Their use of verb agreement was about equal in weight to these latter two cues in Block 3, showing that they had yet to appropriately weight this cue as the strongest. The two-color VIE group also adjusted the weight of case marking above that of animacy and word order as they learned the language. Additionally, they used each of the four cues at some point across the blocks (i.e., noun animacy and case marking in all blocks, word order in Blocks 1 and 3, and verb agreement in Block 2); however, by the time these participants got to Block 3, they were no longer using the verb-agreement cue and thus were not showing the expected continued upward trend in use of this cue.

It appears that participants in the one-color VIE condition were the most successful in learning the cues of the language and starting to get them in the correctly weighted order. This condition presented both the verb-agreement markers and the accusative case in red. Thus, it was not immediately obvious to participants that there were two different cues or how they functioned independently. Therefore, learners may have continued to use both cues without excluding the other or an amalgamation of them in trying to make sense of the

sentences. The two-color VIE, on the other hand, had these two cues marked in different colors, making it easy to acquire the case-marking cue and perhaps to neglect or even reject the verb-agreement cue as irrelevant.

Thus in Experiment 1, VIE (particularly for the one-color VIE group) proved to be beneficial in acquiring and appropriately weighting the enhanced cue of case marking. However, in this experiment, the VIE-marked cues had low overall validity, which should have biased them toward later acquisition, and were high in the dominance hierarchy, which should have caused them to have higher weights as language exposure increased. In order to test the generalizability of the usefulness of VIE, we conducted Experiment 2 to examine what would happen when a VIE-marked cue had high overall validity but was low in the dominance hierarchy.

Experiment 2

In Experiment 2, the cues of word order and case marking had the highest overall validity, while the cues of animacy and verb agreement were high in the dominance hierarchy. Participants should acquire these former two cues initially but use the latter two more strongly later in learning. VIE continued to be used to mark both case marking and verb agreement. Thus, we were able to test if VIE helped in acquiring a cue with high overall validity sooner than without VIE and, later on in learning, if the VIE-marked case cue might be used more strongly than predicted by its place in the dominance hierarchy due to its salience.

Method

Participants

The data from 91 native English-speaking adults were analyzed in Experiment 2. Initially, 33 participants were assigned to the no-VIE condition, 31 to the one-color VIE condition, and 32 to the two-color VIE condition. Two participants from the no-VIE condition were excluded out of caution because they revealed during the completion of the questionnaires that they had simultaneously acquired another language along with English. Another participant from the no-VIE condition and one participant from the one-color VIE condition were removed due to a failure to complete the experimental tasks. Finally, another participant was excluded from the one-color VIE condition due to experimenter error during data collection. Ultimately, 30 participants in the no-VIE condition, 29 participants in the one-color VIE condition, and 32 participants in the two-color VIE condition were entered into our analyses.

Groups did not differ in age ($M = 19.7$ years, $range = 17-24$, $SD = 1.32$), $F(2, 89) = 0.18, p = .83$. Participants were again largely female, with each group having 5–7 males. All but one of the participants reported classroom exposure to a language other than English, and all but one of these reported exposure to one or more Romance languages (Spanish = 69, French = 28, Latin = 5, Italian = 1). A few participants had had classroom exposure to non-Romance languages (Chinese = 2, German = 2, Arabic = 1, Japanese = 1). Groups did not differ by years of reported classroom exposure ($M = 3.65$ years, $range = 1-13.5$, $SD = 2.20$), $F(2, 85) = 2.40, p = .11$. A few participants reported significant exposure to a language outside of the classroom either through family members or environment (Arabic = 1, French = 1, Gujarati = 1, Polish = 1, Spanish = 1).

Stimuli

By changing the relative frequency with which certain sentences types were seen during the learning trials, we were able to directly exchange the relative overall validities and dominance hierarchy rankings between Experiments 1 and 2 for the three cues of verb agreement, case marking, and animacy. The dominance hierarchy now had animacy as the most dominant cue, followed by verb agreement, case marking, and VSO word order. Overall validity again had the opposite order, with word order being highest, followed by case marking, verb agreement, and animacy.

The relative frequency of the various sentence types during the learning blocks in Experiment 2 is illustrated in brief in Figure 5 and in detail in Appendix S2 in the Supporting Information online. Sentences were constructed in the same way as in Experiment 1. However, these new sentence frequencies required a large number ($N = 144$) of sentences in which the animacy cue would not be available. Because there were only 112 unique ways of combining individual animate or individual inanimate nouns together with our stimulus set, it was necessary to use some noun pairs in the same order in more than one sentence. When this was the case, the repeated noun pairs were combined with a different verb and appeared in different learning blocks. The design and procedure of Experiment 2 were identical to those in Experiment 1.

Results

Correct Responses

Figure 6 shows the percent correct for each group in each block. A series of one-sample t tests revealed that all groups performed significantly above chance (all $ps < .05$) in each block. There was a significant main effect of

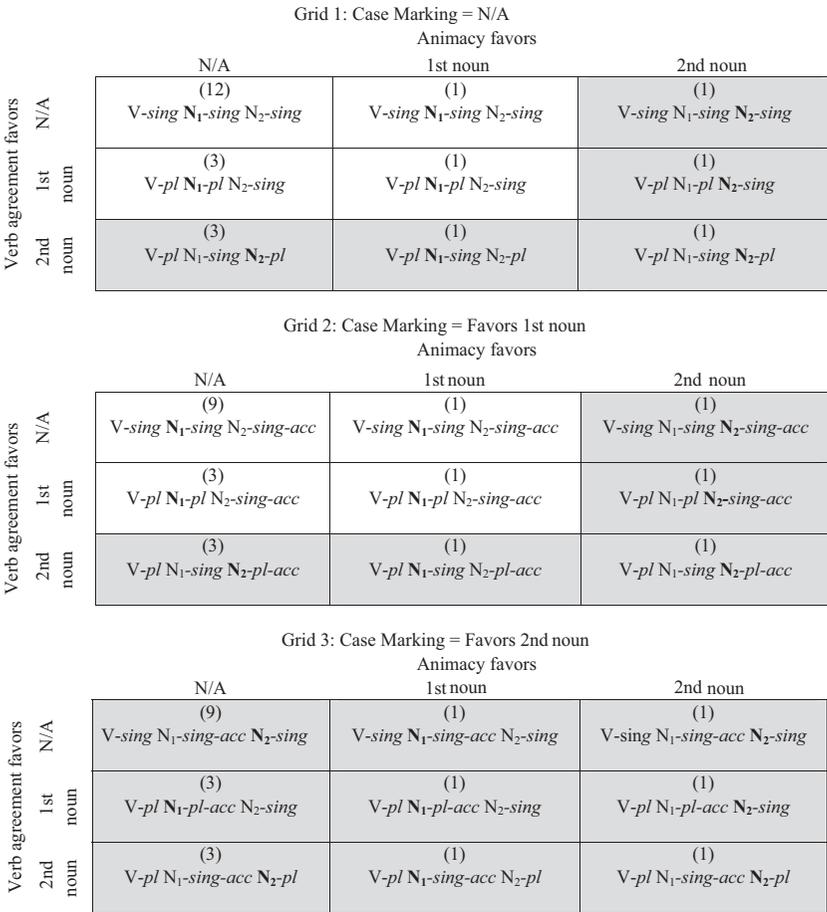


Figure 5 Schematic of the experimental design in Experiment 2, along with the number of times each cue combination was shown within each learning block (in parenthesis). The bolded noun is the correct actor in each context. Shaded cells represent conflict cases. Cues could be: not available (N/A; e.g., for animacy, both nouns of equal animacy); favor the first noun in the sentence as the actor (e.g., for animacy, the first noun was animate and second inanimate); or favor the second noun in the sentence as the actor (e.g., for animacy, the first noun was inanimate and second animate). V = verb, N = noun, sing = singular, pl = plural, acc = accusative.

block, $F_{G-G}(1.73, 152.01) = 4.20, p = .022, \eta_p^2 = .05$. This effect was driven by poorer performance in Block 1 ($M = .60, SD = .12$) than in Blocks 2 or 3 ($M = .62, SD = .11$, and $M = .63, SD = .13$, respectively), although post hoc analyses only approached significance ($p = .09$ for Block 1 vs. Block 2;

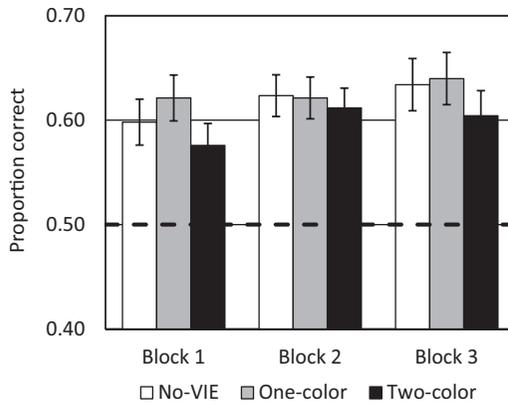


Figure 6 Participants' correct responses as a proportion for the test trials in Experiment 2 using visual input enhancement. Error bars indicate standard error. The dotted line indicates chance performance (50%).

$p = .06$ for Block 1 vs. Block 3). There was no difference between the groups, $F(2, 88) = 0.59, p = .56, \eta_p^2 = .01$.

Use of Cues

Table 2 gives a summary of the results of the ANOVAs. When a cue was significantly used, the results of the Bonferroni corrected post hoc test are provided in the table. We hypothesized again that early on, participants would rely on the two cues highest in overall validity—here, word order and case marking. However, this was only found in two of the conditions (no-VIE and two-color), while all conditions showed an effect of animacy. Specifically, in Block 1, for the no-VIE group, there were significant main effects of word order, $F(1, 29) = 32.67, p < .001$, and case marking, $F_{G-G}(1.62, 46.93) = 5.22, p = .013$. There was also a main effect of animacy, $F_{G-G}(1.37, 39.66) = 13.98, p < .001$, but no main effect of verb agreement, $F(2, 58) = 2.50, p = .09$. Contrary to our predictions, in the one-color VIE group, there were no main effects of word order, $F(1, 28) = 0.18, p = .67$, or case marking, $F_{G-G}(1.45, 40.77) = 2.38, p = .12$. However, there was a main effect of animacy, $F_{G-G}(1.36, 38.15) = 17.30, p < .001$.⁴ There was no main effect of verb agreement, $F(2, 56) = 0.78, p = .46$. For the two-color VIE group, there were main effects of word order, $F(1, 31) = 13.09, p = .001$, and case marking, $F_{G-G}(1.52, 47.23) = 4.54, p = .024$. There was also a main effect of animacy, $F_{G-G}(1.32, 41.03) = 9.29, p = .002$, but no main effect of verb agreement, $F_{G-G}(1.59, 49.18) = 1.02, p = .35$. Thus, even by the first block, all groups showed use of the

Table 2 Summary of the significant effects in the analyses of variance, with post hoc tests for the Experiment 2 test blocks using visual input enhancement (VIE)

No VIE			
Cue	Block 1	Block 2	Block 3
Animacy	$A_2 < A_0 < A_1$ 49% < 64% < 75%	$A_2 < A_0 < A_1$ 38% < 59% < 75%	$A_2 < A_0 < A_1$ 40% < 63% < 74%
Verb agreement	—	—	$VA_2 < VA_0$ 54% < 64%
Case marking	$CM_2 < CM_0$ 56% < 65%	$CM_2 < CM_0 = CM_1$ 48% < 61% = 63%	$CM_2 < CM_0 = CM_1$ 50% < 66% = 61%
Word order	favors N_1 63%	favors N_1 57%	favors N_1 59%
One-color VIE			
Cue	Block 1	Block 2	Block 3
Animacy	$A_2 < A_0 < A_1$ 34% < 53% < 66%	$A_2 < A_0 < A_1$ 34% < 49% < 69%	$A_2 < A_0 < A_1$ 36% < 54% < 72%
Verb agreement	—	—	—
Case marking	—	$CM_2 < CM_0 = CM_1$ 45% < 53% = 54%	—
Word order	—	—	marginal ($p = .066$)
Two-color VIE			
Cue	Block 1	Block 2	Block 3
Animacy	$A_2 = A_0 < A_1$ 52% = 61% < 72%	$A_2 < A_0 < A_1$ 45% < 62% < 75%	$A_2 < A_0 = A_1$ 49% < 63% = 72%
Verb agreement	—	—	—
Case marking	$CM_2 = CM_0 < CM_1$ 54% = 61% < 70%	$CM_2 < CM_0 = CM_1$ 49% < 64% = 70%	$CM_2 < CM_0 = CM_1$ 48% < 67% = 69%
Word order	favors N_1 62%	favors N_1 61%	favors N_1 61%
VA × CM	—	—	significant
A × CM	—	—	significant

Note. Cues in the order of the dominance hierarchy are animacy (A), verb agreement (VA), case marking (CM), and word order (WO). Subscripts denote which noun the cue favored: 0 = not available; 1 = first noun; 2 = second noun. Percentage values indicate the proportion of first noun selection.

cue highest in the dominance hierarchy—animacy. Such early use of a cue with low overall validity but high in the dominance hierarchy was not seen in Experiment 1, suggesting animacy may act differently from morphological cues.

In Block 2, all groups used animacy, along with at least one of the cues high in overall validity. However, no group used the verb-agreement cue. Specifically,

for the no-VIE group, there were significant main effects of animacy, $F_{G-G}(1.39, 40.32) = 19.41, p < .001$, case marking, $F_{G-G}(1.57, 45.56) = 5.96, p = .009$, and word order, $F(1, 29) = 12.28, p = .002$, but no main effect of verb agreement, $F(2, 58) = 1.61, p = .21$. For the one-color group, there were significant main effects of animacy, $F_{G-G}(1.46, 40.79) = 18.89, p < .001$, and case marking, $F(2, 56) = 4.95, p = .01$, but no main effects of verb agreement, $F(2, 56) = 0.18, p = .84$, or word order, $F(1, 28) = .28, p = .60$. For the two-color VIE group, there were main effects of animacy, $F_{G-G}(1.27, 39.32) = 19.58, p < .001$, case marking, $F_{G-G}(1.51, 46.67) = 7.86, p = .003$, and word order, $F(1, 31) = 16.90, p < .001$, but no main effect of verb agreement, $F(2, 62) = 0.45, p = .64$.

In Block 3, while all groups continued to use animacy, only the no-VIE and two-color group showed use of the other cues—either in main effects or interactions. Specifically, for the no-VIE group, there were significant main effects for all four cues: animacy, $F_{G-G}(1.34, 38.77) = 16.73, p < .001$, verb agreement, $F(2, 58) = 6.42, p = .003$, case marking, $F(2, 58) = 8.30, p = .001$, and word order, $F(1, 29) = 15.40, p < .001$. For the one-color VIE group, there was only a main effect of animacy, $F_{G-G}(1.43, 40.14) = 18.89, p < .001$, although the main effect of word order approached significance, $F(1, 28) = 3.65, p = .07$. There were no main effects of verb agreement, $F_{G-G}(1.54, 43.25) = 1.59, p = .22$, or case marking, $F_{G-G}(1.64, 45.87) = 0.79, p = .44$. For the two-color VIE group, there were significant main effects of animacy, $F_{G-G}(1.22, 37.77) = 11.37, p = .001$, case marking, $F_{G-G}(1.27, 39.37) = 10.88, p = .001$, and word order, $F(1, 31) = 20.79, p < .001$. There was no main effect of verb agreement, $F_{G-G}(1.53, 47.52) = 1.75, p = .19$. However, verb agreement entered into an interaction with case marking, $F(4, 124) = 3.41, p = .011$. Tests of simple effects showed that this interaction occurred because verb agreement ($VA_2 < VA_0$) was used only when case marking was not present, indicating verb agreement was being used but was incorrectly placed lower than case marking in this group's dominance hierarchy. In addition, the animacy by case marking interaction was significant, $F(4, 124) = 3.17, p = .016$. Tests of simple effects revealed animacy was not used when case marking was unavailable but was used when case marking favored the first noun ($A_2 < A_0 < A_1$) or second noun ($A_2 < A_0 = A_1$). This is an unusual finding that does not fit with the dominance hierarchy.

Strength of Cue Use

Results of our eta-squared analysis are provided in Figure 7, showing how strength of cue use changed with learning. We had predicted that learners

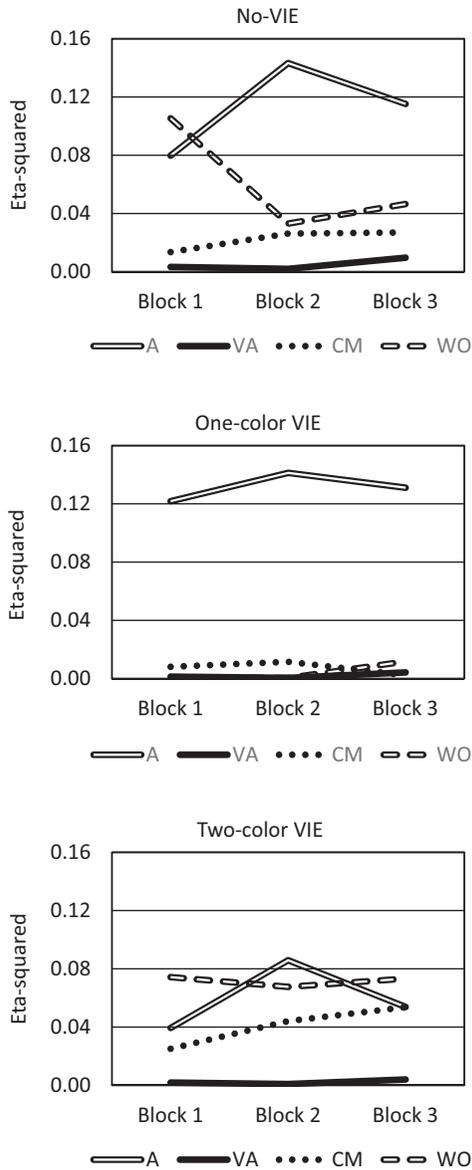


Figure 7 Eta-squared values for each cue in the test trials across blocks in Experiment 2 for each visual input enhancement condition. Cues are ordered in the legend from high to low in the dominance hierarchy for this experiment: animacy (A), verb agreement (VA), case marking (CM), word order (WO).

would start out relying on word order and case marking due to their high overall validity and then shift to animacy and verb agreement because of their high rank in the dominance hierarchy. None of the groups showed this exact pattern of behavior. The no-VIE control group started out using word order most strongly, followed by animacy and then case marking. By the end of the experiment, animacy was being used most strongly, as was appropriate, with word order and case marking coming next and verb agreement last. The one-color VIE group latched on to noun animacy from the first block and continued using this as the dominant cue throughout learning. The two-color VIE showed early strong use of word order as predicted, followed by noun animacy and case marking. However, although noun animacy rose temporarily to be the strongest cue in the second block, this group did not show a successful transition to strongest use of noun animacy and verb agreement by the end of the experiment. Indeed, word order was the strongest cue by the experiment's end, followed by equal use of case marking and noun animacy.

Discussion

As in Experiment 1, all groups in Experiment 2 improved their performance on the actor-assignment task across the test blocks. Interestingly, the correct performance on the test sentences in Experiment 2 was higher than that in Experiment 1, $F(1, 192) = 12.90, p < .001, \eta_p^2 = .06$. This could be due to the use of an animacy (or animacy and word order) strategy that was popular with participants in the initial phases of both experiments (see Figures 4 and 7). Animacy had higher dominance in Experiment 2 than Experiment 1, so this strategy would have yielded more correct answers on the test trials in Experiment 2.

Cues high in overall validity again appeared to be acquired early on. The no-VIE and two-color VIE groups showed significant use of word order and case marking in the first test block. Comparisons of Block 1 performance of the no-VIE condition across Experiments 1 and 2 showed that case marking, which had low overall validity in Experiment 1 and was not significantly used in Block 1, was significantly used during this block in Experiment 2. This provided evidence that the greater overall validity of this cue in Experiment 2 helped participants to acquire it more easily, even in the absence of VIE.

As in Experiment 1, the enhancement of the verb-agreement cue did not lead to earlier acquisition of this cue. Indeed, this cue was first significantly used in test Block 3 as a main effect in the no-VIE group (as well as in an interaction in the two-color VIE group). Visual enhancement of the case-marking cue was not particularly expected to aid its acquisition—given its high overall validity,

all groups were expected to acquire this cue early. As discussed above, two of the three groups did indeed show significant main effects of this cue in Block 1. Of greater interest is how VIE of the case-marking cue affected its strength of use over time. Because this cue was third in the dominance hierarchy, its strength should have decreased with exposure. However, not only did the two-color VIE group continue to use this cue, they continued to increase its weight with exposure across the blocks. On the other hand, the one-color VIE group showed no significant use of this cue by the end of the experiment, indicating VIE here did not cause overuse. The case-marking cue was easily separable from the verb-agreement cue in the two-color condition and not in the one-color condition. This may have played a role in its continued use in the former but not the latter case. However, although at a much lower level, we also saw continued growth in the strength of the case-marking cue in the no-VIE group, so it is not clear how much visual enhancement versus some other factor kept people incorrectly increasing the weight of this cue in the two-color condition.

As learning progressed in the experiment, we expected participants' weighting of the word order and case marking cues to decrease and their weightings of animacy and verb agreement to increase. However, all groups caught on to the animacy cue very early on in the experiment. It is possible that animacy occupies a special role in processing a new language (Clahsen & Felser, 2006; Gass, 1987; Sasaki, 1991). However, it is also possible that animacy was readily interpretable from the beginning because it could be applied appropriately with participants' preexisting semantic knowledge, while acquisition of the morphological cues involved participants learning novel grammatical forms before they could even begin to use them in interpretation strategies (see Ellis, 2006, for a similar argument about lexical cues overshadowing grammatical cues).

While noun animacy was the cue highest in the dominance hierarchy and thus never wrong when present, it was only present in 18 of the 66 sentences in the learning block. It is therefore somewhat puzzling that the one-color VIE group showed so little reliance on any of the other three cues available to aid in interpretation, given that they inevitably were shown many trials in which the animacy cue could not be used. One possibility is that the visual highlighting of the case-marking and verb-agreement cues drew attention to these cues in situations in which they were not valid. For example, if participants were using a strategy involving the case-marking cue during the learning block, eventually they encountered a sentence where case marking was wrong while animacy was correct. This may have caused participants to outright reject the use of case marking rather than just attempting to refine their understanding of situations where it applied. Thus, the early acquisition of the animacy cue may have

hampered the acquisition of the visually enhanced morphological cues in a context where animacy was already high in the dominance hierarchy. We did not see this same pattern in the two-color VIE group, but this group also did not start the experiment with the same overwhelming dominance of the animacy cue.

In summary, no group followed exactly the predicted pattern of acquisition and performance in Experiment 2. The one-color VIE showed a particularly poor strategy, basically acquiring the cue highest in the dominance hierarchy very early and then sticking largely with this single cue, resulting in poor performance when this cue was not available. The no-VIE and two-color VIE groups showed evidence of using all the cues by the end of the experiment, but neither had succeeded in getting the correct ordering of cue strength, although the no-VIE group did make the strongest use of the cue highest in the dominance hierarchy. Thus, there was no evidence for benefits to learning from VIE in Experiment 2.

General Discussion

We had hypothesized that early in acquisition, cue use would be driven by overall validity. Examining the performance of the no-VIE group showed us that the two cues highest in overall validity were acquired by Block 1 in both Experiment 1 (word order and animacy) and Experiment 2 (word order and case marking, although animacy was acquired here as well). We had also hypothesized that later in acquisition, cue use would be determined by the dominance hierarchy. Again, examining the performance of the no-VIE condition showed us that, while there was movement in this direction, this group did not succeed in ordering the cues correctly in strength by the end of the experiment. While the two cues highest in the dominance hierarchy were significantly used by Block 3 in both Experiment 1 (verb agreement—significant in an interaction and marginally significant as a main effect—and case marking) and Experiment 2 (animacy and verb agreement), participants failed to weight them appropriately. Verb agreement in particular generally had a lower weight than its place in the hierarchy would dictate. These results partially replicated those of McDonald and MacWhinney (1991) who found (using abstract stimuli) that learners indeed started out using cues high in overall validity and gradually shifted with exposure to weighting those high in the dominance hierarchy more highly. McDonald and MacWhinney used more learning and test blocks than the current experiment, so perhaps with increased exposure the no-VIE group would have continued to shift cue weights until the one highest in the dominance hierarchy was weighted most heavily. We should also point out that

research on L2 acquisition and the Competition Model has sometimes found that beginning L2 learners bring the cue weights from the L1 to the learning situation rather than starting from a blank slate (Heilenman & McDonald, 1993; McDonald, 1987b; McDonald & Heilenman, 1991; Morett & MacWhinney, 2013). We found little evidence for that here, that is, the predominant strategy for native English speakers on VNN sentences is to interpret them as VOS. However, even by the first test block learners showed no evidence of using this strategy—preferring a VSO strategy along with use of other cues.

We had also predicted that the addition of VIE would aid in the acquisition of the enhanced cues, specifically those which had low overall validity and thus would not be easy to acquire initially. We found support for this prediction in Experiment 1, where the cue of case marking was acquired earlier in both VIE conditions relative to the no-VIE condition. In addition, this cue was correctly weighted higher than the animacy and word-order cues by the end of Experiment 1, but this was only in the one- and two-color VIE conditions, showing that the enhancement effectively aided in correctly placing a higher weight on this cue. We did not find that verb agreement benefited from its marked status in the VIE conditions in either Experiment 1 or Experiment 2. Finally, we had also speculated that visually enhanced cues that had high overall validity but that were relatively low in the dominance hierarchy might be used more strongly than warranted. We examined this in Experiment 2, where case marking had high overall validity but was third in the dominance hierarchy. Visual enhancement of this cue acted differently in the one- and two-color groups. In the one-color group, enhancement seemed to suppress the use of this cue—perhaps because participants noticed it was wrong when it contradicted the strongly used noun-animacy cue. In the two-color group, enhancement did seem to increase the use of this cue over time but led to perpetuated reliance on this cue.

It is interesting that the one- and two-color VIE conditions had different effects in both experiments. Previous work by Simard (2009) had shown that marking the same linguistic feature with three enhancements aided acquisition, but adding two more enhancements to those three was not successful in aiding acquisition beyond that also shown by the control group. This raises the possibility that, if the enhanced input becomes too extreme, learners may feel overloaded. In our experiment the two colors in the two-color VIE condition marked different linguistic features rather than the same one. It was thought that this would serve to make clear that there were two distinct cues to be learned. However, it may also have served to make the input more complicated, thus overwhelming the learner. More work is needed to examine the effectiveness

of VIE for marking multiple cues in the same sentences and whether different types of VIE (e.g., one cue in color, the other in bold) might help or hinder acquisition.

We devised our artificial language and the study procedure to minimize the need for a lengthy vocabulary acquisition process. In particular, the nouns were designated by three-letter strings that resembled English forms phonetically, and participants had a brief training on the vocabulary items before sentence exposure began. However, we did not explicitly test vocabulary acquisition at any point in the experiment, so it is not clear how well participants had mastered the vocabulary. Thus, we do not know if the level of vocabulary mastery affected performance in the actor-assignment task. However, because all participants in each VIE group had equivalent vocabulary training, this should not have differentially affected the conditions.

Two patterns in the data warrant further comment—the difficulty of acquiring the verb-agreement cue and the ease of acquiring the noun-animacy cue. Specifically, the morphological cue of subject–verb agreement seemed consistently harder to acquire and appropriately weight than the morphological cue of case marking. This could be due to several factors. First, in our experiment the case-marking particle, when present, was always after the agreement markers on the noun—thus, it was in the more salient word-ending position and may have been easier to notice. Second, verb agreement involved integrating markers on both the verb and the nouns and was thus a more topological or global cue, while the case-marking particle only involved information on the noun and was thus a more local cue (Kail, 1989). Several studies have found that case marking may be easier to acquire than verb agreement for native speaking children of German (Lindner, 2003) and Spanish (Kail & Charvillat, 1988) as well as for L2 learners (Clahsen, Felser, Neubauer, Sato, & Silva, 2010). Indeed, subject–verb agreement is vulnerable to memory load for native speaking adults (McDonald, 2008), particularly those with low working-memory capacity (Hartsuiker & Barkhuysen, 2006), indicating that it may put more demands on working memory. Thus, cue cost may be playing a role in the late acquisition of verb agreement. However, we must exercise caution in generalizing to all languages, as case marking and verb agreement differ in their overall validity and dominance hierarchy across languages, and these factors should also be important in determining relative ease of acquisition and strength of the verb-agreement cue.

Animacy proved to be a cue that was easy to acquire in both Experiment 1, where it had high overall validity, and in Experiment 2, where it was high in the dominance hierarchy. Thus, it appears that this cue is generally easy to acquire

and use. Because participants will already know that animate nouns are more likely to be actors than inanimate nouns prior to an experiment, this cue will be immediately available for them to use. The form of the morphological cues, however, must first be learned through exposure to the language. Indeed, others have found that the availability of a cue that can be easily used may block the acquisition of grammatical markers for L2 learners (Cintrón-Valentín & Ellis, 2015; Ellis, 2006; Ellis & Sagarra, 2010). In addition, some researchers have proposed that semantic cues, such as noun animacy, hold a particular status for L2 learners (Clahsen & Felser, 2006). These researchers note that L2 learners seem to have weak or totally lacking representation of L2 morphosyntactic cues, while still being able to use semantic information. Other studies have found that it is easier for a learner of a word order–dominated language to learn to use animacy appropriately in an animacy-dominated L2 than it is for a learner of an animacy-dominated language to learn to use word order in a word order–dominated L2 (Gass, 1987; Sasaki, 1991). However, several studies have found that L2 learners do not necessarily start out with animacy as a default cue early on in acquisition (McDonald, 1987b; Su, 2001), and others have shown that advanced adult L2 learners are able to successfully move to using morphological cues more strongly than animacy cues in languages where that is appropriate (McDonald, 1987b; McDonald & Heilenman, 1991). Indeed, we saw this tendency to use the morphological cue of case marking more strongly than animacy in both VIE groups in Experiment 1. Thus, while animacy does seem to be a quickly acquired and easily used cue, its presence does not necessarily universally prevent the acquisition of other types of cues.

Conclusion

Previous research on the effectiveness of VIE has yielded contradictory results, with some studies showing a benefit of VIE in the acquisition of grammatical markings while others have found no effect. Some researchers have posited that the reasons for these different findings might be due to such factors as the way in which VIE was actualized (LaBrozzi, 2016; Simard, 2009) or to differences among linguistics structures (i.e., Leow et al., 2003). Our findings showed that not only did the particular structure of a linguistic cue play a role, but that the effects of VIE were also mediated by the validity statistics of cues in a language, as outlined by the Competition Model.

To the best of our knowledge, this study was the first to apply VIE to multiple cues in the same sentence simultaneously. Additionally, this study contributes to the existing VIE literature through our analysis of how VIE not only affected acquisition but also cue use throughout learning. Ultimately, our two

experiments suggested that the ability of VIE to impact the language-acquisition process is nuanced. Experiment 1 showed that VIE, and specifically one-color VIE, could be effective in promoting early acquisition and correct weighting of a morphological cue low in overall validity but high in the dominance hierarchy. However, this was not universal, as it worked for case marking but not verb agreement. Experiment 2 showed that VIE was not beneficial for the acquisition and correct weighting of a morphological cue high in overall validity but low in the dominance hierarchy. Thus, depending on the characteristics of a given language, the effectiveness of VIE may be limited.

Instructors looking to use VIE in the classroom would need to exercise caution, as students may only benefit from VIE in specific situations. The present study suggests that VIE would be most helpful when students demonstrate a failure to grasp simple, infrequently occurring, but highly dominant grammatical cues. In such a scenario, VIE may serve to draw students' attention toward these cues, helping them to learn and correctly use them. However, if these cues are not highly dominant, students may emphasize them over more important cues, potentially hindering acquisition. Furthermore, if the structure is too complex or resource demanding, and/or if the way VIE itself is realized (e.g., having to deal with two colors) causes an undue burden during processing, then other pedagogical techniques may prove more effective because VIE appears limited in its ability to facilitate the acquisition of such structures in the absence of further instruction.

Final revised version accepted 30 May 2017

Notes

- 1 However, there may be more to these results. Although the groups did not differ statistically on a pretest, some groups appeared to have made larger gains (colored, three-cue combination, all capitals, italics) than others (control, bolded, underlined, five-cue combination) pretest to posttest, but whether these differences were significant was not reported.
- 2 For this cue, appropriate use was determined solely on whether or not the verb-noun suffixes matched as described. Typically, in real languages, verb agreement reflects the numeric or gender properties of the associated nouns, but no such explicit meaning regarding these properties was provided in this experiment. For communicative purposes, we translate the verb-agreement cues as indicating singular *-na/-ji* or plural *-ye/-gu* in the English glosses given throughout this article. However, these markers could just as easily reflect some other property, such as grammatical gender (e.g., masculine *-na/-ji* or feminine *-ye/-gu*). In either case, agreement is required between markers on two different sentence elements.

- 3 Although not reported here, in general, the analyses of performance in the learning blocks showed trends similar to those in the test blocks.
- 4 In the first learning block, the one-color VIE did show significant use of word order and case marking in addition to a strong effect of animacy. Thus, there was some evidence that early on even this group was using the cues highest in overall validity.

References

- Alanen, R. (1995). Input enhancement and rule presentation in second language acquisition. In R. P. Schmidt (Ed.), *Attention and awareness in foreign language learning* (pp. 259–302). Honolulu: Second Language Teaching & Curriculum Center, University of Hawai'i at Mānoa.
- Alsadhan, R. O. (2011). *Effects of textual enhancement and explicit rule presentation on the noticing and acquisition of L2 grammatical structures: A meta-analysis*. Unpublished doctoral dissertation, Colorado State University, Fort Collins, CO.
- Bates, E., & MacWhinney, B. (1981). Second-language acquisition from a functionalist perspective: Pragmatic, semantic, and perceptual strategies. *Annals of the New York Academy of Sciences*, 379, 190–214. <https://doi.org/10.1111/j.1749-6632.1981.tb42009.x>
- Bates, E., & MacWhinney, B. (1989). Functionalism and the competition model. In B. MacWhinney & E. Bates (Eds.), *The crosslinguistic study of sentence processing* (pp. 1–73). New York: Cambridge University Press.
- Bates, E., MacWhinney, B., Caselli, C., Devescovi, A., Natale, F., & Venza, V. (1984). A cross-linguistic study of the development of sentence interpretation strategies. *Child Development*, 55, 341–354. <https://doi.org/10.2307/1129947>
- Bornkessel-Schlesewsky, I., & Schlewsky, M. (2009). The role of prominence information in the real-time comprehension of transitive constructions: A cross-linguistic approach. *Language and Linguistics Compass*, 3, 19–58. <https://doi.org/10.1111/j.1749-818X.2008.00099.x>
- Cintrón-Valentín, M., & Ellis, N. C. (2015). Exploring the interface: Explicit focus-on-form instruction and learned attentional biases in L2 Latin. *Studies in Second Language Acquisition*, 37, 197–235. <https://doi.org/10.1017/S0272263115000029>
- Clahsen, H., & Felser, C. (2006). Grammatical processing in language learners. *Applied Psycholinguistics*, 27, 3–42. <https://doi.org/10.1017/S0142716406060024>
- Clahsen, H., Felser, C., Neubauer, K., Sato, M., & Silva, R. (2010). Morphological structure in native and nonnative language processing. *Language Learning*, 60, 21–43. <https://doi.org/10.1111/j.1467-9922.2009.00550.x>
- Devescovi, A., D'Amico, S., & Gentile, P. (1999). The development of sentence comprehension in Italian: A reaction time study. *First Language*, 19, 129–163. <https://doi.org/10.1177/014272379901905601>

- Ellis, N. C. (2006). Selective attention and transfer phenomena in L2 acquisition: Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics*, 27, 164–194. <https://doi.org/10.1093/applin/aml015>
- Ellis, N. C., & Sagarra, N. (2010). Learned attention effects in L2 temporal reference: The first hour and the next eight semesters. *Language Learning*, 60, 85–108. <https://doi.org/10.1111/j.1467-9922.2010.00602.x>
- Gass, S. M. (1987). The resolution of conflicts among competing systems: A bidirectional perspective. *Applied Psycholinguistics*, 8, 329–350. <https://doi.org/10.1017/S0142716400000369>
- Han, Z., Park, E. S., & Combs, C. (2008). Textual enhancement of input: Issues and possibilities. *Applied Linguistics*, 29, 597–618. <https://doi.org/10.1093/applin/amn010>
- Hartsuiker, R. J., & Barkhuysen, P. N. (2006). Language production and working memory: The case of subject–verb agreement. *Language and Cognitive Processes*, 21, 181–204. <https://doi.org/10.1080/01690960400002117>
- Heilenman, L. K., & McDonald, J. L. (1993). Processing strategies in L2 learners of French: The role of transfer. *Language Learning*, 43, 507–557. <https://doi.org/10.1111/j.1467-1770.1993.tb00626.x>
- Hernandez, A. E., Bates, E. A., & Avila, L. X. (1994). On-line sentence interpretation in Spanish-English bilinguals: What does it mean to be “in between”? *Applied Psycholinguistics*, 15, 417–446. <https://doi.org/10.1017/S014271640000686X>
- Izumi, S. (2002). Output, input enhancement, and the noticing hypothesis. *Studies in Second Language Acquisition*, 24, 541–577. <https://doi.org/10.1017/S0272263102004023>
- Jourdenais, R. M. (1998). *The effects of textual enhancement on the acquisition of the Spanish preterit and imperfect*. Unpublished doctoral dissertation, Georgetown University, Washington, DC.
- Jourdenais, R., Ota, M., Stauffer, S., Boyson, B., & Doughty, C. (1995). Does textual enhancement promote noticing? A think-aloud protocol analysis. In R. P. Schmidt (Ed.), *Attention and awareness in foreign language learning* (pp. 183–216). Honolulu: Second Language Teaching & Curriculum Center, University of Hawai'i at Mānoa.
- Kail, M. (1989). Cue validity, cue cost, and processing types in sentence comprehension in French and Spanish. In B. MacWhinney & E. Bates (Eds.), *The crosslinguistic study of sentence processing* (pp. 77–117). New York: Cambridge University Press.
- Kail, M., & Charvillat, A. (1988). Local and topological processing in sentence comprehension by French and Spanish children. *Journal of Child Language*, 15, 637–662. <https://doi.org/10.1017/S0305000900012605>
- Kubota, S. (2000). *Input enhancement in classroom second language acquisition of Japanese*. Unpublished doctoral dissertation, Purdue University, West Lafayette, IN.

- LaBrozzi, R. M. (2016). The effects of textual enhancement type on L2 form recognition and reading comprehension in Spanish. *Language Teaching Research*, 20, 75–91. <https://doi.org/10.1177/1362168814561903>
- Lee, S. (2007). Effects of textual enhancement and topic familiarity on Korean EFL students' reading comprehension and learning of passive form. *Language Learning*, 57, 87–118. <https://doi.org/10.1111/j.1467-9922.2007.00400.x>
- Lee, S. K., & Huang, H. T. (2008). Visual input enhancement and grammar learning: A meta-analytic review. *Studies in Second Language Acquisition*, 30, 307–331. <https://doi.org/10.1017/S0272263108080479>
- Leeman, J., Arteagoitia, I., Fridman, B., & Doughty, C. (1995). Integrating attention to form with meaning: Focus on form in content-based Spanish instruction. In R. P. Schmidt (Ed.), *Attention and awareness in foreign language learning* (pp. 217–258). Honolulu: Second Language Teaching & Curriculum Center, University of Hawai'i at Mānoa.
- Leow, R. P. (2001). Do learners notice enhanced forms while interacting with the L2? An online and offline study of the role of written input enhancement in L2 reading. *Hispania*, 84, 496–509. <https://doi.org/10.2307/3657810>
- Leow, R. P., Egi, T., Nuevo, A. M., & Tsai, Y. (2003). The roles of textual enhancement and type of linguistic item in adult L2 learners' comprehension and intake. *Applied Language Learning*, 13, 93–108.
- Li, P., Bates, E., & MacWhinney, B. (1993). Processing a language without inflections: A reaction time study of sentence interpretation in Chinese. *Journal of Memory and Language*, 32, 169–192. <https://doi.org/10.1006/jmla.1993.1010>
- Lindner, K. (2003). The development of sentence-interpretation strategies in monolingual German-learning children with and without specific language impairment. *Linguistics*, 41, 213–254. <https://doi.org/10.1515/ling.2003.008>
- Liu, H., Bates, E., & Li, P. (1992). Sentence interpretation in bilingual speakers of English and Chinese. *Applied Psycholinguistics*, 13, 451–484. <https://doi.org/10.1017/S0142716400005762>
- Loewen, S., & Inceoglu, S. (2016). The effectiveness of visual input enhancement on the noticing and L2 development of Spanish past tense. *Studies in Second Language Learning*, 6, 89–110. <https://doi.org/10.14746/ssl.2016.6.1.5>
- Lyddon, P. A. (2011). The efficacy of corrective feedback and textual enhancement in promoting the acquisition of grammatical redundancies. *The Modern Language Journal*, 95, 104–129. <https://doi.org/10.1111/j.1540-4781.2011.01272.x>
- MacWhinney, B. (1997). Second language acquisition and the Competition Model. In A. B. de Groot, J. F. Kroll, A. B. de Groot, & J. F. Kroll (Eds.), *Tutorials in bilingualism: Psycholinguistic perspectives* (pp. 113–142). Mahwah, NJ: Lawrence Erlbaum.
- MacWhinney, B. (2005). A unified model of language acquisition. In J. F. Kroll & A. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 49–67). New York: Oxford University Press.

- MacWhinney, B. (2012). The logic of the Unified Model. In S. Gass & A. Mackey (Eds.), *The Routledge handbook of second language acquisition* (pp. 211–227). New York: Routledge.
- MacWhinney, B., Bates, E., & Kliegl, R. (1984). Cue validity and sentence interpretation in English, German, and Italian. *Journal of Verbal Learning and Verbal Behavior*, 23, 127–150. [https://doi.org/10.1016/S0022-5371\(84\)90093-8](https://doi.org/10.1016/S0022-5371(84)90093-8)
- MacWhinney, B., Pléh, C., & Bates, E. (1985). The development of sentence interpretation in Hungarian. *Cognitive Psychology*, 17, 178–209. [https://doi.org/10.1016/0010-0285\(85\)90007-6](https://doi.org/10.1016/0010-0285(85)90007-6)
- McDonald, J. L. (1986). The development of sentence comprehension strategies in English and Dutch. *Journal of Experimental Child Psychology*, 41, 317–335. <https://doi.org/10.1016/0022-0>
- McDonald, J. L. (1987a). Assigning linguistic roles: The influence of conflicting cues. *Journal of Memory and Language*, 26, 100–117. [https://doi.org/10.1016/0749-596X\(87\)90065-9](https://doi.org/10.1016/0749-596X(87)90065-9)
- McDonald, J. L. (1987b). Sentence interpretation in bilingual speakers of English and Dutch. *Applied Psycholinguistics*, 8, 379–413. <https://doi.org/10.1017/S014271640000382>
- McDonald, J. L. (2008). Differences in the cognitive demands of word order, plural, and subject-verb agreement constructions. *Psychonomic Bulletin & Review*, 15, 980–984. <https://doi.org/10.3758/PBR.15.5.980>
- McDonald, J. L., & Heilenman, L. K. (1991). Determinants of cue strength in adult first and second language speakers of French. *Applied Psycholinguistics*, 12, 313–348. <https://doi.org/10.1017/S0142716400009255>
- McDonald, J. L., & MacWhinney, B. (1991). Levels of learning: A comparison of concept formation and language acquisition. *Journal of Memory and Language*, 30, 407–430. [https://doi.org/10.1016/0749-596X\(91\)90014-B](https://doi.org/10.1016/0749-596X(91)90014-B)
- Morett, L. M., & MacWhinney, B. (2013). Syntactic transfer in English-speaking Spanish learners. *Bilingualism: Language and Cognition*, 16, 132–151. <https://doi.org/10.1017/S1366728912000107>
- Oetting, J. B., & McDonald, J. L. (2001). Nonmainstream dialect use and specific language impairment. *Journal of Speech, Language, and Hearing Research*, 44, 207–223. [https://doi.org/10.1044/1092-4388\(2001/018\)](https://doi.org/10.1044/1092-4388(2001/018))
- Park, H., Choi, S., & Lee, M. (2012). Visual input enhancement, attention, grammar learning, and reading comprehension: An eye movement study. *English Teaching*, 67, 241–265. <https://doi.org/10.15858/engtea.67.4.201212.241>
- Park, E. S., & Nassif, L. (2014). Textual enhancement of two L2 Arabic forms: A classroom-based study. *Language Awareness*, 23, 334–352. <https://doi.org/10.1080/09658416.2013.808645>
- Robinson, P. (1995). Attention, memory, and the “noticing” hypothesis. *Language Learning*, 45, 283–331. <https://doi.org/10.1111/j.1467-1770.1995.tb00441.x>

- Sasaki, Y. (1991). English and Japanese interlanguage comprehension strategies: An analysis based on the competition model. *Applied Psycholinguistics*, *12*, 47–73. <https://doi.org/10.1017/S0142716400009371>
- Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics*, *11*, 129–158. <https://doi.org/10.1093/applin/11.2.129>
- Schmidt, R. (1992). Awareness and second language acquisition. *Annual Review of Applied Linguistics*, *13*, 206–226. <https://doi.org/10.1017/S0267190500002476>
- Schmidt, R. (2001). Attention. In P. Robinson, M. Long, & J. Richards (Eds.), *Cognition and second language instruction* (pp. 3–32). Cambridge, UK: Cambridge University Press. <https://doi.org/10.1017/CBO9781139524780.003>
- Simard, D. (2009). Differential effects of textual enhancement format on intake. *System*, *37*, 124–135. <https://doi.org/10.1016/j.system.2008.06.005>
- Sokolov, J. L. (1989). The development of role assignment in Hebrew. In B. MacWhinney & E. Bates (Eds.), *The crosslinguistic study of sentence processing* (pp. 118–157). Cambridge, UK: Cambridge University Press.
- Su, I. (2001). Transfer of sentence processing strategies: A comparison of L2 learners of Chinese and English. *Applied Psycholinguistics*, *22*, 83–112. <https://doi.org/10.1017/S0142716401001059>
- Su, I. (2004). The effects of discourse processing with regard to syntactic and semantic cues: A competition model study. *Applied Psycholinguistics*, *25*, 587–601. <https://doi.org/10.1017/S0142716404001286>
- Szekely, A., Jacobsen, T., D'Amico, S., Devescovi, A., Andonova, E., Herron, D., et al. (2004). A new on-line resource for psycholinguistic studies. *Journal of Memory and Language*, *51*, 247–250. <https://doi.org/10.1016/j.jml.2004.03.002>
- Tolentino, L. C., & Tokowicz, N. (2014). Cross-language similarity modulates effectiveness of second language grammar instruction. *Language Learning*, *64*, 279–309. <https://doi.org/10.1111/lang.12048>
- Tomlin, R. S., & Villa, V. (1994). Attention in cognitive science and second language acquisition. *Studies in Second Language Acquisition*, *16*, 183–203. <https://doi.org/10.1017/S0272263100012870>
- Tortora, C., & den Dikken, M. (2010). Subject agreement variation: Support for the configurational approach. *Lingua*, *120*, 1089–1108. <https://doi.org/10.1016/j.lingua.2009.04.004>
- Winke, P. M. (2013). The effects of input enhancement on grammar learning and comprehension: A modified replication of Lee (2007) with eye-movement data. *Studies in Second Language Acquisition*, *35*, 323–352. <https://doi.org/10.1017/S0272263112000903>
- Wong, W. (2003). Textual enhancement and simplified input effects on L2 comprehension and acquisition of non-meaningful grammatical form. *Applied Language Learning*, *13*, 109–132.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1. Sentence Types Used in Experiment 1.

Appendix S2. Sentence Types Used in Experiment 2.