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The Role of Salience in Second Language Acquisition

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THE ROLE OF SALIENCE IN SECOND LANGUAGE ACQUISITION

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TABLE OF CONTENTS

ABSTRACT

Cues to the actor role such as word order, noun animacy, case inflection and verb agreement vary in strength across languages. The competition model (CM; MacWhinney, 2005) suggests that adult L2 acquisition is difficult due to differences in cue strength between the native and target languages. Using a paradigm inspired by the CM, the present study examines whether salience plays a role in facilitating adjustments of cue strength during L2 learning. Native English speakers were exposed to an artificial language (via an actor-assignment task) which utilized four different cues: verb agreement, case marking, animacy, and word order. Word order, the strongest English cue, was the weakest relative to the other cues, requiring a shift in cue interpretation strategies. Salience was manipulated through the use of visual input enhancement (VIE). The two available morphological cues were presented with 1) no color contrast, 2) both marked with the same color contrast, or 3) each marked with a different color contrast. In Experiment 1, the cue hierarchy was dominated by the morphological cues (verb agreement > case marking > animacy > word order). It was found that VIE was effective in facilitating participant reliance upon the relevant cues, particularly so for the case marking cue. However, in Experiment 2, the cue hierarchy was rearranged so that a semantic cue was most the dominant (animacy > verb agreement > case marking > word order). With this hierarchy rearrangement, we failed to observe any benefit of VIE; participants continuously relied up the animacy cue. We conclude that VIE is a potentially effective tool for helping language learners adapt to the strength of cues in their target language. However, the efficacy of VIE seems limited 1) situations where it marks cues that are very high in the dominance hierarchy, and 2) to cues with low cognitive cost.

CHAPTER 1 - INTRODUCTION

The difficulty experienced by adults in attempting to learn a second language (L2) is well known both within the field of psycholinguistics and to the general public. Specifying a single cause that can account for adults' ability (or lack thereof) to acquire a second language is difficult, as many factors have been found to correlate with second language acquisition (Flege, Komshian, & Liu, 1999). Nevertheless, there have been several proposed causes to account for this difficulty. These proposals range from natural biological changes in the brain that coincide with maturation (for example, the well-known *critical period hypothesis* (Lenneberg, 1967)) to differences in cognitive capacity between children and adults (such as the *less-is-more hypothesis*; Newport, 1990).

The present study is based upon the *competition model* (CM; MacWhinney, 2005a), which focuses on the role of cues within a language and how these cues guide interpretation. A more in-depth discussion of the CM and these language cues follows.

The Competition Model

The CM (MacWhinney, 2005a) is an *emergentist* theory of language acquisition. The emergentist approach holds that a particular phenomenon is not the result of any one specific factor, but rather is a product of multiple factors interacting with one another (MacWhinney, 2005b). The CM attributes the difficulty in adult L2 learning as a result of *transfer* effects. Late L2 learners approach their new language with well-established knowledge from their L1. In many cases, L1 knowledge is either not applicable or must be applied differently in the L2. When the application of knowledge from L1 leads to difficulty or deficits in L2 performance, *negative transfer* is said to have occurred. *Positive transfer* is also possible in situations where L1 information is relevant and facilitates performance in the L2. Tolentino and Tokowicz (2014) provide examples of transfer for English speakers learning Spanish: In English, adjectives are placed before the noun that they are describing while in Spanish they are placed after the noun. English speakers beginning to learn Spanish may find difficulty in placing the adjectives appropriately in their new language (*negative transfer*). Conversely, an English speaker attempting to learn Spanish should encounter little difficulty in remembering to add "-s" to plural nouns, as the rules for making plural nouns are very similar across the two languages (*positive transfer).*

The CM originally was proposed as a theory of sentence processing that focused on how the available cues in a language are utilized during sentence interpretation (Bates & MacWhinney, 1989). These *cues* refer to various features within a language, as well as their meanings and relationships to one another. Examples of these cues

include *verb agreement*, *animacy*, *case marking*, and *word order* (these cues will be described in greater detail later). According to the CM, successful language acquisition depends upon the ability of speakers to choose the appropriate "victor" out of all available cues in order to determine the correct interpretation of statements. In the laboratory, speakers' cue interpretation strategies have traditionally been examined using the *actor-assignment task.* In this task, participants are given a sentence consisting of a transitive verb and two nouns. Participants are asked to choose which of the two nouns fulfills the semantic role of *actor* (the noun that performs the action in the sentence). For example, participants may see a sentence such as:

*The rocks eats the zebra.

Participants then choose between either *the rocks* or *the zebra* as the actor of the sentence. To speakers of English, which possess a subject-verb-object word order, the *word order* cue favors the noun phrase *the rocks.* However, the cue of *verb agreement* favors *the zebra*, as English grammar dictates that the *–s* suffix on the verb *eat* requires a third-person singular noun. The cue of *animacy* also favors *the zebra*, as it is more likely for a living creature to instigate an action than it is for an inanimate object to do so. Thus, in this example, we see a case in which there are conflicting cues. English speakers, when confronted with such conflict, tend to utilize the cue of word order over others, and interpret the pre-verbal noun as being the actor and the post-verbal noun as being the object (i.e. *the rocks*) (MacWhinney, Bates, & Kliegl, 1984; MacWhinney, 2005a). This indicates that word order is a stronger cue than either verb agreement or animacy for native English speakers. By analyzing participants' pattern of responses, particularly to sentences that possess various configurations of conflicting cues (such as above), the intrinsic cue hierarchies of a given language can be understood.

The strength (or *validity*) of a cue determines its place within the hierarchy. *Validity* for a cue is determined both by its *accessibility*, or how often it appears in the language, and its *reliability*, or how often a particular cue, when present, leads to understanding of the intended meaning (MacWhinney, 1987). Validity can be classified further into *overall validity* and *conflict validity*. Overall validity is determined by multiplying reliability and accessibility for all instances of a cue and tends to be predictive of the order in which cues are initially acquired by L1 learners (Bates, MacWhinney, Caselli, Devescovi, Natale, & Venza, 1984). Conflict validity is determined by multiplying reliability by accessibility only for instances in which a particular cue is in conflict with another and is, by definition, a better predictor of adult comprehension (McDonald, 1986; 1987). Furthermore, McDonald (1987) shows that as English-Dutch bilinguals spend more time immersed in their L2 environment, their sentence

interpretation strategies shift to mimic those of native speakers. Although speakers may only be aware of these relationships between cues implicitly, this research suggests that L2 mastery and achieving more native-like usage is linked to conflict validity.

There are many such cues that can be found throughout the world's languages. Various CM studies have looked at word order, case marking, verb agreement, animacy, pronominalization and topicalization as viable cues across languages (MacWhinney, 2005a). Of particular interest to the present study are the cues of *word order*, *case marking*, *verb agreement*, and *animacy*. We will now discuss each of these cues in more detail.

Word Order. The *word order* cue involves interpreting meaning based upon the order of words in a given sentence. This concept refers to the high degree of overlap between the grammatical and semantic roles of a word based upon its location in the sentence. English speakers will almost always (outside of untraditional syntactic structures such as poetic prose) interpret the preverbal noun as being the subject of a sentence (Bates & MacWhinney, 1989).

In contrast, word order is not as rigid in other languages. For example, Bates, McNew, MacWhinney, Devescovi & Smith (1982) provide an example of a rhetorical dinner conversation in Italian that contains all six possible arrangements of subject, verb, and object positioning with all six instances being acceptable Italian utterances. Furthermore, it was found that in an actor-assignment task, the word order cue accounted for 50% of the variance in English speakers' responses, compared to only 1.4% of the variance for Italian speakers. The importance of word order is also less significant in German, which relies heavily on a system of case marking (discussed below).

Case Marking. Case marking refers to morphosyntactic indicators of what role a particular noun in a sentence fulfills. Case marking is not a prominent cue in English; it is seen only in the use of the gendered third-person singular pronouns. The pronouns *he* and *she* are used when serving as the subject of a sentence (the *nominative* case) and are transformed into *him* and *her* when used as the direct or indirect object of a sentence (the *accusative* and *dative* cases, respectively). Due to the low accessibility of this cue, case marking does not possess a high level of validity in English (MacWhinney et al., 1984).

In addition to marking case with pronouns in a similar manner to English, all German nouns are marked as one of four cases: nominative, accusative, dative and genitive. For example, a masculine noun is marked in the nominative case by the article *der* when it is the subject of a sentence. The same noun would be marked in the accusative case by the use of the article *den* when it serves as the direct object in a sentence. In other languages,

such as Russian, case marking is conveyed via suffixes attached to the noun (Kempe & MacWhinney, 1998). In languages where this cue is more accessible, it also tends to be more valid. Indeed, MacWhinney et al. (1984) refrained from including case marking as one of the cues included in their cross-linguistic comparison between English, German, and Italian, as it emerged during pilot testing that case marking could singularly predict participant responses in German.

Verb Agreement. Verb agreement refers to the notion that the verb agrees with the numeric (singular or plural) and deictic qualities of the noun that carries out the action. In English, the verb agreement cue is available only in the case of certain irregular verbs (i.e. "be" – I *am*, you *are*, it *is*) and for present-tense regular verbs, which are generally required to end in -s when a third-person singular noun serves as the subject of a sentence. Other languages possess more elaborate systems of conjugation, allowing for the verb agreement cue to convey more information. For example, Spanish regular present-tense verbs can be conjugated in a variety of different ways to account for all possible combinations of grammatical person and number. Indeed, Hernandez, Bates, and Avila (1994) found that verb agreement accounted for 67% of the variance in noun choice for Spanish monolinguals (contrasted with 14% for English monolinguals). Thus, verb agreement is a useful cue for determining the actor in Spanish sentences (Morett & MacWhinney, 2013).

Animacy. Animacy refers to the tendency to assign the role of actor to whichever noun is more sentient or animate. Evidence has been found that animacy plays a large part in actor determination in Chinese (Liu, Bates, & Li, 1992; Li, Bates, & MacWhinney, 1993), as well as children's determination of actors in many different languages (Bates & MacWhinney, 1989).

Animacy is unique from the other cues we have previously discussed. Rather than being indicated by morphosyntactic features, the notion of animacy arises as a byproduct of semantic knowledge (MacWhinney et al., 1984). This has interesting implications for other theories of language processing and learning, particularly the Shallow Structure Hypothesis (SSH) (Clahsen & Felser, 2006), which suggests that L2 users rely more on semantic and pragmatic features of the language, while relying less upon syntactic structures. This hypothesis has often been contrasted with the CM in the literature (Tolentino & Tokowicz, 2011; Yao, 2013) as these theories predict different patterns of performance over the course language learning. We will return to the predictions of these models, as well discuss the SSH in greater detail later.

Cue Conflict Resolution

To understand how the cue hierarchy of a language is determined, a few examples and cross-linguistic comparisons are provided below. As stated previously, word order is the predominant cue in English. The position of word order as the fundamental cue can be seen through English speakers' responses to ungrammatical or cue-conflicted sentences in actor-assignment tasks. For example, in a sentence such as:

*The lion eat the gazelles.

the cues of word order and verb agreement are in conflict with one another. English word order dictates that "the lion" is the actor of the sentence. However, the verb "eat" disagrees with the third-person singular preverbal noun (the lion) and agrees with the third-person plural noun "the gazelles". Bates & MacWhinney (1989) showed that, while English speakers are aware that such sentences are ungrammatical, when forced to choose an actor they tend to choose "the lion", showing a clear preference to word order over verb agreement.

The cue hierarchy is arranged differently in German. Consider the following English sentence and its German translation:

English: The man hits the ball.

German: Der Mann schlägt den Ball.

(the-nom. man hits the-acc. ball)

Here, all of the cues discussed thus far are in agreement in both sentences, so there is no conflict. Both English speakers and German speakers would interpret "the man/der Mann" as the actor. However, if the noun positions were switched:

The ball hits the man.

Den Ball schlägt der Mann.

(the-acc. ball hits the-nom. man)

English speakers would now interpret "the ball" as striking the man described in the sentence. However, German speakers' interpretations would not change: they would choose "der Mann" in either example. In both German examples, *the ball* is marked in the accusative case (by use of the article *den*), which dictates that it is the direct object in the sentence, regardless of the position in which it appears. Conversely, *the man* is marked in the nominative case (by use of the article *der),* indicating that it is the actor of the sentence. This consistency with case

marking allows for more flexibility with word order. Thus, in German, case marking possesses greater conflict validity than word order.

As a further example, consider the following sentence:

*The rock eat the lions.

English speakers should interpret *the rock* as the actor in the sentence, given its pre-verbal position and the dominance of the word order cue in English. Chinese speakers would be more likely to choose *the lions* as the actor in the sentence, given the high conflict validity of the animacy cue in Chinese. Italians would also tend to choose *the lions,* but would do so on the basis of verb agreement as well as animacy. If this sentence were to be translated into German, the case marking cue would then become available and German speakers would likely choose the actor based upon whichever noun was marked in the nominative case.

In sum, adult speakers of different languages will rely more strongly upon different cues for interpreting the actor in sentences depending upon those languages' conflict validity hierarchy. (See Bates & MacWhinney, 1989, for a listing of cue hierarchies in a variety of different languages). Speakers of different languages thus resort to different strategies in language comprehension. From this perspective, it is easy to understand why late L2 learners tend to struggle in their new language; their tried and true strategies are no longer adequate. This notion of transfer is fundamental to the CM. However, as discussed previously, the SSH questions the extent of this transfer.

The Shallow Structure Hypothesis (SSH)

A central tenant of the CM is "whatever can transfer will" (MacWhinney, 2005a). However, this assumption has been questioned, particularly in regards to syntax. Clahsen and Felser (2006) proposed the SSH to account for the observations that L2 speakers are unable to incorporate syntactic information to the same extent as native speakers in language processing but show comparable usage of pragmatic, semantic, and lexical information. This suggests that L2 learners are unable to apply cues embedded in the structural aspects of languages and thus try to make sense of the L2 in other ways. The predictions of the SSH also fall in line with "good enough" processing accounts (Ferreira, Bailey, & Ferraro, 2002). Such accounts suggest that learners will interpret cues in a manner that leads to the most plausible interpretations based upon what is most likely to occur in the real word (such as reliance upon the animacy cue). It is worth noting that the authors of the CM state that the apparent dearth of transfer effects in morphosyntax is due to the often unique nature of morphosyntactic structures between languages, meaning that transfer is not applicable in most cases (MacWhinney, 2005a).

Summary of Models and Implications for Language Learning

The CM and SSH predict very different trajectories for language learners. The CM model does not discriminate based upon the nature of a given cue. Rather, the validity of a cue is determined only by its reliability and accessibility, with conflict validity determined by reliability and accessibility in situations where there is cue conflict. It is these validities that determine how cues will be acquired and, ultimately, how they should be utilized.

In contrast, the SSH predicts an emphasis on semantic cue usage, with a lack of reliance on syntactic cues. If syntactic cues possess the highest conflict validity in a target L2, then we would expect late learners to have difficulty in comprehension. Effectiveness in utilizing morphologically based cues (such as case marking) would be limited by similarity between cues in the L1 and L2 and ease of processing. Thus, regardless of how cognizant learners become of their L2 structure, the SSH predicts that they will fail to adopt an L2's conflict validity hierarchy unless that hierarchy is based upon semantic, pragmatic and lexical information. Late L2 learners will consistently resort to interpretation strategies that produce relationships between sentence elements that make the most sense given what tends to make the most sense or actually occurs in reality.

Regardless of which model holds true, late L2 learners can expect difficulty in their endeavor. The predictions of each model merely differ on their predictions of the magnitude of this difficulty as well as the prognosis (with the CM being more positive in this regard). Before we can begin to explore how we may mitigate this difficulty, it is essential to consider the process of language learning. Although explicit instruction is typically the format provided in most foreign language education, most people begin speaking their first language without any formal training. This suggests that language learning (at least initially) is done implicitly. We will now turn to the role implicit learning plays in language learning.

Implicit Learning and Language Acquisition

Implicit learning is conceptualized as learning that takes place without conscious awareness, although drawing a clear distinction between implicit and explicit learning, as well as the mechanisms involved is not without controversy (Frensch & Rünger, 2003). Nevertheless, implicit learning mechanisms are accepted as playing a pivotal role in language acquisition and usage (Rebuschat & Williams, 2012). The seeming necessity of implicit learning for successful language learning is evidenced through the push for immersion programs and experiences in language education, as well as the established effectiveness of such programs (McInnis & Donoghue, 1980; Lo & Murphy, 2010). Further evidence comes from studies of L2 acquisition that suggest that conveying explicit information in

language instruction does not provide any further long-term improvements in language comprehension beyond what is already conferred through implicit learning and feedback (although additional benefits of explicit instruction have been observed in language production; see Stafford, Bowden, & Sanz, 2012).

The Competition Model as a Framework for Language Learning

Following the premise of the CM, successful language acquisition requires mastery of the cues present in a given language and their importance relative to one another in determining the role of actor. If we consider implicit learning as the necessary mechanism for language acquisition and proper cue adjustment as the desired result, a method of language instruction presents itself. The goal of such methodology would be to utilize techniques that can implicitly draw learners' attention to key aspects of a target language. Such a method may be possible through salience manipulation.

The Role of Salience. Schmidt (1990) proposed the *noticing hypothesis*, which holds that attention is the mechanism through which implicit learning of a language is possible. This mechanism is thought to work through the same principles outlined in traditional incidental learning literature (Schmidt, 1992). When particular aspects of a language are more salient than others, it is reasonable to believe that learners' attention will be drawn to the more salient features. Following the logic of the noticing hypothesis, we may also predict that these more salient features are more readily learned than their less salient counterparts. Indeed, in a meta-analysis on morpheme acquisition in English L2 learners, Goldschneider and DeKeyser (2005) suggested that the factors underlying acquisition order in English L2 learners (e.g. frequency of occurrence, morphological complexity, and others) could all be conceptualized as aspects of salience.

In the present study, we will manipulate salience through visual input enhancement (VIE). VIE is a technique by which visual stimuli are made more salient by typographical alterations, such as bolded text or presenting certain letters in different colors. VIE has been reported to produce beneficial effects in L2 learning (Lee, 2007), although the ability for VIE to facilitate the language acquisition in and of itself is not without controversy (Izumi, 2002; Winke, 2013).

Tolentino and Tokowicz (2014) used a methodology utilizing VIE in a study of language cues. This study was focused the interaction of the degree of similarity between languages and the method of instruction (explicit or implicit) in language learning. They cite the CM as part of their rationalization as they outline their hypotheses concerning transfer between languages. The CM predicts that if two languages possess similar structures (structures

that superficially resemble one another and function similarly in both languages), then facilitation in acquiring these structures should be observed. Conversely, if there are dissimilar structures (structures that may or may not superficially resemble one another but do not function in a similar manner), acquisition of these structures should be hindered due to negative transfer effects.

Tolentino and Tokowicz (2014) looked at native English speakers attempting to learn Swedish. Participants were placed into one of three conditions: (1) a control condition, in which participants learned grammar by viewing pairs of Swedish sentences, (2) a salience-only condition (SO) where participants were again shown pairs of Swedish sentences, but the pairs emphasized contrasting morphological structures, with critical morphemes being shown in blue text (as opposed to black), and (3) salience with explicit instruction (S&E), which had the same training procedure as the SO group, except that additional explicit grammar instruction on the relevant language structures was provided. In all three conditions, participants showed comparable performance on similar structures (those that were similar between the L1 and L2), providing evidence of positive linguistic transfer. Furthermore, the S&E group showed better performance than the SO group in the case of unique structures (structures that were present in the target language with no equivalent structure in the L1). However, these two groups performed similarly on sentences containing dissimilar constructions and were better than controls on both unique and dissimilar constructions. Interestingly, the authors discuss the possibility that the explicit instructions in the S&E group required participants to use a greater amount of cognitive resources, which diminished the effect size of explicit instruction when compared to the salience-only group.

It is important to note that while Tolentino and Tokowicz (2014) examined the predictions of the CM in the context of language learning, their focus was on the role of similarity in linguistic transfer. The goal of the present study is to explore the extent to which salience is able to affect sentence interpretation strategies over the language learning process, with scrutiny towards whether or not participants maintain L1 interpretation strategies, appropriately adjust to L2 interpretation strategies, or continuously rely upon a naïve cue usage strategy (such as using animacy to make semantic based decisions).

The Present Study

In the present study, it is our intention to examine the differing predictions of the CM and SSH as well as the notion that a shift to interpretation strategies using L2 conflict validities can be facilitated by VIE. Participants will be carry out an actor-assignment task using sentences in an artificial language. By manipulating the manner in

which cues appear as well as which cues hold precedent when there is conflict, the overall and conflict validity of cues within this language can be established a priori by the experimenter. Based upon the CM, we expect participants to implicitly acquire knowledge of these cues and their relationship to one another as they receive feedback, consequently improving their performance in the actor-assignment task over time. Based upon the findings from Tolentino and Tokowicz (2014), we expect VIE to expedite and increase the magnitude of this improvement.

We can contrast these hypotheses with predictions based upon the SSH. According to the SSH, we should anticipate different patterns of acquisition depending upon the established cue hierarchy in artificial language. If morphosyntactic cues, such as verb agreement, are at the top of the hierarchy, then we should expect to see slower conversion to appropriate L2 cue usage and ultimately, low overall performance. If semantic cues, such as animacy, occupied the top position, then the SSH would predict a consistent high level of performance as participants should be naively utilizing the semantic based cues.

To test these hypotheses, two experiments were designed. Participants took part in an actor-assignment task involving an artificial language. By receiving feedback, participants were implicitly exposed to the cue validities of the language. Salience, through VIE, was manipulated between-subjects in order to investigate its effects. Participants' adjustments in their reliance upon cues throughout the language learning process were compared from when morphosyntactic cues have the highest conflict validity (Experiment 1) to when a semantic cue has the highest conflict validity (Experiment 2). In Experiment 1, the morphosyntactic cues of verb agreement and case marking have the lowest overall validities, yet the highest conflict validities. Given the findings of McDonald (1986), as well as the predictions of the CM concerning transfer effects, we predict that participants will initially begin to utilize the word order and animacy cues, as these two cues possess the highest overall validity. Additionally, word order is the primary cue utilized by English speakers. However, participants should be able to utilize the morphosyntactic cues of verb agreement and case marking as they are exposed to the language. Based upon the principles outlined in the noticing hypothesis, we expect VIE to expedite this process.

In Experiment 2, our predictions are more ambivalent, as VIE will now be applied to the cues with the second and third highest conflict validities in the hierarchy (verb agreement and case marking, respectively) and will be absent on the cue with the highest conflict validity (animacy). While we predict that the presence of VIE will continue to be beneficial to the language acquisition process by directing participants' attention to key grammatical

features, we must also consider the possibility of a detrimental effect. It such a scenario, VIE may direct participants' attention towards less valid cues, potentially delaying or hindering learning. Experiment 2 will allow us to discriminate between these two possible outcomes.

CHAPTER 2 – EXPERIMENT 1

Method

Participants. 103 native English speakers were recruited from the psychology undergraduate participant pool at Louisiana State University. Language education and experience was assessed via a self-report questionnaire. Data gathered from participants who self-reported as being fluent in a language(s) other than English was omitted from analysis. Data from participants with experience or education in languages other than English was included in analyses provided that the participant did not self-report native-like fluency. 35 participants were assigned to the no-VIE condition, 34 to the one-color VIE condition, and 34 to the two-color VIE condition.

Materials. The lexicon of the artificial language was drawn from the publically available materials in the International Picturing Naming Project at the Center for Research at the University of California, San Diego (Szekely et al., 2004; database is available at http://crl.ucsd.edu/experiments/ipnp/). Words were chosen based upon their inclusion in previous studies that utilized the actor-assignment paradigm (Li et al., 1993; MacWhinney, Bates, & Kliegl, 1984; MacWhinney, Pleh, & Bates 1985; Su, 2004). All verbs were required to be monotransitive so that complete sentences could be formed using only two nouns (subject & direct object) and a verb. In total, eight animate nouns (bird, tiger, camel, elephant, lion, lizard, mouse, zebra), eight inanimate nouns (balloon, broom, glass, kite, lamp, rock, window, radish), and eight verbs (bite, chase, eat, hit, kick, push, wash, watch) were chosen. In order to control for possible bias towards selecting human nouns as actors, all animate nouns were non-human animals.

Verbs in the artificial language were created by generating a list of two-syllable, nonsense English words and randomly assigning each of the chosen English verbs to a particular nonsense word. Nouns were generated by shortening the English words to their first three phonemes. This was done to assist participants in determining the meaning of each noun in a sentence, as mistranslating the noun could potentially result in trials where participants know which noun illustrated the actor in the sentence but choose the incorrect picture (or vice versa) in the actor assignment task, rendering data from this task invalid. By making the artificial nouns similar to their English counterparts, it was the experimenters' goal to obtain valid data from the actor-assignment test. While these nouns were not normed prior to the study, participants consistently reported observing similarities between the nouns and their English referents, suggesting that this manipulation was effective.

Nonsense suffixes were used to indicate verb agreement and case marking. Verb agreement was indicated by the suffixes "-na" (singular) and "-ye" (plural) appearing on the verb and "-ji" (singular) and "-gu" (plural) for the nouns. Case marking indicated the direct object of the sentence by attaching "-pa" to a noun following the agreement marker. All sentences followed a verb-noun-noun construction. For an example, the following sentence contains all of the elements discussed above. Note that in this case, no cues are in conflict with one another (suffixes have been italicized):

inpa*na* zeb*ji* rok*gupa*

(hit-sing. zebra-sing. rock-plural-obj)

English translation: *A zebra hits rocks*.

Sentences were created based upon the experimental design in McDonald and MacWhinney (1991). There were three different cues (verb agreement, case marking, animacy) that could vary in three different ways (non-applicable, favored first noun, favored second noun) which resulted in 27 different possible cells in the design. Word order was held consistent (VSO) and thus did not vary throughout the experiment.

Sentences used in the feedback portion of the procedure were semi-randomly generated by selecting the verb and two nouns that comprised each sentence, with the restriction that no sentence would be generated with the same two nouns occurring in the same position as in a previous sentence. Each noun and verb appeared in roughly the same amounts throughout the sample. In order to obtain the desired levels of overall and conflict validity, 66 different test sentences were created for each of the three feedback sessions. The respective numbers for each type of sentence in regards to which cues are available and valid are displayed in Figure 1. Additionally, information concerning the validity statistics for each cue are available in Table 1. In total, 198 sentences were created.

For the test without feedback portion of the procedure, sentences from the feedback portions were randomly selected and had the verb changed in order to create a novel sentence. This selection process had the constraint that any sentence appearing in a test session could not be derived from a sentence that appeared in the most recent feedback session: Sentences for the first test session were drawn from the second feedback session, the second test session from the third feedback session, and the third test session from the first feedback session). Verb and case markings were adjusted so that the correct actor for the test sentence matched the actor from its feedback

Grid 1: Animacy = N/A

Case Marking \ Verb Agreement	N/A	Favors 1st Noun	Favors 2nd Noun
N/A	(12) hits-sing. rock-sing. lamp-sing.	(1) hits-pl. rock-pl. lamp-sing.	(1) hits-pl. rock-sing. lamp-pl.
Favors 1st Noun	(3) hits-sing. rock-sing. lamp.-sing.-acc.	(1) hits-pl. rock-pl. lamp-sing.-acc.	(1) hits-pl. rock-sing. lamp-pl.-acc.
Favors 2nd Noun	(3) hits-sing. rock-sing.-acc. lamp-sing.	(1) hits-pl. rock-pl.-acc. lamp-sing.	(1) hits-pl. rock-sing.-acc. lamp-pl.

Grid 2: Animacy = Favors 1st Noun

Case Marking \ Verb Agreement	N/A	Favors 1st Noun	Favors 2nd Noun
N/A	(9) hits-sing. zebra-sing. lamp-sing.	(1) hits-pl. zebra-pl. lamp-sing.	(1) hits-pl. zebra-sing. lamp-pl.
Favors 1st Noun	(3) hits-sing. zebra-sing. lamp.-sing.-acc.	(1) hits-pl. zebra-pl. lamp-sing.-acc.	(1) hits-pl. zebra-sing. lamp-pl.-acc.
Favors 2nd Noun	(3) hits-sing. zebra-sing.-acc. lamp-sing.	(1) hits-pl. zebra-pl.-acc. lamp-sing.	(1) hits-pl. zebra-sing.-acc. lamp-pl.

Grid 3: Animacy = Favors 2nd Noun

Case Marking \ Verb Agreement	N/A	Favors 1st Noun	Favors 2nd Noun
N/A	(9) hits-sing. rock-sing. zebra-sing.	(1) hits-pl. rock-pl. zebra-sing.	(1) hits-pl. rock-sing. zebra-pl.
Favors 1st Noun	(3) hits-sing. rock-sing. zebra-sing.-acc.	(1) hits-pl. rock-pl. zebra-sing.-acc.	(1) hits-pl. rock-sing. zebra-pl.-acc.
Favors 2nd Noun	(3) hits-sing. rock-sing.-acc. zebra-sing.	(1) hits-pl. rock-pl.-acc. zebra-sing.	(1) hits-pl. rock-sing.-acc. zebra-pl.

Figure 1. Examples of all possible cue contexts in Experiment 1 along with the number of times each context was shown in each feedback portion (in parenthesis). The correct actor has been highlighted in each example.

Table 1. Cue validity and associated information for Experiment 1.

Cue	Accessibility	Reliability	Overall Validity	Conflict Validity
Word Order	100%	59%	59%	22%
Verb Agreement	27%	100%	27%	100%
Case Marking	45%	80%	36%	73%
Animacy	63%	71%	45%	57%

session counterpart roughly half of the time. Each test without feedback session consisted of 54 sentences – two sentences for each possible 3x3x3 combination of cues. Thus, across the three sessions, there were a total of 162 test sentences.

Salience was manipulated between-subjects and was produced with VIE. In the no-VIE condition, all text was presented in black font throughout the experiment. In the one-color VIE condition, the suffixes that indicated verb conjugation and case marking were presented in red text during the feedback blocks (all text in the no-feedback blocks was presented in black font, across all groups). In the two-color VIE condition, the suffixes that indicated verb conjugation were presented as in the one-color group, but now the suffixes that indicate case marking were also presented in green text.

Successful determination of the actor in the sentences depended upon knowledge of the dominance hierarchy between cues to resolve potential conflict that may be present in a given sentence. From all available cues in a given sentence, the one with the highest conflict validity dictates the appropriate actor, regardless of whether or not other available cues agree or disagree. In Experiment 1, verb agreement was designated as the cue with the conflict validity, followed by case marking, animacy, and word order. Consider the following examples:

verugye octgupa pengji.

(wash-pl. octopus-pl-obj. penguin-sing.)

English translation: *Octopuses wash a penguin.*

Here, "*octopuses"* serves as the actor despite being marked as a direct object. This is due to the higher conflict validity of the verb agreement cue as compared to the case marking cue. Case marking would be valid in a case where the cue of verb agreement was unavailable:

verugye octgupa penggu.

(wash-pl. octopus-pl.-obj. penguin-pl.)

English translation: *Penguins wash octopuses.*

In this case, the verb agreement cue cannot be used to determine the actor as both nouns agree with the plural verb. In such a case, the next cue in the hierarchy (case marking) must be used. Animacy would be the determining cue in a situation where neither verb agreement nor case marking could be used to make a decision:

hilsina kytji birji.

(chase-sing. kite-sing. bird-sing.)

English translation: *A bird chases a kite.*

Finally, word order could be used to determine the correct actor of the sentence only if all other cues were unavailable. The word order in this artificial language was always verb-subject-object:

pontaye brugu kytgu.

(eats-pl. broom-pl. kite-pl.)

English translation: *The brooms eat the kites.*

Note that these cues can also lead to the correct interpretation of the actor in situations where other cues are present, but are in agreement. Word order has relatively high overall validity, as the cue is valid any time that the first noun in the sentence is the actor. However, it possesses the lowest conflict validity.

Design and Procedure. At the beginning of the experiment, questionnaires to collect demographic information and language background were administered. Participants then took part in in a vocabulary learning phase, followed by an actor-assignment test with feedback then an actor-assignment test without feedback. Participants then alternated between with-feedback and without-feedback (also known as 'test') blocks until they had completed the third without-feedback block. An exit interview was then conducted, followed by debriefing.

Vocabulary learning. Participants were shown an image with the corresponding word (noun or verb) in the artificial language along with its English translation presented beneath it. Each picture was shown for 3000 milliseconds before the screen was blanked and another picture-word-translation set appeared. Every picture was shown twice during the phase. Pictures were presented in a randomized order, but each picture was shown once before any picture had appeared for a second time.

Actor- assignment task. Participants were exposed to sentences in the artificial language. Sentences were divided in feedback and no-feedback lists. The feedback lists consisted of 66 sentences each (this was to provide a language

sample that would reflect the desired values for reliability, accessibility, and overall and conflict validities) and the no-feedback lists consisted of 54 sentences each (to provide two examples of every possible cue combination). In each condition, a sentence in the artificial language would be displayed for five seconds before being replaced with a prompt to select which noun served as the actor. The prompt screen consisted of a written prompt at the top of the computer screen with two pictures below, labeled (a) and (b), each depicting one of the nouns used in the sentence. The order of the pictures matched the order in which the nouns appeared in the sentence only half of the time. Participants responded via keypress (using the number keys located along the top row of a standard keyboard; "1" for picture (a) and "0" for picture (b)). Participants had as much time as desired to make a choice between the two pictures.

After providing an answer to the sentences in the feedback list, feedback was provided by displaying the words "Correct" and "Incorrect" beneath the appropriate picture. In order to avoid association with the colors used in the VIE manipulation, "Correct" appeared in blue text, while "Incorrect" appeared in grey text. After receiving feedback, participants proceeded to the next test sentence by pressing the spacebar. Refer to Figure 2 for a visual depiction of the procedure.

Sentences and prompts in the no-feedback condition were presented similarly. The only difference was 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 choice between the two pictures. Instructions informing the participants that they would no longer be receiving feedback were also provided at the start of all test without feedback blocks. Response choices and reaction times in the actor-assignment task for both the feedback and test sessions were collected for analysis. However, for the purposes of this study, we will be focused on response choices; reaction times are not analyzed here.

If the predictions of the CM model are true, we expect to see strong improvement over both the feedback and test sessions as feedback is provided, due to implicit learning of the cue hierarchy. Salience should increase performance by increasing awareness of important cues. If the predictions of the SSH are true, we do not expect to see strong improvement as exposure to the language increases, as participants will be unable to learn the pivotal role played by the verb agreement cue and fail to apply it in their interpretation strategies. In this case, salience is

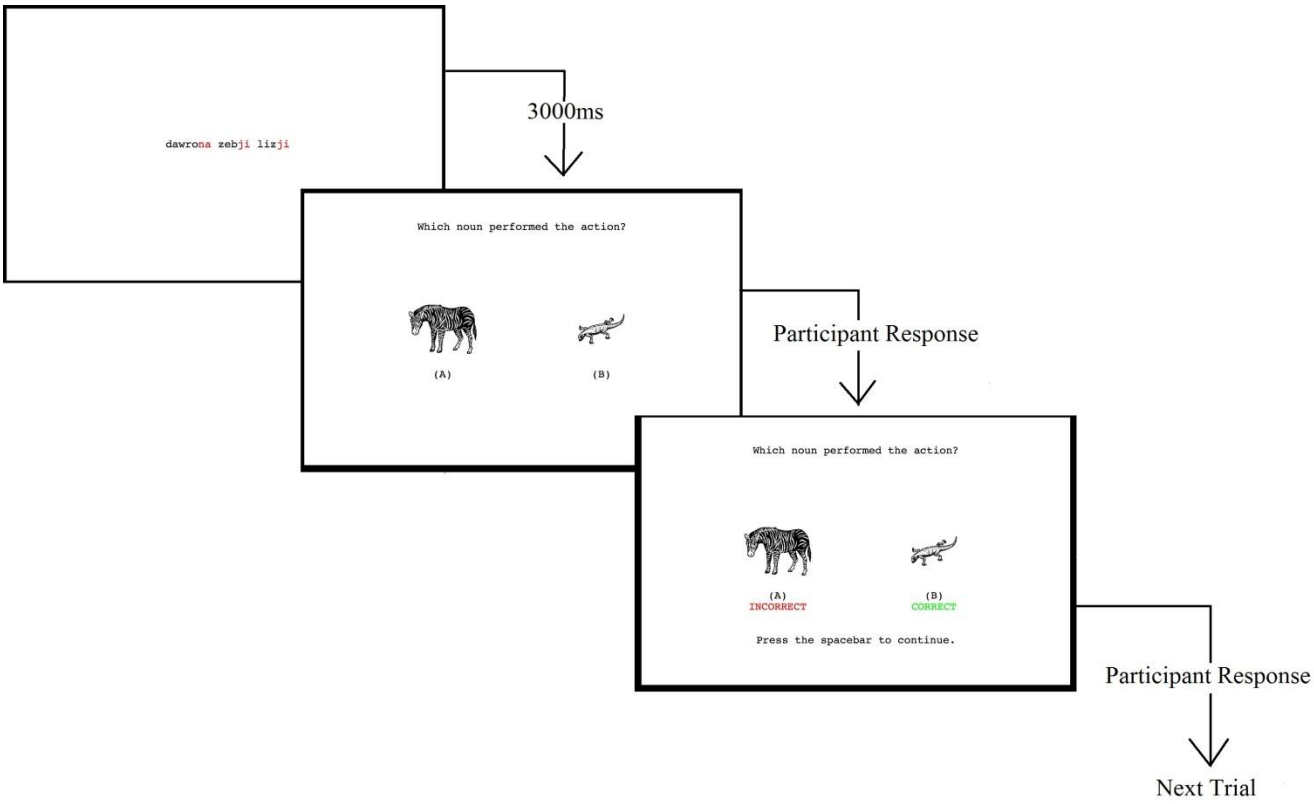

Figure 2. A depiction of the actor-assignment task used in this study. Above is trial from a feedback session in the one-color VIE condition. In the no VIE condition, this procedure was identical except that the suffixes were not presented in red font during initial sentence exposure. Here, the article demonstrating case marking is unavailable. The trials in the test sessions had the third screen omitted; participants did not receive feedback and the next test sentence was immediately presented after their response to screen two.

predicted to not have an effect, although, as stated previously, the inclusion of salience may lower processing demands which may help learners to apply the verb agreement cue.

Results

To best understand our variables of interest, we conducted three separate series of analyses. First, in order to assess the general performance of all three groups, we analyzed participants' proportion of correct responses in a 3 x 3 mixed-factors ANOVA, with group (no VIE, one-color VIE, and two-color VIE) as a between-subjects variable and block (1, 2, or 3) as a within-subjects variable. Feedback and no-feedback blocks were analyzed separately in all analyses.

To determine whether or not participants were utilizing the cues, we analyzed our cues in a 3 x 3 x 3 repeated measures design, with our three cues (verb agreement, case marking, and animacy) having three possible configurations each (not available, favors 1st noun, favors 2nd noun). Thus, there were 27 different contexts in which

these cues could be arranged within the experiment. Note that word order was fixed throughout the experiment (favors first noun). For sentences in each of these cue contexts, participants' percent choice of first noun was averaged (expressed as a decimal). We then subtracted .5 from these values. This produced scores ranging from -.5 to .5, with a score of .5 meaning a participant always selected the first noun in that particular cue context, -.5 meaning they always chose the 2nd noun, and 0 representing chance performance. By organizing the data as such, it allowed for us to test the significance of the word order cue by analyzing the intercept value. Note, however, that when we report participants' proportion of first noun responses here, we resume using the 0-1 scale, with 0 meaning the participants always chose the second noun and a 1 meaning the participants always chose the first noun (with .5 representing chance performance).

Finally, in order to get a measure regarding to what extent participants used these cues, we calculated eta-squared values. Eta-squared provides a measure of effect size, and thus serves as an indicator as to how much variance in a participants' responses can be attributed to a given cue. For the eta-squared values reported here, we used data from the 3 x 3 x 3 ANOVA conducted on participants' first noun choice at each level of cue for our calculations.

When it was necessary to follow up the results of an ANOVA with post-hoc tests, means were compared using a Bonferroni correction. All significant interactions are reported; non-significant interactions were omitted from further analysis. 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, $F_{G\text{-}G}$.

Correct Responses. The averages for each group within each block were compared against chance performance (50%) using a series of one-sample t-tests. For the feedback blocks, these analyses showed that all groups performed significantly better than chance. A 3 x 3 ANOVA revealed a significant main effect of group, F (2, 100) = 3.58, p < .05. Post-hoc comparisons showed that this finding was driven by the single-color VIE group performing significantly better than the no-VIE group (averages of 61% versus 56%). However, the two-VIE group (average 57%) did not perform significantly different from either group. There was also a main effect of block, $F_{G\text{-}G}$ (1.84, 3.68) = 21.63, p < .05. Post-hoc comparisons showed that this finding was driven by participants performing worse in block 1 than compared to either block 2 or 3 (55% versus 59% and 61% respectively). Refer to Figure 3 for a depiction of this data.

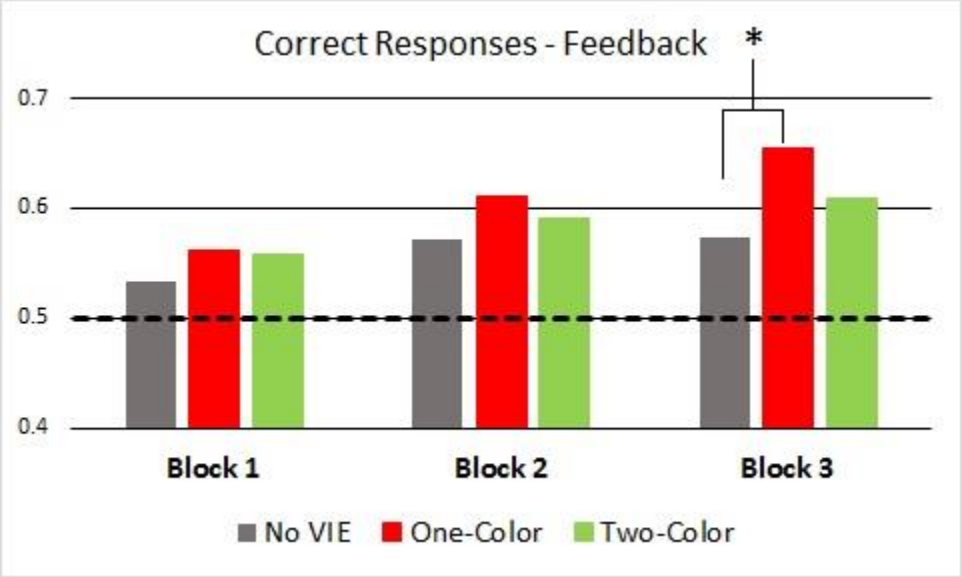

Figure 3. Participants' correct responses in the feedback trials in Experiment 1, as a proportion.

For the test trials, in the first block, the no-VIE group did not perform significantly better than chance, t = 1.68, p = .10. Performance was significantly above chance in all other blocks for all other groups (all ps < .05). Again, there was a significant main effect of block, $F_{G\text{-}G}$ (1.63, 3.26) = 15.11, p < .05. Post-hoc comparisons revealed a similar trend as in the feedback trials, where participants scored significantly worse on block 1 than compared to blocks 2 or 3 (53% vs 58% and 59% respectively). However, in these trials, there was no main effect of group, F (2, 100) = .86, p = .43. Refer to Figure 4 for a depiction of this data.

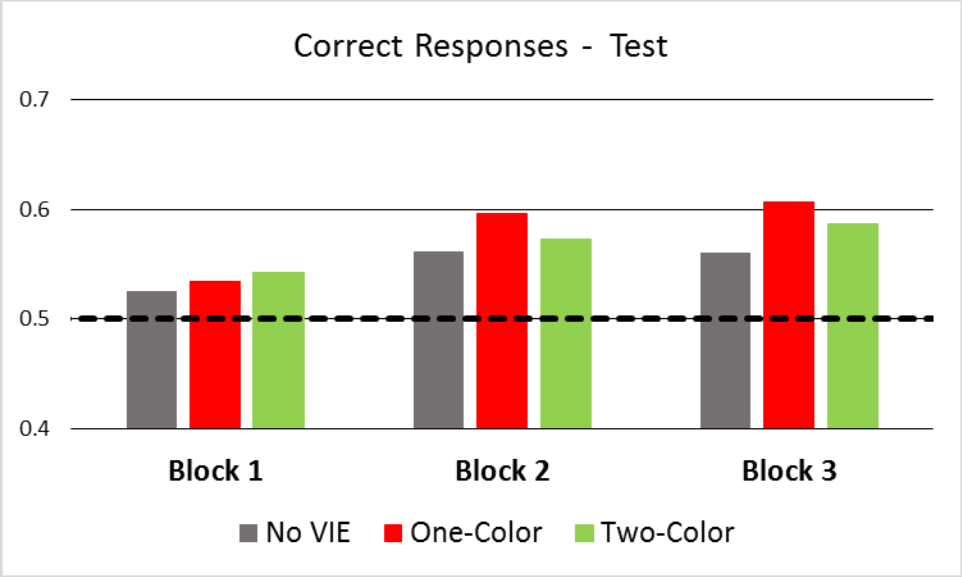

Figure 4. Participants' correct responses in the test trials in Experiment 1, as a proportion

Effects of Cues. For the sake of brevity, in our reporting of these effects, we will use the abbreviation of the cue (VA, CM, and A) followed by a subscript, indicating the context (0 = not available, 1 = favors first noun, 2 = favors second noun). For example, the notation CM_2 refers to a context in which the case marking cue is available, and favors the second noun in the sentence. The word order cue did not vary, and any significant effects reported in regards to this cue reflect a tendency to select the first noun more often than the second noun. The information that follows is summarized in Table 2 (feedback trials) and Table 3 (test trials).

Effects of Cues – Feedback Trials. In the first feedback block, for the no-VIE group, there was a significant main effect of animacy, $F_{G\text{-}G}$ (1.53, 51.97) = 8.75, $p < .001$, and word order, F (1, 34) = 36.16, $p < .001$. There was no main effect of verb agreement, F (2, 68) = .46, $p = .64$, or case marking, $F_{G\text{-}G}$ (1.63, 55.46) = 1.07, $p = .34$. The main effect of animacy was due to participants being less likely to choose the first noun when A_2, than either A_1 or A_0 ($A_2 < A_1 = A_0$). There was a significant interaction between the case marking and animacy cues, F (4, 136) = 5.14, $p < .01$. This interaction was driven by due to participants choosing the first noun less, $A_0 < A_1$ when CM_0, $A_2 < A_0 = A_1$ when CM_1, and $A_2 < A_1$ when CM_2. Refer to Figure 5 for a visual depiction of this interaction. For the one-color group, there was a main effect of animacy, $F_{G\text{-}G}$ (1.42, 15.55) = 20.75, $p < .05$, and word order, F (1, 33) = 18.01, $p < .001$. The main effect of animacy was due to participants being less likely to select the first noun when A_2, than either A_1 or A_0. There was no main effect of verb agreement, F (2, 66) = .10, $p = .90$, or case marking, F (2, 66) = 2.49, $p = .09$. For the two-color group, there was a main effect of case marking, $F_{G\text{-}G}$ (1.67,55.07) = 4.57, $p < .05$,

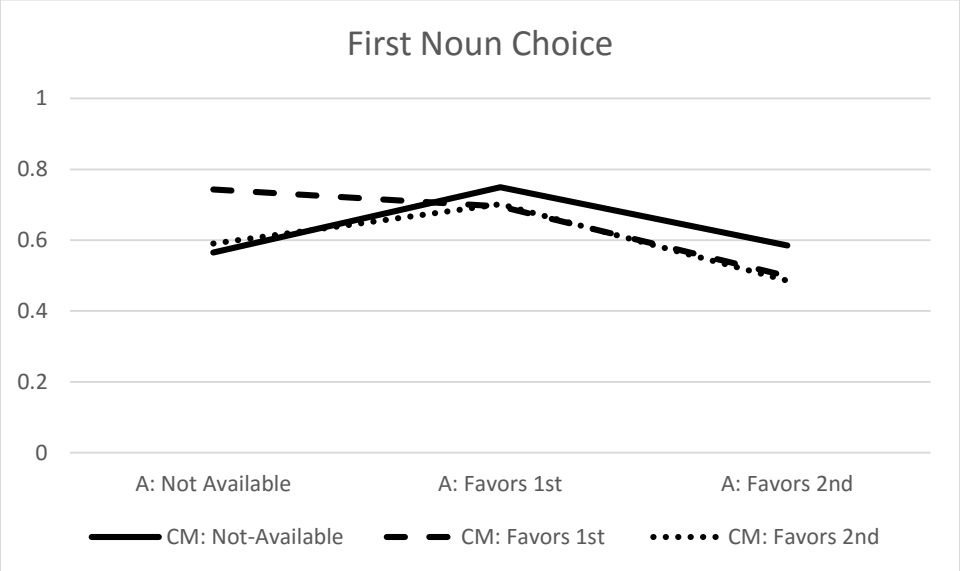

Figure 5. Visual depiction of the CM * A interaction observed in the no-VIE group in the first feedback block, Experiment 1. The different lines represent different levels of the case marking cue.

Table 2. Summary of ANOVAs for the Experiment 1 feedback blocks (* indicates marginal significance)

No-VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	n.s.
Case Marking	n.s.	n.s.	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 = A_1$	$A_2 = A_0 < A_1$	$A_2 < A_0 < A_1$
Word Order	Favors N_1	Favors N_1	n.s.
CM * A	See Figure 5	n.s.	n.s.

One-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	$VA_2 < VA_0$*
Case Marking	n.s.	$CM_2 < CM_0$	$CM_2 < CM_0 < CM_2$
Animacy	$A_2 < A_0 = A_1$	$A_2 < A_0 = A_1$	$A_2 < A_1$
Word Order	Favors N_1	Favors N_1	n.s.
VA * CM	n.s.	n.s.	See Figure 7

Two-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	n.s.
Case Marking	$CM_2 < CM_0$	$CM_2 < CM_0 < CM_1$	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 = A_1$	$A_2 < A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	n.s.	Favors N_1
VA * CM	n.s.	See Figure 6	n.s.

Table 3. Summary of ANOVAs for the Experiment 1 test blocks

No-VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	$VA_2 < VA_0$	n.s.
Case Marking	n.s.	$CM_2 < CM_1$	$CM_2 < CM_0$
Animacy	$A_2 < A_0 = A_1$	$A_2 < A_0 < A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
VA * CM	n.s.	See Figure 8	See Figure 11
CM * A	n.s.	See Figure 9	n.s.
VA * CM * A	n.s.	See Figure 10	n.s.

One-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	$VA_2 < VA_0$	$VA_2 < VA_1$
Case Marking	$CM_2 < CM_1$	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 < A_1$	$A_2 = A_0 < A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
VA * CM	n.s.	n.s.	See Figure 12

Two-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	$VA_2 < VA_0$	n.s.
Case Marking	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 < CM_1$
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 = A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
CM * A	n.s.	n.s.	See Figure 13

animacy, $F_{G\text{-}G}$ (1.57, 51.75) = 5.71, $p < .001$, and word order, F (1, 33) = 5.03, $p < .05$. The main effect of case marking was due to participants being less likely to select the first noun when CM_2 than when CM_0. The main effect of animacy was due to participants being less likely to select the first noun when A_2 than either A_1 or A_0. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.46, 48.16) = .41, $p = .66$.

In the second feedback block, for the no-color group, there was a main effect of animacy, $F_{G\text{-}G}$ (7.50, 23.31) = 10.94, $p < .001$, and word order, F (1, 34) = 9.32, $p < .01$. The main effect of animacy was driven by participants being less likely to select the first noun when A_2 or A_0 than A_1. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.49, 50.62) = 1.25, $p = .29$, or case marking, $F_{G\text{-}G}$ (1.58, 53.56) = .94, $p = .38$. For the one-color group, there were significant main effects of case marking, $F_{G\text{-}G}$ (1.52, 50.26) = 2.42, $p < .05$, animacy, $F_{G\text{-}G}$ (2.55, 48.32) = 9.02, $p < .01$, and word order, F (1, 33), $p < .001$. The main effect of case marking was caused by participants being less likely to select the first noun when CM_2 than CM_0. The main effect of animacy was caused by participants being less likely to pick the first noun when A_2 than either A_1 or A_0. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.36, 44.93) = 2.55, $p = .11$. For the two-color group, there was a main effect of case marking, $F_{G\text{-}G}$ (1.36, 44.75) = 20.95, $p < .001$, and animacy, $F_{G\text{-}G}$ (1.50, 49.46) = 1.68, $p < .05$. The main effect of case marking was driven by participants responding differently to all levels of the case marking cue, $CM_2 < CM_0 < CM_1$. The main effect of animacy was driven by participants being less likely to pick the first noun when A_2 rather than A_1. There was no significant main effect of either verb agreement, $F_{G\text{-}G}$ (1.51, 49.67) = .36, $p = .64$, or word order, F (1, 33) = 3.07, $p = .09$. There was a significant interaction between verb agreement and case marking, F (4, 132) = 3.14, $p < .05$. This interaction was driven by $CM_2 < CM_0 = CM_1$ when VA_0 or VA_2; when VA_1, $CM_0 = CM_2 < CM_1$. Refer to Figure 6 for a visual depiction of this interaction.

In the third feedback block, for the no-color group, there were main effects of case marking, F (2, 68) = 9.20, $p < .001$, and animacy, $F_{G\text{-}G}$ (1.75, 59.58) = 18.96, $_p < .001$. The main effect of case marking was driven by $CM_2 < CM_1 = CM_0$. The main effect of animacy was due to participants tending to choose the first noun differently at all levels, $A_2 < A_0 < A_1$. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.38, 46.91) = 1.85, $p = .17$, or word order, F (1, 34) = 2.86, $p = .10$. For the one-color group, there were significant main effects of case marking, $F_{G\text{-}G}$ (1.42, 46.75) = 17.41, $p < .001$, animacy, $F_{G\text{-}G}$ (1.41, 22.05) = 2.36, $p < .01$, and word order, F (1, 33) = 13.40, $p < .01$. The main effect of case marking was driven by participants tending to choose the first noun different at all levels, $CM_2 < CM0 < CM_1$. The main effect of animacy was driven by participants being less likely to choose the

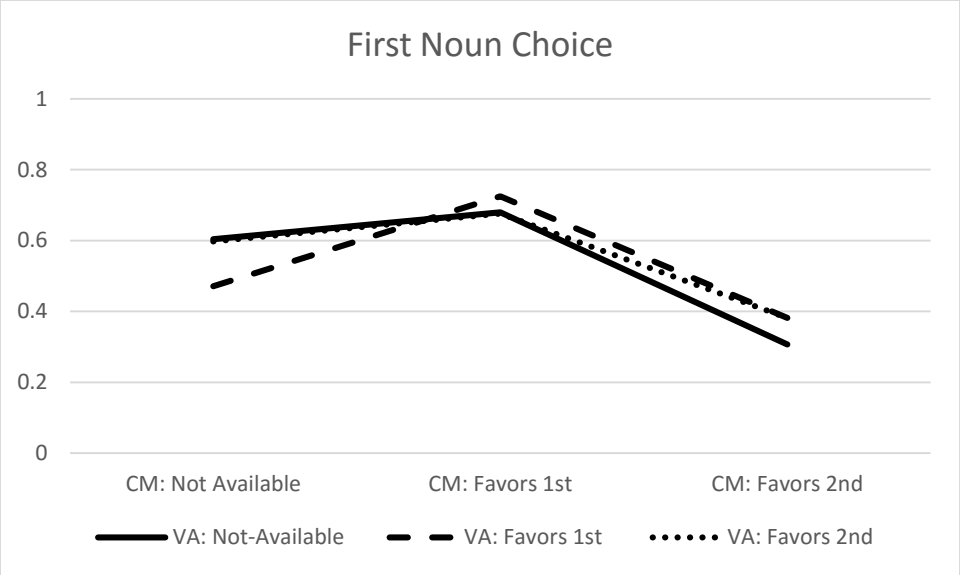

Figure 6. Visual depiction of the VA * CM interaction observed in the two-color VIE group in the second feedback block, Experiment 1.

first noun when A_2 than A_1. Verb agreement also approached significance, $F_{G\text{-}G}$ (1.34, 25.28) = 3.61, p = .052. This was driven by participants being less likely to select the first noun when VA_2 than when VA_0. There was a significant interaction between verb agreement and case marking, $F_{G\text{-}G}$ (3.125, 103.121) = 7.65, p < .001. Tests of simple main effects showed that this interaction was caused by participants utilizing the case marking cue differently at all levels of VA: when VA_0, $CM_2 < CM_0 = CM_1$, when VA_1, $CM_0 = CM_1 = CM_2$, when VA_2, $CM_2 = CM_0 < CM_1$.Refer to Figure 7 for a visual depiction of this interaction. For the two-color group, there were significant main effects of case marking, $F_{G\text{-}G}$ (1.41, 46.52) = 17.28, p < .001, animacy, F (2, 66) = 9.09, p < .001 and word order, F (1, 33) = 5.80, p < .05. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 than either CM_0 or CM_1. The main effect of animacy was driven by the same pattern of results, $A_2 < A_0 = A_1$. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.30, 42.98) = .34, p = .71.

Effects of Cues – Test Trials. In the first test block, for the no-color group, there was a main effect of animacy, $F_{G\text{-}G}$ (1.22, 41.60) = 9.74, p < .01, and word order, F (1, 34) = 4.16, p < .05. The main effect of animacy was driven by participants being less likely to choose the first noun when A_2 than either A_1 or A_0. There was no main effect for either verb agreement, F (2, 68) = 1.66, p = .20, or case marking, $F_{G\text{-}G}$ (1.50, 50.83) = .79, p = .46. For the one-color group, there were main effects of case marking, $F_{G\text{-}G}$ (1.50, 49.60) = 1.87, p < .05, animacy, $F_{G\text{-}G}$ (1.47, 48.45) = 11.27, p < .001, word order, F (1, 33) = 17.44, p < .001. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than CM_1. The main effect of animacy was driven

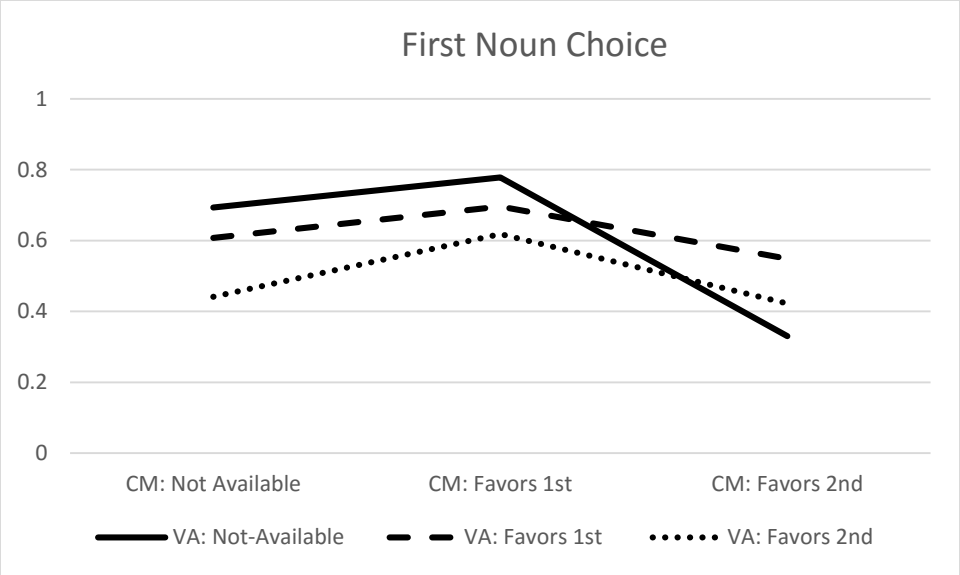

Figure 7. Visual depiction of the VA * CM interaction observed in the one-color VIE group in the third feedback block, Experiment 1.

by participants responding differently to all levels of this cue: $A_2 < A_0 < A_1$. There was no main effect of verb agreement, F (2, 66) = .91, p = .41. For the two-color group, there were significant main effects of case marking, $F_{G\text{-}G}$ (1.64, 54.12) = 5.89, p < .01, animacy, $F_{G\text{-}G}$ (1.47, 48.38) = 15.34, p < .001, and word order, F (1, 33) = 5.42, p < .05. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 than either CM_1 or CM_0. The main effect of animacy was driven by participants responding differently to all levels of this cue, $A_2 < A_0 < A_1$. There was no main effect of verb agreement, F (2, 66) = .27, p = .77.

In the second test block, for the no-color group, there was a significant main effect for all four cues, verb agreement, $F_{G\text{-}G}$ (1.47, 50.23) = 4.66, p < .05, case marking, F (2, 68) = 4.51, p < .05, animacy, $F_{G\text{-}G}$ (3.62, 44.04) = 12.03, p < .001, and word order, F (1, 34) = 6.92, p < .05. The main effect of verb agreement was driven by participants being less likely to choose the first noun when VA_2 than VA_0. The main effect of case marking was driven by the marginal effect of participants being less likely to select the first noun when CM_2 than CM_1 (p = .06). The main effect of animacy was driven by participants responding differently to all levels of this cue, $A_2 < A0 < A_1$. There was a significant interaction between verb agreement and case marking, F (4, 136) = 2.92, p < .05. Test of simple main effects showed that this interaction was driven by $CM_2 < CM_1 = CM0$ when VA_0; however, when VA_1 or VA_2, there was no significant difference in first noun selection between any level of the case marking cue. Refer to Figure 8 for a visual depiction of this interaction. The interaction between case marking and animacy was also

significant, F (4, 136) = 2.62, $p < .05$. Tests of simple main effects showed that this interaction was driven by $A_2 < A_0 = A_1$ when CM_0, and $A_2 < A_1$ when CM_1 and CM_2. Refer to Figure 9 for a visual depiction of this interaction. The three-way interaction between verb agreement, case marking, and animacy was also significant, F (68, 272) = 2.50, $p < .05$. Refer to Figure 10 for a visual depiction of this interaction. Visual analysis suggests that this

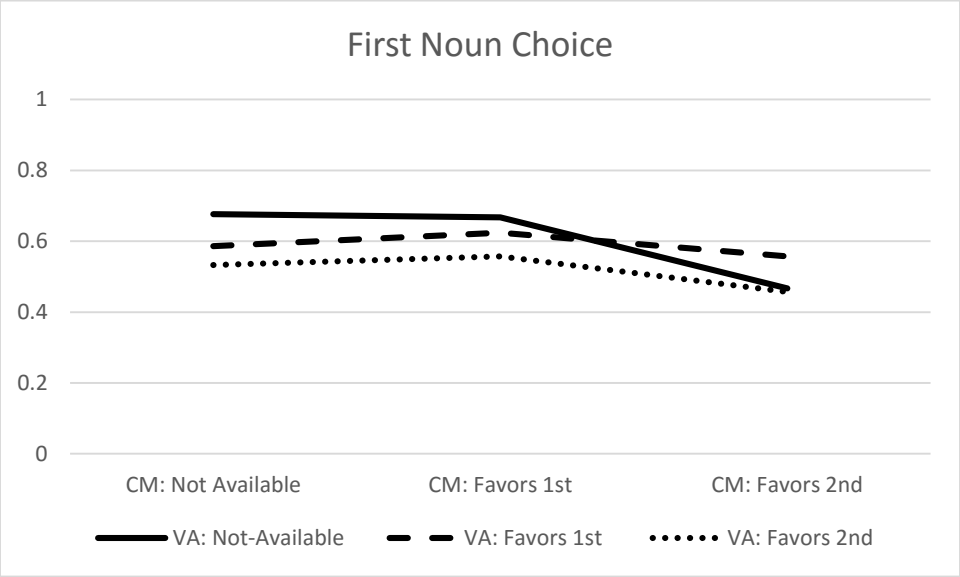

Figure 8. Visual depiction of the VA * CM interaction observed in the no-VIE group in second test block, Experiment 1.

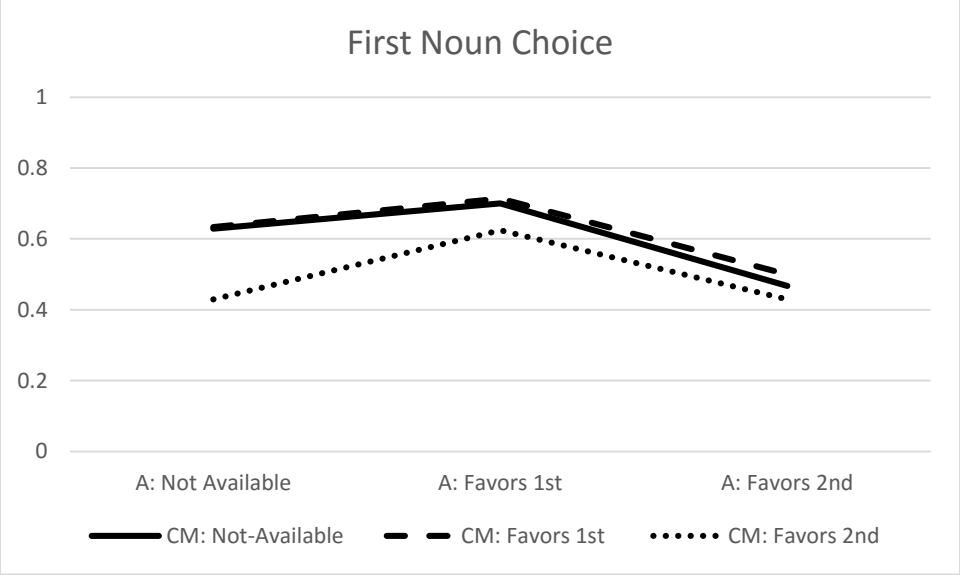

Figure 9. Visual depiction of the CM * A interaction observed in the no-VIE group in second test block, Experiment 1.

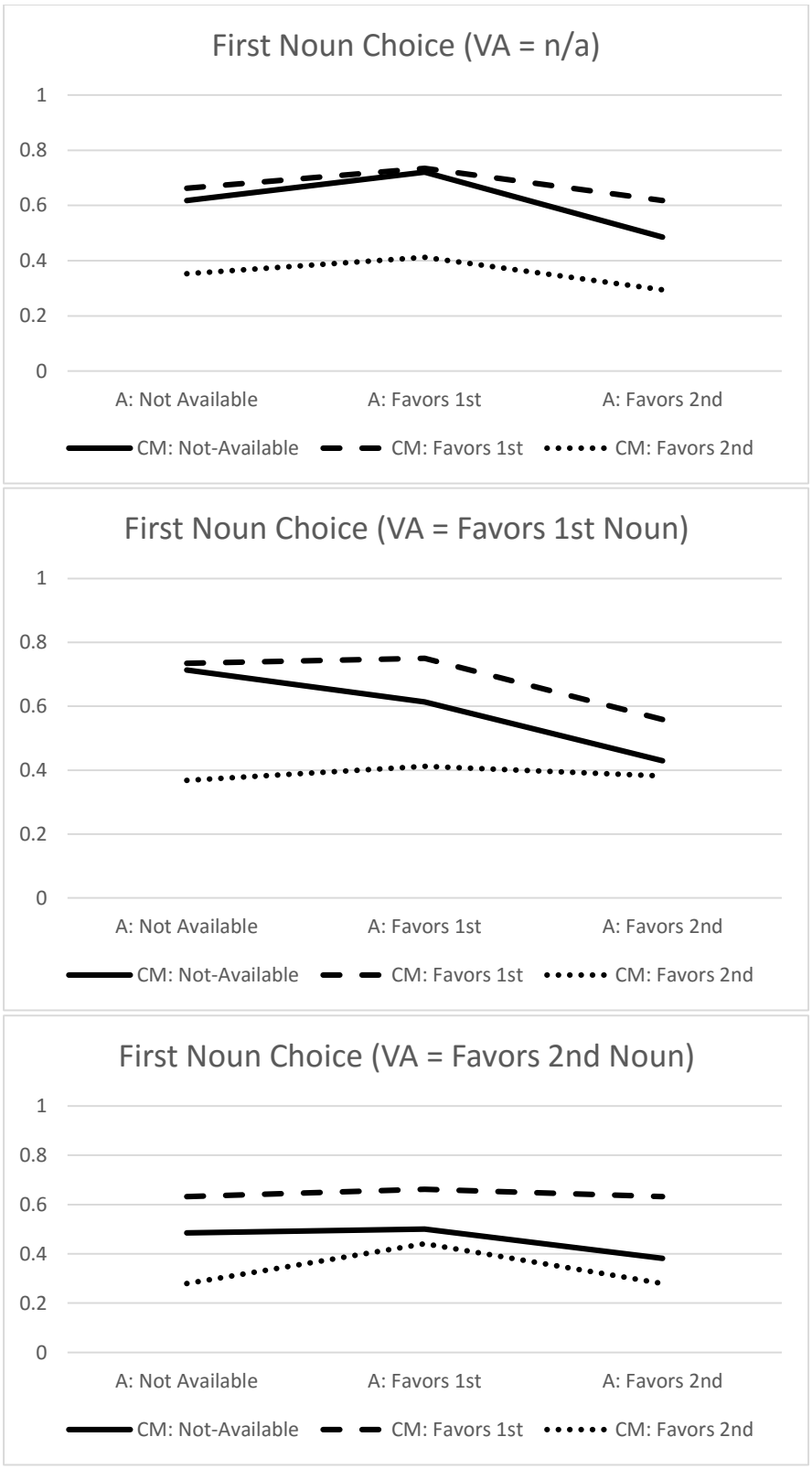

Figure 10. Visual depiction of the VA *CM * A interaction observed in the no-VIE group in second test block, Experiment 1.

interaction was driven by the animacy cue having more of an influence when it preferred the first noun in the absence of other cues. For the one-color group, there were again significant main effects for all four cues, verb of agreement, $F_{G\text{-}G}$ (1.42, 46.96) = 5.64, $p < .05$, case marking, $F_{G\text{-}G}$ (1.37, 45.05) = 7.69, $p < .001$, animacy, $F_{G\text{-}G}$ (1.40, 46.11) = 8.01, $p < .01$, and word order, F (1, 33) = 11.99, $p < .01$. The main effect of verb agreement was driven by participants being less likely to select the first noun when VA_2 than VA_0. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 than either CM_1 or CM_0. The main effect of animacy was driven by participants being less likely to select the first noun when either A_2 or A_0 than A_1. The interaction between verb agreement and case marking was also significant, F (3.26, 107.51) = 5.06, $p < .01$. Tests of simple main effects showed that this interaction was due to participants responding differently to the case marking cue at each level of verb agreement: when VA_0, $CM_2 < CM_0 = CM_1$, when VA_1, $CM_0 = CM_2 < CM_1$, and when VA_2, $CM_2 < CM_0$. For the two-color group, there was a main effect of verb agreement, F (2, 66) = 3.53, $p < .05$, case marking, $F_{G\text{-}G}$ (1.63, 53.92) = 13.13, $p < .001$, and animacy, $F_{G\text{-}G}$ (1.23, 40.53) = 8.39, $p < .01$, but no main effect of word order, F (1, 33) = .65, $p = .43$. The main effect of verb agreement was driven by participants being marginally less likely to select the first noun when VA_2 than VA_0 ($p = .06$). The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than either CM_1 or CM_0. The main effect animacy was driven by participants being less likely to select the first noun when A_2 than either A_1 or A_0.

In the third test block, for the no-color group, there were significant main effects of case marking, $F_{G\text{-}G}$ (1.64, 55.86) = 6.32, $p < .01$, animacy, $F_{G\text{-}G}$ (1.57, 53.43) = 12.51, $p < .001$, and word order, F (1, 34) = 12.63, $p < .01$, but no main effect of verb agreement, $F_{G\text{-}G}$ (1.53, 51.90) = 2.56, $p = .10$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than CM_0. The main effect of animacy was driven by participants being less likely to choose the first noun when A_2 than either A_1 or A_0. There was a significant interaction between verb agreement and case marking, $F_{G\text{-}G}$ (3.04, 103.19) = 4.07, $p < .01$. Tests of simple main effects show that participants responded differently to the case marking cue at each level of verb agreement: when VA_0, $CM_2 < CM_0$, when VA_1, $CM_2 < CM_0$ or CM_1, and when VA_2, there was no significant difference between levels of the CM cue. Refer to Figure 11 for a visual depiction of this interaction. For the one-color group, there were significant main effects for all four cues, verb agreement, $F_{G\text{-}G}$ (1.38, 45.37) = 5.64, $p < .05$, case marking, $F_{G\text{-}G}$ (1.57, 51.66) = 13.63, $p < .001$, animacy, $F_{G\text{-}G}$ (1.36, 44.94) = 7.52, $p < .01$, and word order, F (1, 33) = 6.67, $p < .05$. The main effect of verb agreement was driven by participants being less likely to choose the first noun when

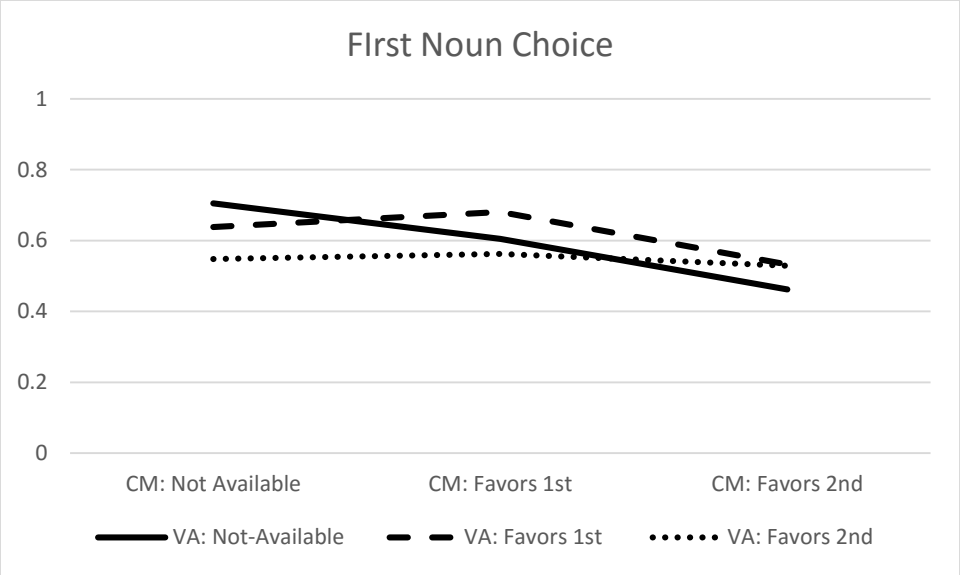

Figure 11. Visual depiction of the VA * CM interaction in the no-VIE group in third test block, Experiment 1.

VA_2 than VA_1. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 than either CM_1 or CM_0. The main effect of animacy was driven by the same pattern, $A_2 < A_1 = A_0$.

There was also a significant interaction between the verb agreement and case marking cues, $F_{G\text{-}G}(2.93, 96.59) = 5.37$, $p < .01$. Tests of simple main effects showed that this was due to $CM_2 < CM_1 = CM_0$, when VA_0 or VA_1; when VA_2, there were no significant differences between the levels of the case marking cue. Refer to Figure 12 for a visual depiction of this interaction. For the two-color group, there was a significant main effect of case

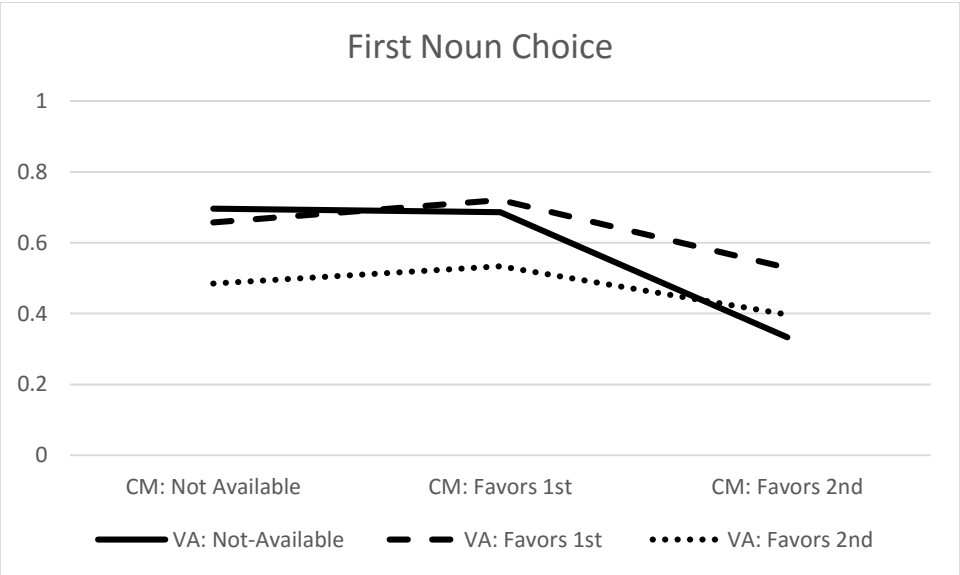

Figure 12. Visual depiction of the VA * CM interaction observed in the one-color VIE group in third test block, Experiment 1.

marking, $F_{G\text{-}G}$ (1.27, 41.85) = 24.29, $p < .001$, animacy, $F_{G\text{-}G}$ (1.45, 47.93) = 9.37, $p < .01$, and word order, F (1, 33) = 5.43, $p < .05$. The main effect of case marking was driven by participants responding differently to all levels of the cue, $CM_2 < CM_0 < CM_1$. The main effect of animacy was driven by participants being less likely to choose the first noun when A_2 than either A_0 or A_1. There was no significant main effect of verb agreement, $F_{G\text{-}G}$ (1.47, 48.63) = 2.34, $p = .12$. There was a significant interaction of case marking and animacy, F (3.27, 107.93) = 3.22, $p < .05$. Tests of simple main effects showed that this was due to $A_2 < A_1 = A_0$, but only when CM_0; when case marking was available (CM_1 & CM_2) there were no differences between the levels of the animacy cue. Refer to Figure 13 for a visual depiction of this interaction.

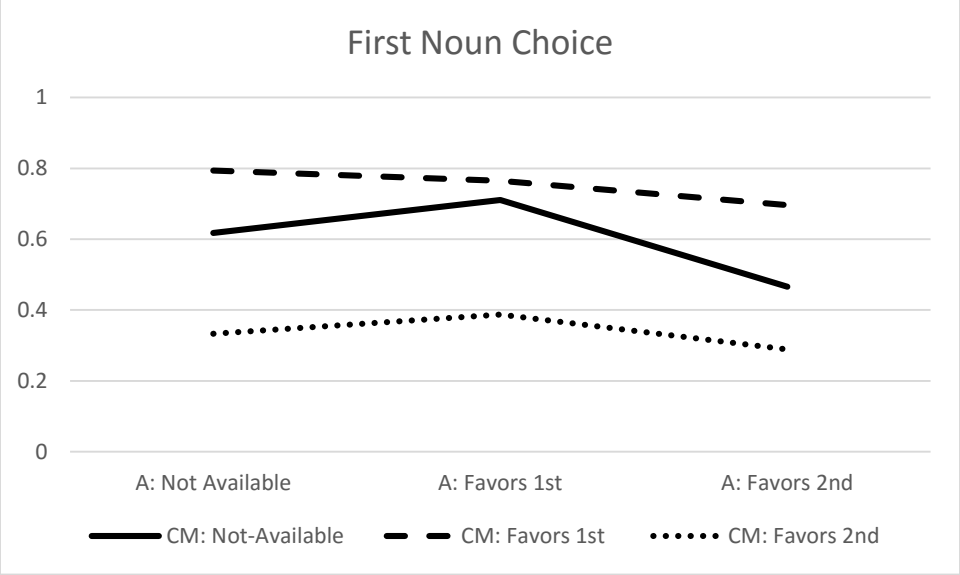

Figure 13. Visual depiction of the CM * A interaction observed in the two-color VIE group in third test block, Experiment 1.

Influence of Cues – Eta Squared values. Using the data from the above ANOVAs, eta-squared values were calculated for all cues and for each block. Figure 14 shows the eta-squared values for all three groups during the feedback trials; Figure 15 shows the eta-squared values for the test trials.

In general, we see all groups begin with an initial reliance upon the animacy and word order cues (although the two-color group did not demonstrate heavy reliance on the word order cue in the first feedback block). However, while the no-VIE group continues to rely primarily on the animacy and word order cues throughout the experiment, we see both the one-color and two-color VIE groups reduce the extent of their reliance upon these cues. Instead, these two groups begin to primarily utilize the case marking cue in their decision making. This trend is especially pronounced in the two-color VIE group; in the final test block, case marking accounted for over 12% of the variance

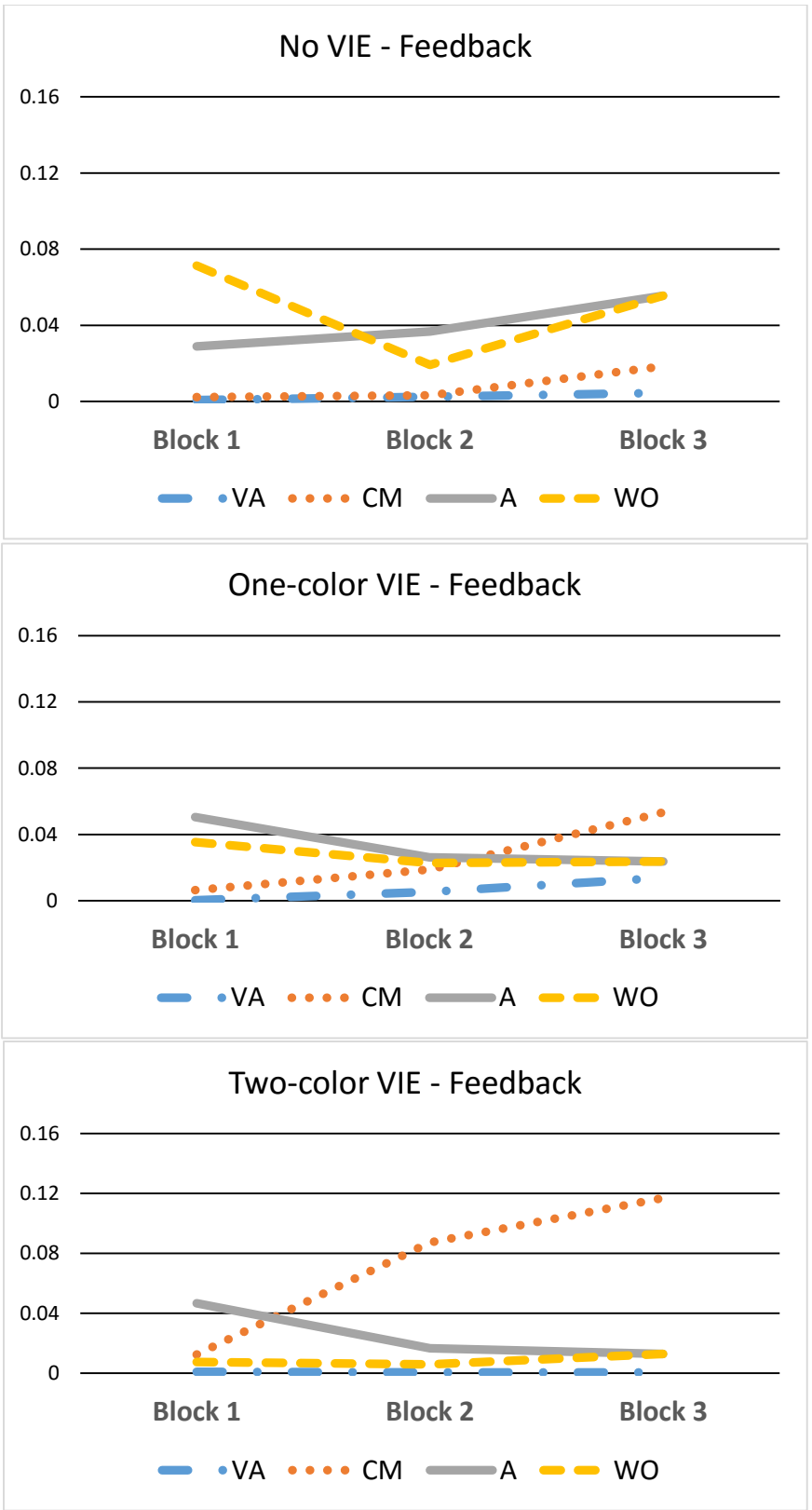

Figure 14. Eta-squared values for each cue in the feedback trials across blocks in Experiment 1. Groups are separated by chart.

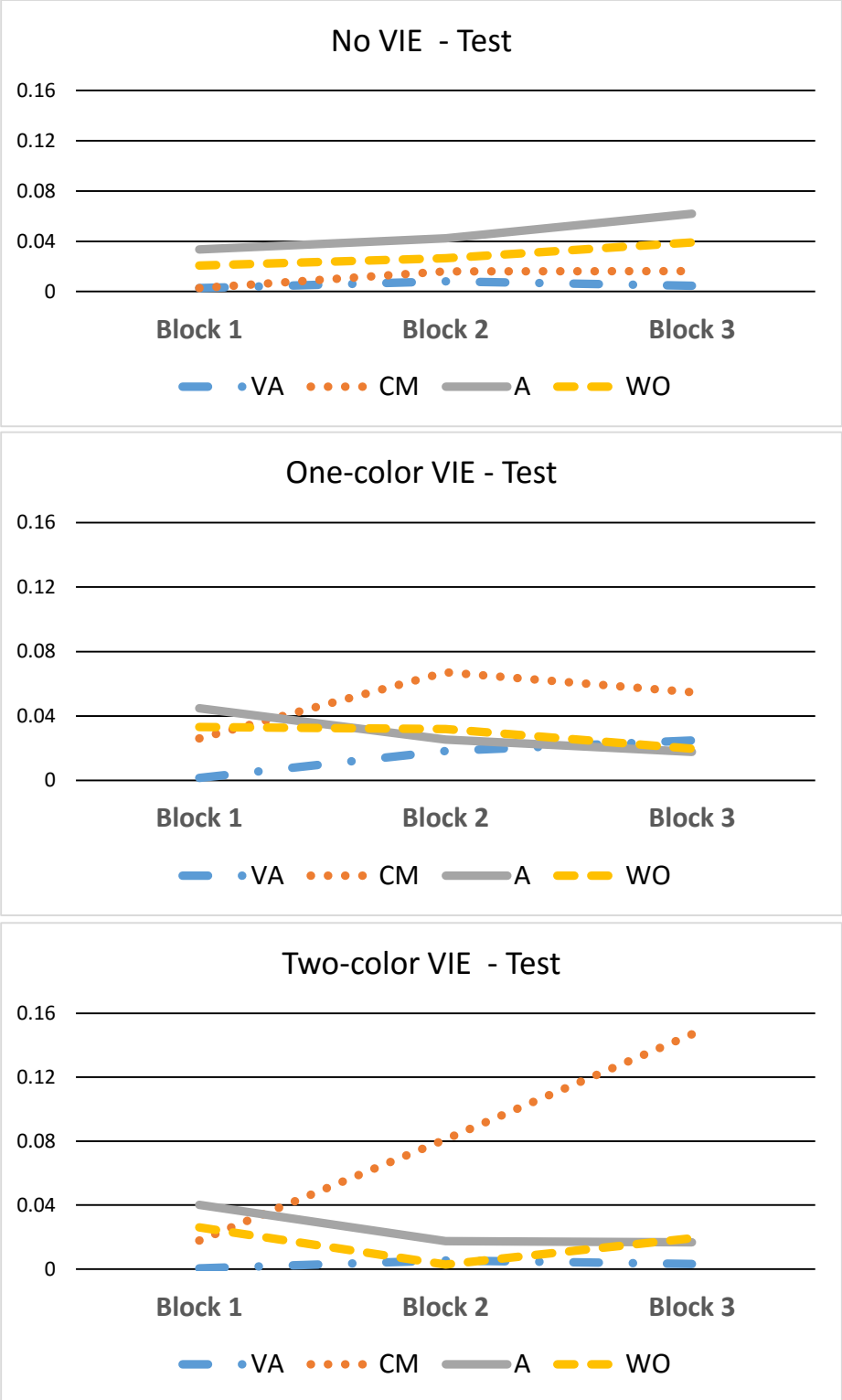

Figure 15. Eta-squared values for each cue in the test trials across blocks in Experiment 1. Groups are separated by chart.

in participants' decisions, while no other cue was able to account for more than 3%. Note also, the pattern of reliance on the verb agreement cue in the one-color VIE condition. Although this cue never became the most important cue to participants (as what would be predicted if participants fully followed conflict validity), by the end of the experiment, it accounted for more variance in responses in the one-color group than either the no-VIE group (which prioritized the animacy and word order cues at the expense of case marking and verb agreement) or the two-color group (which heavily emphasized the case marking cue).

Discussion

From the results of our first experiment, VIE appears to be effective in manipulating the manner in which participants utilize the various cues in the artificial language. While all groups began by relying upon the cues of word order and animacy, only the no-VIE group continued to primarily rely upon these cues throughout the experiment. Both the one-color and two-color VIE groups reduced their reliance upon the animacy and word order cues as training went on, and began to utilize the case marking cue to a greater extent. This trend was particularly strong in the two-color VIE group – indeed, our eta-squares analysis showed that the two-color VIE group relied upon the case marking cue seemingly at the expense of the other cues. This assertion is backed by the results of the correct response analysis: although non-significant, there was a trend for the two-color VIE group to perform worse than the one-color VIE group. This suggests that VIE potentially led to an 'over-reliance' upon the case marking cue.

One particular finding that was unexpected was the failure for any group to make strong use of the cue of verb agreement. Recall that verb agreement possessed a conflict validity of 100%. That is, in any situation where verb agreement was available, participants should have learned to rely upon that cue to make a decision. However, the data from both our ANOVA and eta-squares analysis show that this was not the case.

We consider two potential explanations for this. First, verb agreement was a substantially more difficult cue to utilize than case marking. To use the case marking cue, one simply needed to verify the presence of '-pa' appearing at the end of the word and chose the other noun. Conversely, to use the verb agreement cue, participants needed to memorize two different verb suffixes, two different noun suffixes, and the appropriate match between the suffixes on the verb and the nouns. Additionally, to appropriately use the verb agreement cue, the suffixes of all three words in a given sentence must be identified. Contrast this with only needing to identify a single suffix in order to use the case marking cue. This disparity in cue difficulty may have prevented participants from reaching an

understanding of how the verb agreement cue worked, or may have encouraged participants to useless cognitively demanding cues.

A second explanation is that the base rate of exposure to the verb agreement cue may have been too low. Although verb agreement had perfect conflict validity, it also had the lowest accessibility of any cue in the feedback trials. It is possible that, while this cue was available, participants had so few opportunities to utilize it that ultimately reliance upon it was disregarded as a viable strategy. This possibility will be examined in Experiment 2.

CHAPTER 3 – EXPERIMENT 2

Experiment 2 was a replication of Experiment 1, except that the cue hierarchy was rearranged so that animacy was the cue with the highest conflict validity, followed by verb agreement, case marking and word order. VIE continued to be applied onto the morphosyntactic cues only, as in Experiment 1. There are two critical aspects to this rearrangement of the cue hierarchy. First, VIE is now being applied to cues which do not possess the highest conflict validity and thus are not always valid. However, as these cues must still be utilized in certain grammatical contexts for correct interpretation (i.e. when animacy is unavailable), it is still necessary for participants to learn the function of these grammatical markers to perform well. We predict that VIE will still promote appropriate usage of these markers by serving to direct attention towards them. However, we must also consider the possibility that VIE may have a detrimental effect due to diverting attention away from the most valid cue in the hierarchy (animacy). Such a scenario was seemingly observed in the two-color VIE group from Experiment 1, where we saw an over-reliance upon the cue of case marking, despite its position as the cue with only the second highest conflict validity. Experiment 2 will help us to examine this scenario.

Secondly, Experiment 1 was designed to force participants to adopt new cue interpretation strategies. The SSH predicted that participants would initially utilize the cue of animacy, while the CM suggested that word order would be the primary cue used initially, and both assertions were supported by our findings in Experiment 1. However, whereas in experiment 1 these two cues always lost to either case marking or verb agreement if there was a conflict, in Experiment 2, animacy possesses the greatest conflict validity, taking precedent over all other cues. If participants began utilizing the animacy cue early, as in Experiment 1, they will find success whenever this cue is present and thus may be less motivated to look for alternative sentence interpretation strategies, in line with the predictions of good-enough processing accounts (Ferreira et al., 2002). However, although animacy possesses the greatest conflict validity, it will also be the least accessible cue. As this cue will not always be accessible, we predict that participants will still attempt to utilize other cues.

Experiment 2 will also allow us to investigate one potential explanation for the lack of reliance upon the verb agreement cue across all three groups in Experiment 1. Recall in our discussion for Experiment 1 that we suggested that one possibility for the disregard towards the verb agreement cue was its overall low accessibility in the feedback trials. By rearranging the cue hierarchy as we have done in Experiment 2, verb agreement was now of the same accessibility that case marking, a cue that was clearly able to be utilized, had in Experiment 1. If a base

level of accessibility is required for participants to begin utilizing a cue, verb agreement should now meet that criterion in Experiment 2.

Method

Participants. 95 native English speakers were recruited from the undergraduate participation pool at Louisiana State University. Criterion for inclusion was the same as in Experiment 1. 33 participants were assigned to the no-VIE condition, 30 to the one-color VIE condition, and 32 to the two-color VIE condition.

Stimuli. Sentences in the artificial language were generated in a similar fashion as in Experiment 1. However, now that the animacy cue possessed the same validity statistics that verb agreement possessed in experiment, this led to the requirement of a large amount of sentences in which the animacy cue would not be available (144 total throughout all three feedback blocks). As there were only 112 possible sentences in which this was possible, given the lexicon of the artificial language (8 x 7 for both inanimate and animate nouns), it was necessary to have sentences in which the same two nouns appeared in the same order as a previously viewed sentences. When this was the case, the repeated noun-pair was combined with a different verb than what had previously been used. The sentences were also distributed so that any noun-pair that had a duplicate did not appear within the same block. Refer to Figure 16 for a depiction of how the sentences were distributed throughout the feedback block.

Design and Procedure. All tasks were identical to and presented in the same manner as they were in Experiment 1 except as noted. The primary difference between the two experiments was that the cue hierarchy was rearranged. The reliability, accessibility, overall validity and conflict validity for each cue are shown in Table 4.

Results

The same data analysis procedures described in Experiment 1 were followed in Experiment 2. As before, summary statistics for cue usage are available in Table 5 (feedback blocks) and Table 6 (test blocks).

Correct Responses. As in Experiment 1, a series of independent samples t-tests revealed that all groups performed significantly above chance across all feedback and test blocks (all *p*s < .05). For the feedback blocks, a 3 x 3 ANOVA revealed a marginal main effect of block, $F_{G\text{-}G}(1.83, 184) = 3.09$, $p = .05$, but no main effect of group, $F(2, 92) = 1.05$, $p = .36$. Post hoc tests reveal that the marginal effect of block was driven by greater performance in block 3, relative to block 1 ($p = .09$). See Figure 17 for a visual depiction of this data. For the test

Grid 1: Case Marking = N/A

Verb Agreement	Animacy: N/A	Animacy: Favors 1st Noun	Animacy: Favors 2nd Noun
N/A	(12) hits-sing. rock-sing. lamp-sing.	(1) hits-pl. zebra-pl. lamp-sing.	(1) hits-pl. rock-sing. zebra-pl.
Favors 1st Noun	(3) hits-pl. rock-pl. lamp.-sing.	(1) hits-pl. zebra-pl. lamp-sing.	(1) hits-pl. rock-pl. zebra-sing.
Favors 2nd Noun	(3) hits-pl. rock-sing. lamp-pl.	(1) hits-pl. zebra-sing. lamp-pl.	(1) hits-pl. rock-sing. zebra-pl.

Grid 2:Case Marking= Favors 1st Noun

Verb Agreement	Animacy: N/A	Animacy: Favors 1st Noun	Animacy: Favors 2nd Noun
N/A	(9) hits-sing. rock-sing. lamp-sing.-acc.	(1) hits-sing. zebra-sing. lamp-sing.-acc.	(1) hits-sing. rock-sing. zebra-sing.-acc.
Favors 1st Noun	(3) hits-pl.. rock-pl. lamp.-sing.-acc.	(1) hits-pl. zebra-pl. lamp-sing.-acc.	(1) hits-pl. rock-pl. zebra-sing.-acc.
Favors 2nd Noun	(3) hits-pl. rock-sing. lamp-pl.-acc.	(1) hits-pl. zebra-sing. lamp-pl.-acc.	(1) hits-pl. rock-sing. zebra-pl.-acc.

Grid 3: Case Marking = Favors 2nd Noun

Verb Agreement	Animacy: N/A	Animacy: Favors 1st Noun	Animacy: Favors 2nd Noun
N/A	(9) hits-sing. rock-sing.-acc. lamp-sing.	(1) hits-sing. zebra-sing.-acc. lamp-sing.	(1) hits-sing. rock-sing.-acc. zebra-sing.
Favors 1st Noun	(3) hits-pl. rock-pl.-acc. lamp-sing.	(1) hits-pl. zebra-pl.-acc. lamp-sing.	(1) hits-pl. rock-pl.-acc. zebra-sing.
Favors 2nd Noun	(3) hits-pl. rock-sing.-acc. lamp-pl.	(1) hits-pl. zebra-sing.-acc. lamp-pl.	(1) hits-pl. rock-sing.-acc. zebra-pl.

Figure 16. Examples of all possible cue contexts in Experiment 2, along with the number of times each context was shown in each feedback portion (in parenthesis). The correct actor has been highlighted in each example.

Table 4. Cue validity and associated information for Experiment 2.

Cue	Accessibility	Reliability	Overall Validity	Conflict Validity
Word Order	100%	59%	59%	22%
Animacy	27%	100%	27%	100%
Verb Agreement	45%	80%	36%	73%
Case Marking	63%	71%	45%	57%

blocks, there was a main effect of block, $F_{G\text{-}G}$ (1.72, 184) = 4.34, $p < .05$, but no main effect of group, F (2, 92) = .46, $p = .63$. Post-hoc procedures again showed that the effect of block was driven by participants performing worse in block 1 block 3, $p < .05$; there was virtually no difference between scores in blocks 2 and 3, $p = .89$. See Figure 18 for a visual depiction of this data.

Table 5. Summary of ANOVAs for the Experiment 2 feedback blocks

No-VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	$VA_1 < VA_0$	n.s.
Case Marking	n.s.	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_1$
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$
Word Order	Favors N_1	n.s.	Favors N_1
One-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	$VA_2 < VA_0$
Case Marking	$CM_2 < CM_1$	n.s.	$CM_2 < CM_0$
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 = A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	n.s.	n.s.
Two-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	n.s.
Case Marking	$CM_2 < CM_0$	n.s.	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 = A_1$	$A_2 < A_0 < A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
VA * CM	n.s.	See Figure 19	n.s.

Effects of Cues – Feedback Trials. For the no-VIE group, there was a significant main effect of animacy, $F_{G\text{-}G}$ (1.59, 50.96) = 17.76, $p < .001$, and word order, F (1, 32) = 32.11, $p < .001$. There were no significant main effects of verb agreement, F (2, 64) = .04, $p = .97$, or case marking, F (2, 64) = .08, $p = .78$. Post-hoc tests showed that the

Table 6. Summary of ANOVAs for the Experiment 2 test blocks

No-VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	$VA_2 < VA_0$
Case Marking	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
One-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	n.s.
Case Marking	n.s.	$CM_2 < CM_0 = CM_1$	n.s.
Animacy	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$	$A_2 < A_0 < A_1$
Word Order	n.s.	n.s.	n.s.
Two-Color VIE			
Cue	Block 1	Block 2	Block 3
Verb Agreement	n.s.	n.s.	n.s.
Case Marking	$CM_2 = CM_0 < CM_1$	$CM_2 < CM_0 = CM_1$	$CM_2 < CM_0 = CM_1$
Animacy	$A_2 < A_0 = A_1$	$A_2 < A_0 < A_1$	$A_2 < A_0 = A_1$
Word Order	Favors N_1	Favors N_1	Favors N_1
VA * CM	n.s.	See Figure 20	See Figure 21
A * CM	n.s.	n.s.	See Figure 22

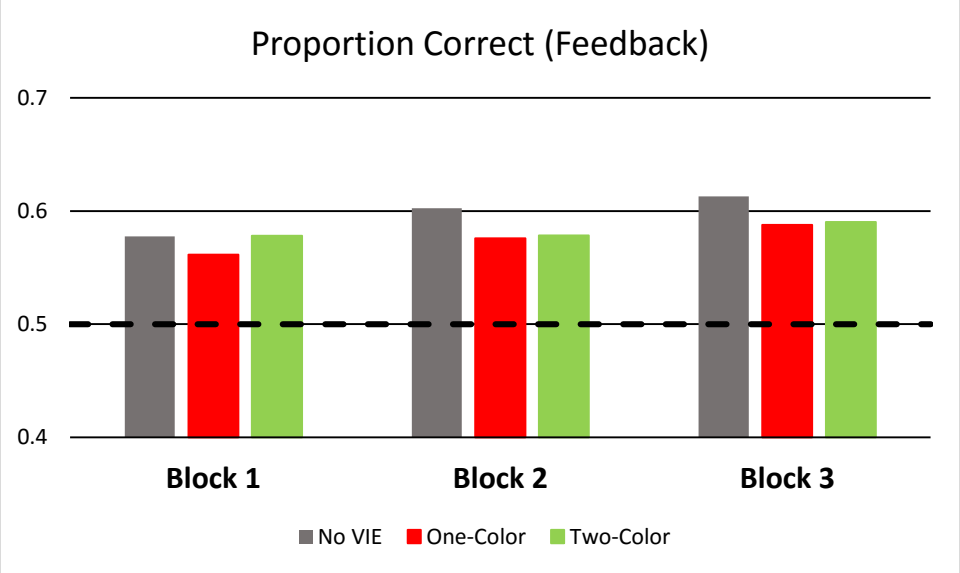

Figure 17. Participants' correct responses in the feedback trials from Experiment 2, as a proportion.

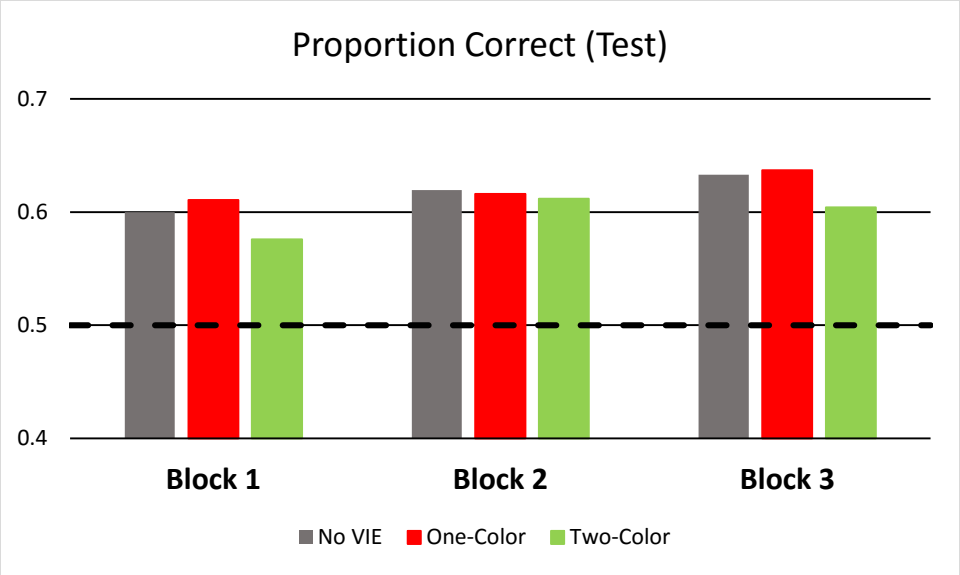

Figure 18. Participants' correct responses in the test trials from Experiment 2, as a proportion

main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. For the one-color VIE group, there were main effects of animacy, $F_{G\text{-}G}$ (1.38, 40.02) = 16.50, $p < .001$, case marking, F (2, 58) = 3.30, $p < .05$, and word order, F (1, 29) = 6.15, $p < .05$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 than CM1. There was no main effect of verb agreement, F (2, 58) = .35, $p = .71$. For the two-color VIE group, there were main effects of animacy, $F_{G\text{-}G}$ (1.31, 40.59) = 17.21, $p < .001$, case marking, F (2, 62) = 5.49, $p < .01$, and word order, F (1, 31) = 12.69, $p < .01$ Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than CM_0. There was no main effect of verb agreement, F (2, 62) = .24, $p = .78$.

In the second feedback block, for the no-VIE group, there were significant main effects of all four cues, animacy, $F_{G\text{-}G}$ (1.43, 45.80) = 32.65, $p < .001$, verb agreement, F (2, 64) = 3.20, $p < .05$, case marking, F (2, 64) = 5.03, $p < .01$, and word order, F (1, 32) = 27.37, $p < .001$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of verb agreement was driven by participants being less likely to choose the first noun when VA_1 compared to VA_0. Note, that if the participants in this condition were appropriately using the verb agreement cue, this trend should be in the opposite direction (that is less likely to choose the first noun when VA_0 compared to VA_1). The

main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than CM_1 and, marginally, CM_0 (p = .05). For the one-color VIE group, there was a main effect of animacy, $F_{G\text{-}G}$ (1.38, 40.03) = 12.92, p < .001. There were no main effects of verb agreement, F (2, 58) = 2.14, p = .13, case marking, F (2, 58) = 1.63, p = .21, or word order, F (1, 29) = 2.53, p = .12. The main effect of animacy was driven by participants being less likely to select the first noun when A_2, than either A_0 or A_1. For the two-color VIE group, there were main effects of animacy, $F_{G\text{-}G}$ (1.44, 44.50) = 10.24, p < .001, and word order, F (1, 31) = 9.21, p < .01. There were no main effects of verb agreement, F (2, 62) = .07, p = .94 or case marking, F (2, 62) = 2.06, p = .14. The main effect of animacy was driven by participants being less likely to select the first noun when A_2, than either A_0 or A_1. Additionally, the verb agreement by case marking interaction was also significant, F (4, 124) = 3.80, p < .01. Test of simple main effects showed that this interaction was driven by $CM_2 < CM_1$ when VA_0; when VA_1 or VA_2, there was no significant differences between levels of the CM cue. Refer to Figure 19 for a visual depiction of this interaction.

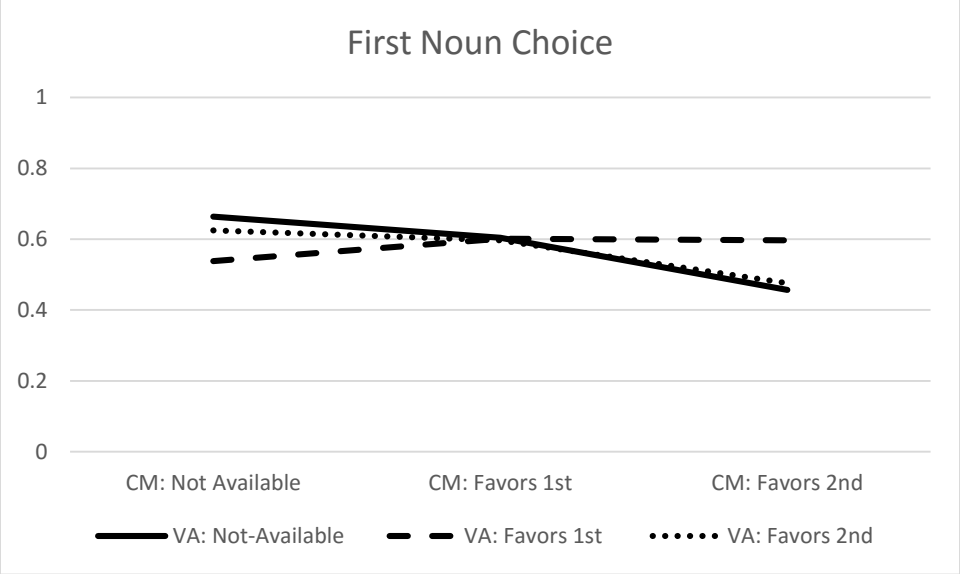

Figure 19. Visual depiction of the VA * CM interaction observed in the two-color VIE group in the second feedback block, Experiment 2.

In the third feedback block, for the no-VIE group, there were significant main effects of animacy, $F_{G\text{-}G}$ (1.40, 44.87) = 27.61, p < .001, case marking, $F_{G\text{-}G}$ (1.51, 48.29) = 5.68, p < .05, and word order, F (1, 32) = 12.46, p < .01. There was no main effect of verb agreement, F (2, 64) = .67, p = .51. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than when CM_1. For the one-color VIE group, there were main effects of animacy, $F_{G\text{-}G}$ (1.29, 37.36) = 10.81,

$p < .01$, verb agreement, $F_{G\text{-}G}(1.64, 47.62) = 5.66$, $p < .05$, and case marking, $F(2, 58) = 3.17$, $p < .05$. There was no main effect of word order, $F(1, 29) = 3.26$, $p = .08$. Post-hoc tests showed that the main effect of animacy was driven by participants being less likely to select the first noun when A_2 than either A_0 or A_1. The main effect of verb agreement was driven by participants being less likely to choose the first noun when VA_2 than VA_0.The main effect of case marking was driven by participants being marginally less likely to select the first noun when CM_2 than when CM_0 ($p = .07$) For the two-color VIE group, there were main effects of animacy, $F_{G\text{-}G}(1.32, 40.85) = 14.89$, $p < .001$, case marking, $F_{G\text{-}G}(1.52, 46.91) = 11.05$, $p < .001$, and word order, $F(1, 31) = 12.88$, $p < .01$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2, compared to either CM_0, or CM_1. There was no main effect of verb agreement, $F(2, 62) = .98$, $p = .38$.

Effects of Cues – Test Trials. In the first test block, for the no-VIE group, there were significant main effects of animacy, $F_{G\text{-}G}(1.43, 45.75) = 16.86$, $p < .001$, case marking, $F_{G\text{-}G}(1.61, 51.41) = 6.97$, $p < .01$, and word order, $F(1, 32) = 28.83$, $p < .001$. There was no main effect of verb agreement, $F(2, 64) = 1.73$, $p = .18$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than either CM_0 or CM_1. For the one-color VIE group, there was only a main effect of animacy, $F_{G\text{-}G}(1.35, 39.25) = 16.67$, $p < .001$. There were no main effects of verb agreement, $F(2, 58) = 1.15$, $p = .32$, case marking, $F_{G\text{-}G}(1.46, 42.39) = 2.52$, $p = .11$, or word order, $F(1, 29) = .48$, $p = .49$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. For the two-color VIE group, there were main effects of animacy, $F_{G\text{-}G}(1.32, 41.03) = 4.59$, $p < .01$, case marking, $F_{G\text{-}G}(1.52, 47.23) = 4.54$, $p < .05$, and word order, $F(1, 31) = 13.09$, $p < .01$. There was no main effect of verb agreement, $F_{G\text{-}G}(1.59, 49.18) = .15$, $p = .36$. Post-hoc tests showed that the main effect of animacy was driven by participants being less likely to pick the first noun when A_2 than when $A_1$and (marginally) A_0, $p = .07$. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2 or CM_0, than when CM_1.

In the second test block, for the no-VIE group, there were significant main effects of animacy, $F_{G\text{-}G}(1.39, 44.31) = 21.45$, $p < .001$, case marking, $F_{G\text{-}G}(1.53, 49.09) = 6.25$, $p < .01$, and word order, $F(1, 32) = 12.10$, $p < .01$.

There was no main effect of verb agreement, F (2, 64) = 1.22, p = .30. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2 than when CM_0 or CM_1. For the one-color group, there were significant main effects of animacy, $F_{G\text{-}G}$ (1.43, 41.41) = 17.08, p < .001, and case marking, F (2, 58) = 4.69, p < .05. There were no main effects of verb agreement, F (2, 58) = .19, p = .83 or word order, F (1, 29) = .49, p = .49 Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2, than CM_1, and (marginally) CM_0., p =.06 For the two-color VIE group, there were main effects of animacy, $F_{G\text{-}G}$ (1.27, 39.32) = 19.58, p < .001, case marking, $F_{G\text{-}G}$ (1.51, 46.57) = 7.86, p < .01, and word order, F (1, 31) = 16.90, p < .001. There was no main effect of verb agreement, F (2, 62) = .45, p = .64. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2, than when either CM_0 or CM_1. Additionally, the verb agreement by case marking interaction was marginally significant, F (4, 124) = 2.40, p = .05. Test of simple main effects showed that this interaction was driven by $CM_2 < CM_0 = CM_1$, when VA_0 and VA_1, but $CM_2 < CM_1$ when VA_2. Refer to Figure 20 for a visual depiction of this data.

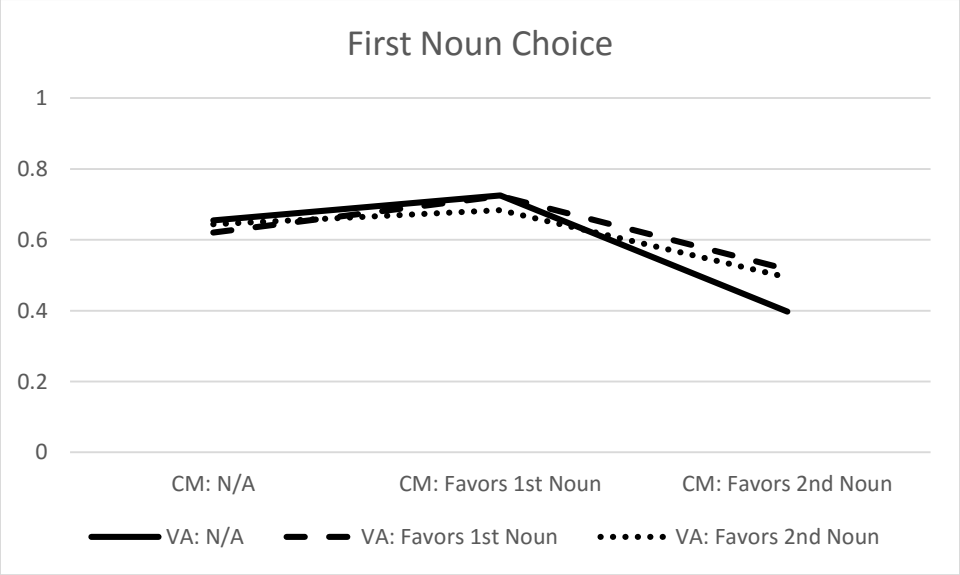

Figure 20. Visual depiction of the VA * CM interaction observed in the two-color VIE group in the second test block, Experiment 2.

In the third test block, for the no-VIE group, there were significant main effects for all four cues, animacy, $F_{G\text{-}G}$ (1.34, 43.00) = 18.80, $p < .001$, verb agreement, F (2, 64) = 6.81, $p < .01$, case marking, $F_{G\text{-}G}$ (1.65, 52.74) = 9.92, $p < .001$, and word order, F (1, 32) = 19.64, $p < .001$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. The main effect of verb agreement was driven by participants being less likely to choose the first noun when VA_2 than when VA_0. The main effect of case marking was driven by participants being less likely to select the first noun when CM_2, than when either CM_0 or CM_1. For the one-color VIE group, there was a main effect of animacy, $F_{G\text{-}G}$ (1.44, 41.62) = 19.88, $p < .001$. There were no main effects of verb agreement, $F_{G\text{-}G}$ (1.54, 44.76) = 1.59, $p = .22$, case marking, $F_{G\text{-}G}$ (1.65, 47.75) = 1.04, $p = .35$, or word order, F (1, 29) = 3.27, $p = .08$. Post-hoc tests showed that the main effect of animacy was driven by participants choosing the first noun differently at all levels of the animacy cue, $A_2 < A_0 < A_1$. For the two-color VIE group, there were significant main effects of animacy, $F_{G\text{-}G}$ (1.22, 37.77) = 11.37, $p < .01$, case marking, $F_{G\text{-}G}$ (1.27, 39.37) = 10.88, $p < .01$, and word order, F (1, 31) = 20.79, $p < .001$. There was no main effect of verb agreement, $F_{G\text{-}G}$ (1.53, 47.52) = 1.75, $p = .19$. Post-hoc tests showed that the main effect of animacy was driven by participants being less likely to select the first noun when A_2 than either A_0 or A_1. The main effect of case marking was driven by participants being less likely to choose the first noun when CM_2, than when CM_0 or CM_1.The verb agreement by case marking interaction was also significant, F (4, 124) = 3.41, $p < .05$. Tests of simple main effects showed that this interaction was driven by $CM_2 < CM_0 = CM_1$ when VA_0 and VA_1, but $CM_2 < CM_1$ when VA_2. Refer to Figure 21 for a visual depiction of this data. Additionally, the animacy by case marking interaction was significant, F (4, 124) = 3.17, $p < .05$. Tests of simple main effects revealed that $CM_2 < CM_0 = CM_1$ at all levels of the animacy cue. However, visual analysis suggests that this interaction was flagged due to participants showing a strong additive effect when both the case marking and animacy cues prefer the second noun. Refer to Figure 22 for a visual depiction of this data.

Influence of Cues – Eta Squared values. Results of our eta-square analysis are provided in Figures 23 and 24. Our analysis shows that across all groups and blocks, participants relied on the animacy cue to a high degree, and continued to rely upon it throughout the entirety of the experiment. Given the animacy cue's position atop of the cue hierarchy in Experiment 2, this is not surprising. The no-VIE group relies heavily upon the animacy cue, while also utilizing word order throughout the experiment and case marking to a small extent on the final blocks. Surprisingly, the pattern of cue reliance in the one-color VIE group suggests that they failed to utilize any cues other

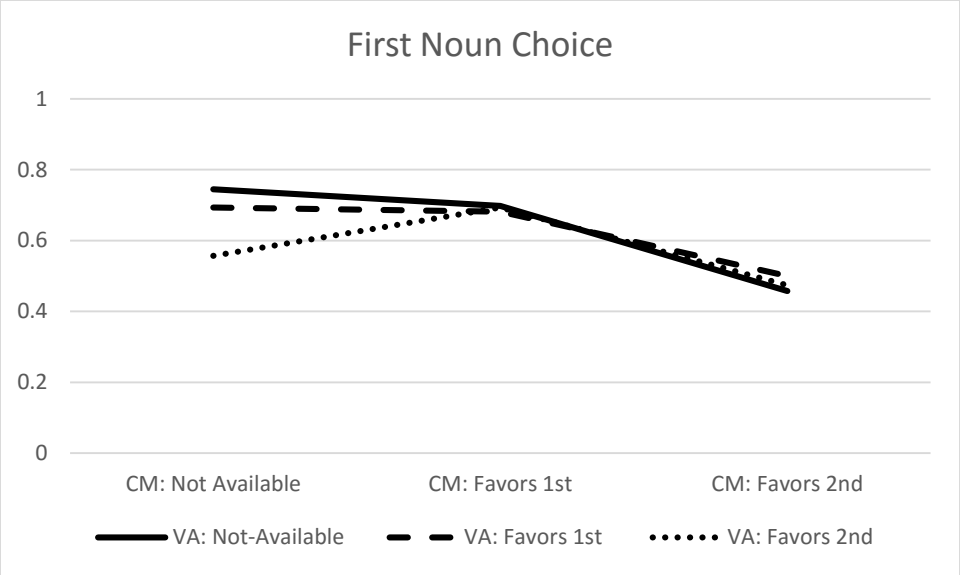

Figure 21. Visual depiction of the VA * CM interaction observed in the two-color VIE group in the third test block, Experiment 2.

than animacy to any appreciable extent, as the eta-squared values for all other cues are virtually non-existent. The two-color group, in addition to utilizing the animacy and word order cues, also utilized case marking to notable extent throughout the experiment.

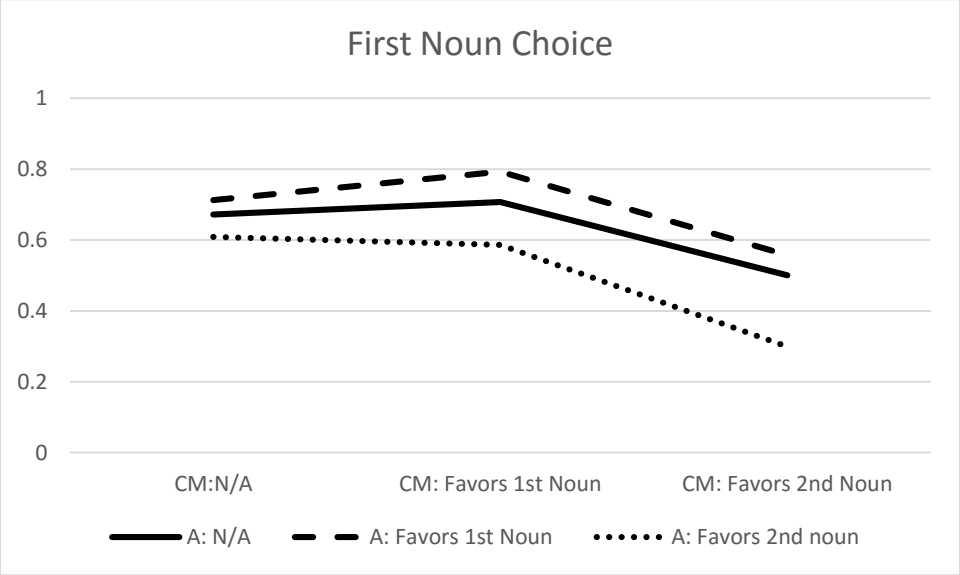

Figure 22. Visual depiction of the A * CM interaction observed in the two-color VIE group in the third test block, Experiment 2.

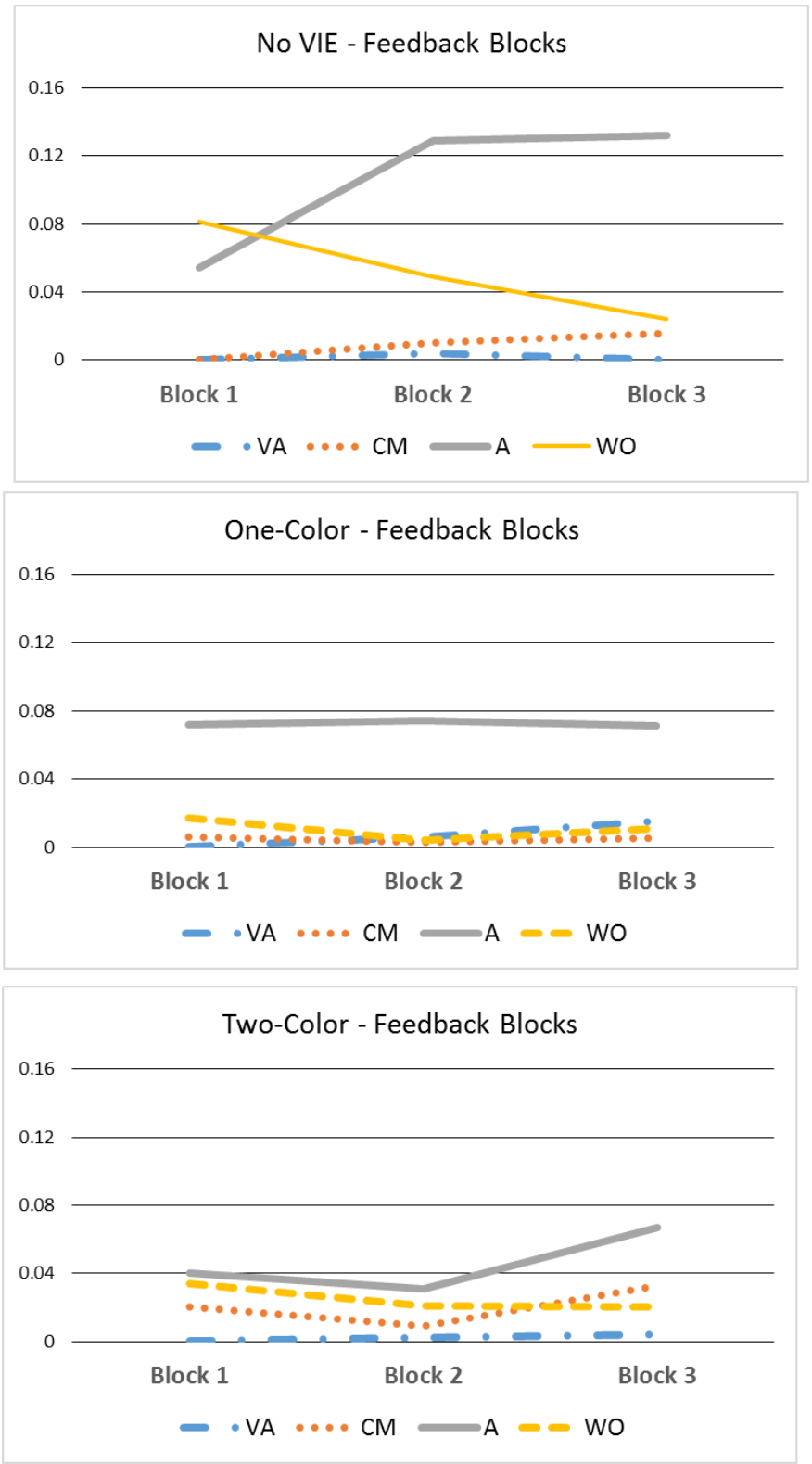

Figure 23. Eta-squared values for each cue in the feedback trials across blocks in Experiment 2. Groups are separated by chart.

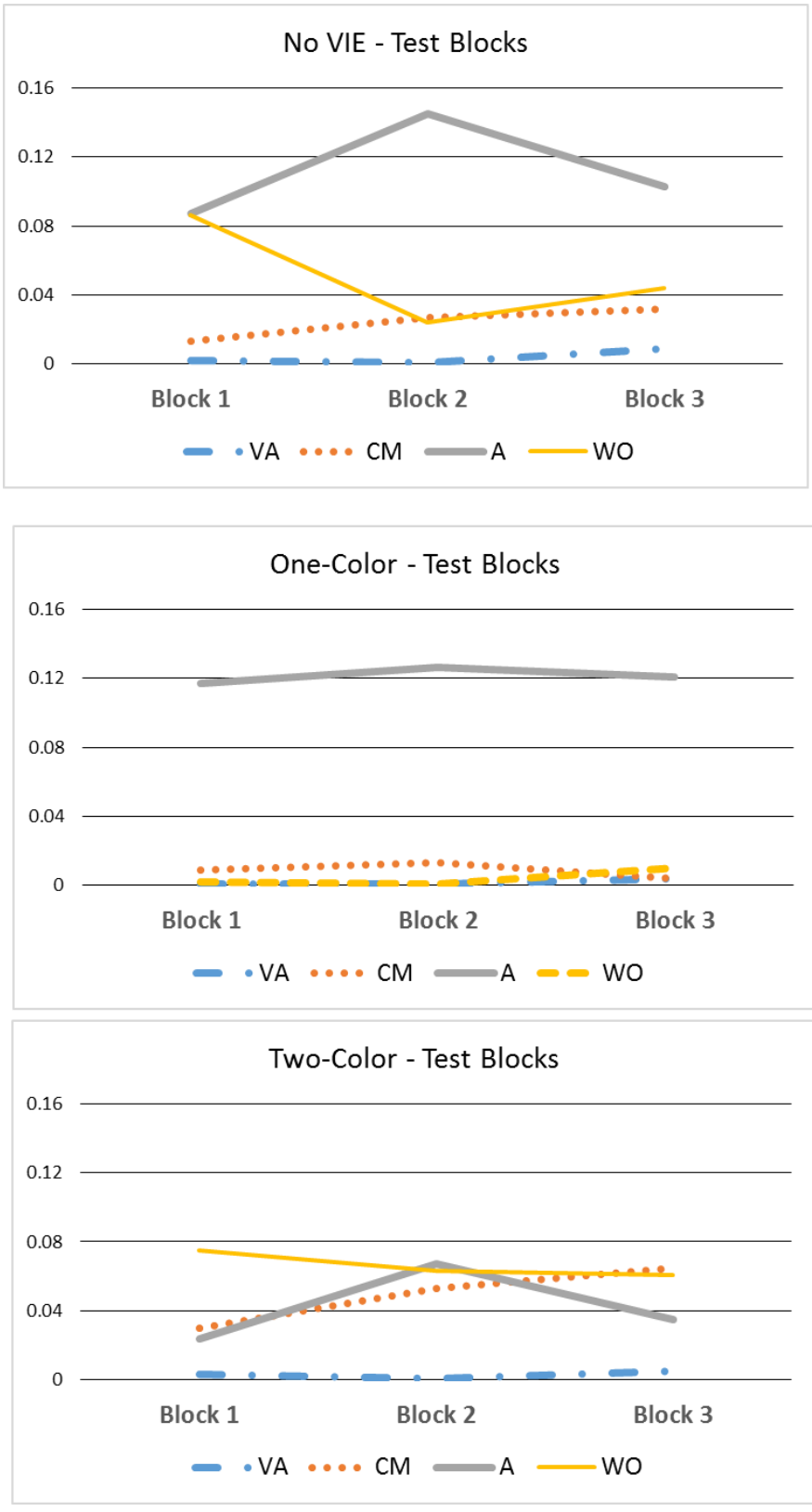

Figure 24. Eta-squared values for each cue in the test trials across blocks in Experiment 2. Groups are separated by chart.

Discussion

In Experiment 2, the results indicated no differences in correct responses across groups. Additionally, the trend was for both VIE conditions to perform worse than the no-VIE condition on the feedback blocks. This trend disappeared in the test blocks, but only for the one-color VIE condition. On these test blocks, the two-color VIE condition performed progressively worse as they continued through the experiment. As our analysis produced no significant effect of group, we can state that in Experiment 2, VIE failed to have a beneficial effect in terms of overall performance.

Analysis of cues showed that across all groups, participants relied upon the animacy cue to a large extent. All groups utilized this cue early and continued to rely upon it throughout the duration of the experiment. The no-VIE group also utilized the word order cue, albeit to a lesser extent. Additionally, the no-VIE group began to utilize the case marking cue to a minor degree by the final blocks of the experiment. Surprisingly, the one-color VIE group relied seemingly entirely upon animacy and failed to use the other cues to any appreciable extent. The two-color VIE group, similar to the no-VIE group, utilizes word order and animacy, however, the overreliance upon the case marking cue observed in Experiment 1 seems to be manifesting in Experiment 2 as well, albeit to a lesser degree.

Cross-Experiment Comparison

We now compare the results of Experiment 1 and 2 in order to examine if effects beyond cue validities were operative across the experiments. Recall that, although the cue that was assigned to a particular validity value within each hierarchy changed between experiments, the validity values themselves (in both terms of overall and conflict validities) remained fixed. That is, there was a cue at an identical cue strength at each level of the hierarchy across experiments. For example, verb agreement possessed the same validity in Experiment 1 as animacy did in Experiment 2. Refer back to Tables 1 and 4 for a visual comparison of cue validities across the experiments. A 3 (cue 1; N/A, favors 1st, favors 2nd) x 3 (cue 2; N/A, favors 1st, favors 2nd) X 3 (cue 3; N/A, favors 1st, favors 2nd) x 2 (experiment; Experiment 1 or Experiment 2) mixed-factors ANOVA was ran, with experiment as the sole between-subjects variable. To review, cue 1 was verb agreement in Experiment 1 and animacy in Experiment 2. Cue 2 was case marking in Experiment 1 and verb agreement in Experiment 2. Finally, cue 3 was animacy in Experiment 1 and verb agreement. We carried out this analysis on the first and third test blocks only, as our primary focus is upon potential differences in the early and late stages of learning between experiments. We report any significant interaction between the cues and the experiment variable, as this represents a situation in which cues were used

differently between experiments due to reasons other than cue validity. Note, that word order was not entered into this analysis, as it maintained a constant position in the cue hierarchy across experiments.

First, the cue 1 by experiment interaction was significant for all three VIE groups in both blocks (all *p*s < .05), except for the one-color VIE group in the third block, where it was marginally significant, $F_{G\text{-}G}$ (1.41, 87.59) = 3.44, p = .052. In every case, this was driven by participants responding more strongly to animacy (cue 1) in Experiment 2 than to verb agreement (cue 1) in Experiment 1. This suggests that, across the VIE manipulations, the animacy cue was easier to utilize than verb agreement when validities were equated.

Now we will look at what occurred within each test block, by condition. In the first test block, for the no VIE group, the cue 1 by cue 2 by experiment interaction was significant, F (4, 264) = 2.58, p < .05. Post-hoc analyses revealed that this was primarily driven by participants strongly responding to animacy (cue 1) in Experiment 2, regardless of verb agreement (cue 2), while a clear pattern of dominance did not emerge between verb agreement (cue 1) and case marking (cue 2) in Experiment 1. This suggests that the animacy cue was dominant over the verb agreement cue for the no-VIE group in Experiment 2, at least during the early stages of the experiment. Conversely, neither verb agreement nor case marking were dominant over one another during the early stages of Experiment 1 for this group. For the one-color VIE group, the cue 2 by experiment interaction was significant, $F_{G\text{-}G}$ (1.60, 99.04) = 4.91, p < .05. Post-hoc tests revealed that this was due participants consistently choosing the noun favored by cue 2 (case marking) in Experiment 1, but inconsistently so in Experiment 2 (when cue 2 was verb agreement). This suggests that the one-color VIE group was able to use the case marking cue in Experiment 1, but were not able use verb agreement effectively in Experiment 2, despite the fact that their validities were equivalent and both were marked through VIE. Additionally, the cue 3 by experiment interaction was marginally significant, $F_{G\text{-}G}$ (1.47, 91.16) = 3.11, p = .07. Post-hoc tests revealed that participants tended to choose the noun favored by cue 3 in both experiments, but this tendency was stronger in Experiment 1 (animacy) than in Experiment 2 (case marking). This suggests that the animacy cue was easier to apply than the case marking cue. For the two-color VIE group, the cue 2 by experiment interaction was significant, $F_{G\text{-}G}$ (1.78, 114.12) = 3.96, p < .05. Post-hoc analysis tests revealed that this was due to participants in this group tending to choose the noun favored by cue 2 in Experiment 1 (case marking), but not in Experiment 2 (verb agreement). Given that case marking was heavily favored by the two-color VIE group throughout both experiments as well as the greater complexity of the verb agreement cue within this artificial language, this finding is not surprising.

In the third test block, for the no-VIE group, the cue 1 by cue 2 by experiment interaction was again significant, F (4, 264) = 2.56, $p < .05$. Post-hoc tests revealed a similar pattern of results as observed in block 1, with animacy (cue 1) strongly dominating verb agreement (cue 2) in Experiment 2, and no clear dominance emerging between verb agreement (cue 1) and case marking (cue 2) in Experiment 1. For the one-color VIE group, the cue 2 by experiment interaction was again significant, $F_{G\text{-}G}$ (1.56, 96.64) = 4.74, $p < .01$. Post-hoc tests shows that this was due to participants preferring the noun favored by cue 2 (case marking) in Experiment 1, but not in Experiment 2 (verb agreement). This suggests once again that the case marking cue was more readily utilized than the verb agreement cue. Additionally, the cue 1 by cue 2 by experiment interaction was significant, $F_{G\text{-}G}$ (3.49, 216.31) = 3.17, $p < .05$. Post-hoc tests showed a weak dominance of case marking (cue 2) over verb agreement (cue 1) in Experiment 1, while animacy (cue 1) strongly dominated verb agreement (cue 2) in Experiment 2. For the two-color VIE group, the cue 2 by experiment interaction was significant, $F_{G\text{-}G}$ (1.34, 85.84) = 13.50, $p < .001$. Post-hoc tests showed that this was once again driven by participants in this group choosing strongly based upon case marking (cue 2) in Experiment 1, but not verb agreement (cue 1) in Experiment 2. Additionally, the cue 1 by cue 3 by experiment interaction was significant, F (4, 256) = 3.81, $p < .01$. Post-hoc tests showed that this was driven by an additive effect that emerged only in Experiment 2; when animacy (cue 1) and case marking (cue 3) agreed upon a common noun, participants very strongly preferred that noun. Such an additive effect was not observed in Experiment 1 between verb agreement (cue 1) and animacy (cue 3). However, the relationship between animacy and case marking in Experiment 2 is more ambiguous when they are in conflict and there is no clear dominance of either cue over the other. Finally, the four-way interaction of cue 1 by cue 2 by cue 3 by experiment was marginally significant, F (8, 512) = 1.95, $p = .051$. However, given that this finding was only marginally significant, we will not discuss it further.

We can infer several things from the results of these analyses. As stated previously, the consistent significance of the cue 1 by experiment interaction across groups and blocks suggests that the animacy cue was easier to utilize than the verb agreement cue in general. The cue 2 by experiment interactions further suggests that case marking was also more readily applicable than the verb agreement cue. Additionally, the cue 2 by experiment interactions only appeared in the one- and two-color VIE groups, suggesting that the presence of VIE helped participants to utilize the case marking cue, but that it was less helpful in regards to the verb agreement cue. The cue 1 by cue 2 by experiment three-way interactions were primarily driven by animacy being strongly dominant over the

verb agreement cue in Experiment 2, but with no strong dominance pattern between verb agreement and case marking in Experiment 1. This interaction was found primarily in the no-VIE groups, which makes sense, as this group seemed to primarily rely upon animacy over the morphosyntactic cues. However, this interaction also emerged in the third test block for the one-VIE group. As this interaction was not significant for this group on the first test block, this suggests that this group may have originally tried to utilize the morphosyntactic cues, but began to favor animacy more as the experiment progressed – a point we return to in our general discussion. Ultimately, the results of these analyses serve as evidence that certain cues were more difficult to use than others, even when validities were equated, with verb agreement being the most difficult and animacy being the easiest.

CHAPTER 4 – GENERAL DISCUSSION

The purpose of this research was to investigate the ability of salience to facilitate the process of language acquisition within the framework of the CM. Recall that the CM contends that language acquisition and processing primarily depends upon understanding a hierarchy of linguistic cues that serve to orientate users of that language towards the appropriate meanings. A cue's place within this hierarchy depends upon the strength, or validity, of the cue in relation to the others. Validity can be further divided into overall and conflict validities. Overall validity predicts how new learners of a language rely upon cues, while conflict validity reflects what is appropriate for proficient speakers of a language. Using an artificial language, we were able to directly control the validity values of the cues in this experiment. In both experiments, the hierarchies established by overall and conflict validities differed from one another, requiring participants to shift cue interpretation strategies in order to perform better. Thus, this paradigm allowed us to analyze how participants' reliance upon cues changed as the experiment progressed. Differences in this pattern between groups would be due to the inclusion of the VIE manipulations.

In Experiment 1, we concluded that VIE was an effective manipulation in that it affected participants' reliance upon cues. While all groups initially relied upon the word order and animacy cues, only the no-VIE group continued to primarily rely upon these cues throughout that experiment. In contrast, both VIE-present groups eventually began to utilize the case marking cue. This was especially pronounced in the two-color VIE group, in which the morpheme that indicated case marking was particularly salient. Additionally, we also observed evidence that the one-VIE group was beginning to rely upon the verb agreement cue, based upon the eta-squared values for this cue in the final test block.

In Experiment 2, we concluded that VIE failed to have a beneficial effect on language acquisition. There was a non-significant trend for the both of the VIE groups to perform worse on the actor-assignment task in the feedback trials. Additionally, as revealed by our eta-squares analysis, the one-VIE group failed to utilize any cues other than animacy. Finally, we saw that the reliance upon the case-marking cue observed in Experiment 1 re-emerged, albeit diminished, in Experiment 2. This suggests that VIE may not serve to enhance language acquisition per se, but rather induces participants to place a stronger reliance on certain cues, regardless of their validity. We shall revisit this point further in our discussion.

Rearranging the cue hierarchy from Experiment 1 to Experiment 2 produced a very different pattern of results that provides further insight into how VIE serves to influence participants' cue usage. Compared to their

counterparts in Experiment 1, the no-VIE group in Experiment 2 exhibited a similar pattern of eta-square values, indicating that participants in this condition across the two experiments relied upon similar cue interpretation strategies. For the two-color group, the strong overreliance upon the case marking cue observed in Experiment 1 was diminished in Experiment 2 where the animacy cue could be relied upon to always arrive at the correct interpretation.

Most striking are the differences observed in the one-color group between Experiments 1 and 2. Recall that in Experiment 1, the one-color VIE group appeared to show the greatest gains during learning; they reduced their reliance upon the word order and animacy cues and began to utilize the case marking cue. To a lesser extent, this group also began to utilize the verb agreement cue. The notion that participants in this group had made gains in their knowledge of how to correctly apply these cues was supported by their greater performance in regards to correct responses. However, in Experiment 2, the one-color VIE group continuously relied upon the animacy cue throughout the experiment and did not seem to adopt new cue interpretation strategies as the experiment progressed. Even when the ANOVA flagged a significant main effect of a cue other than animacy in the one-color group, the subsequent eta-squared values were very low, even relative to the values obtained throughout both experiments. This suggests that, in Experiment 2, the morphosyntactic cues ultimately accounted for little of the variance in the one-VIE groups' responses. The inability of the one-color VIE group to effectively adjust their cue interpretation strategies is supported by their poorer performance in regards to correct responses. Although there was no main effect of group found, there was an observed trend of poorer performance in the feedback blocks for both VIE groups, compared to the no-VIE group. Interestingly, this trend disappears in the test trials; in the later blocks, performance in the one-color group is similar to the no-VIE group, with the two-color group having the worst overall performance. We must stress, however, that there was no significant difference between the VIE groups in either the feedback or test blocks in Experiment 2.

Ultimately, our two experiments suggest that the ability of VIE to impact the language acquisition process, at least within the context of the CM, is nuanced. Experiment 1 showed that VIE could be effective in facilitating the shift from reliance upon overall validity to conflict validity that has been identified as being key to language mastery. In that experiment, a main effect of group was found in regards to correct responses, and was driven by participants in the one-color VIE condition significantly outperforming participants in the no-VIE condition on the final block of feedback trials. However, the two-color VIE group's performance with regards to correct responses

fell in-between the one-color VIE and no-VIE groups, and was not significantly different from either. We interpreted this as being due to an overreliance on the case marking cue, caused by the increased salience of this cue relative to the other cues in the two-color condition. This greater reliance upon the case marking cue, albeit diminished, was observed again in Experiment 2.

Experiment 2 demonstrated further shortcomings of VIE. Although performance tended to be better overall compared to Experiment 1, the trend was for the one-color VIE group to perform similarly to the two-color group and worse than the no-VIE group on the feedback trials. Interestingly, this trend disappeared in the test trials, in which the one-color group performed similarly to the no-VIE condition, while the two-color VIE group showing the worst (although not significantly different) performance.

Why did VIE seem to benefit participants in the one-color VIE group in Experiment 1, yet fail to benefit them in Experiment 2? Our interpretation is that it is a result of the lower conflict validity for the verb agreement cue in Experiment 2 in combination with the greater difficulty in utilizing the verb agreement cue relative to the others. In Experiment 1, verb agreement possessed a conflict validity of 100%. That is, anytime that verb agreement preferred a noun in the sentence, that noun would be the correct response without exception. In Experiment 2, however, although verb agreement possessed a relatively high conflict validity (72%), it was not 100% valid. Our interpretation is that, in this experiment, VIE continued to draw attention to the marked cues (verb agreement and case marking) but on some trials, using these cues would lead to an incorrect decision. Thus, instead of learning that the verb agreement cue was reliable, the one-color VIE group learned that this cue were inconsistent. Upon finding that these cues were unreliable, these participants would most likely turn to strategies involving the non-morphosyntactically based cues. Our cross-experiment comparison provides some evidence for this. The cue 1 by cue 2 by experiment interaction was significant for the no-VIE group (who clearly relied on animacy to a high degree) and for the one-VIE group in block 3 only. That this interaction was not flagged significant in block 1 for the one-VIE group suggests that these participants attempted to use the morphosyntactic cues over the semantic cue of animacy, before abandoning this strategy as the experiment continued.

Thus, noticing that the morphosyntactic were not reliable in Experiment 2 led the one-color VIE group in to utilize the morphological cues inconsistently in their decision making process, leading to a ‘wash-out’ effect in the eta-squares analysis, where it appears that no morphological cues were utilized. As to why this ‘wash-out’ effect did not emerge in regards to the case marking cue in the two-color VIE group, we suggest that this can be accounted for

by cue difficulty. In this experiment, case was marked by the addition of the particle '-pa' onto the end of noun serving as the direct object. Contrast this to the verb agreement cue, which required participants to identify two different suffixes that could appear at the end of the verb, an additional set of two different suffixes that could appear at the end of the nouns, what the relationship between these two sets of suffixes were, and to actively identify all three verb-agreement suffixes that were present within in a given sentence. This assertion is supported by the results of the cross-experiment comparison. The cue 1 by experiment interaction that was found to be significant (or marginally so) for every group examined showed that, even when validities were equated, animacy was more readily applied than verb agreement. More importantly, the cue 2 by experiment interactions were driven by case marking being more readily applied in Experiment 1 than verb agreement in Experiment 2, again despite equivalent validities.

Additionally, in the one-color VIE group, both the case marking and the verb agreement suffixes were presented in the same red font. Participants may have failed to disassociate between these two cues, potentially leading to the formation of inconsistent or unproductive strategies. This assertion is supported by evidence from our post-experimental questionnaire, in which several participants mention utilizing word length as a cue (that is, participants would explicitly mention choosing either the 'long' or 'short' word as the actor of the sentence).

The Competition Model Versus The Shallow Structure Hypothesis

Previously, we considered our hypotheses for the present experiment within the context of two different models, the SSH (Clahsen & Felser, 2006) and the CM (MacWhinney, 2005a). To review, the SSH predicts that language learners will fail to utilize morphosyntactic cues in a new language, and will instead rely upon semantic, lexical, or pragmatic cues. Conversely, the CM predicts a pattern of cue usage contingent upon cue validity – participants will begin by relying upon cues with the greatest overall validity and ultimately shift to rely upon cues with the greatest conflict validity. Additionally, the CM also suggests that influence of transfer effects, suggesting that participants may attempt to use cues based upon successful interpretation strategies in their L1 – for our native English speaking participants, this means that they would attempt to deploy a strategy based upon the word order cue. Our data supports elements of both, although ultimately better fits the predictions of the CM.

In regards to the predictions of the SSH, there was a tendency across all experimental groups to utilize the animacy cue to a relatively high degree during the initial blocks. This finding falls in line with the predictions of the SSH. However, our eta-squares analysis showed that participants did demonstrate a shift in their cue interpretation

strategies as the experiment progressed, regardless of group and across both experiments. The only group that did not demonstrate such a shift was the one-color VIE group in Experiment 2. However, as we have argued above, this may have been due to participants reaching the conclusion that the morphosyntactic cues were unreliable, rather than an unwillingness or inability to use the morphosyntactic cues, as suggested by the SSH.

Thus, based upon the observation that participants, in general, altered their cue usage strategies throughout the course of the experiment, we conclude that our data are a better fit with the CM. We previously noted that participants naively utilized the animacy cue, in line with the predictions of the SSH, but participants also often relied upon the word order cue in the early stages of the experiment – indicative of the transfer effects predicted by the CM. Participants also demonstrated a tendency to increase their reliance upon the case marking and (to a lesser extent) verb agreement cues, thus showing the ability to incorporate morphosyntactic cues and in opposition to the predictions of the SSH. However, there is still the matter of participants seemingly not relying upon the verb agreement cue. As we discussed previously, the CM suggests a shift based upon cue validities. Based upon this, we would have predicted that participants would primarily utilize the verb agreement cue by the end of the experiment. This was not the case; participants more readily acquire the cue with the second highest conflict validity (case marking). However, as we've previously argued, this finding can be explained by differences in cue difficulty – in this artificial language, applying the case marking cue is much less complicated than applying the verb agreement cue. Furthermore, our cross-experimental comparison provides some evidence that VIE interacts with cue validity and difficulty when it comes to influencing participants' interpretation strategies. VIE seemed to more strongly encourage the use of the case marking cue than it did for the verb agreement cue. Additionally, the animacy cue did not seem to require any sort of visual enhancement in order to be prioritized as a cue; participants seemed to readily attempt to use this cue, as predicted by the SSH. Further research designed specifically to examine this intersection of cue difficulty, modality, validity and VIE is necessary.

Ultimately, based upon our data, the predictions of the SSH only hold true during the early stages of learning. During the beginning blocks, participants seemed to form strategies either based upon their semantic understanding of the world, in line with the SSH, or based upon word order, as predicted by the CM. However, participants also demonstrated the ability to use the morphosyntactic cues as the experiment continued, in line with the predictions of the CM and in opposition to the predictions of the SSH. Based upon these observations, the SSH

seems to be best suited towards describing how people behave in early L2 acquisition, while the CM is the better model for the L2 acquisition process over time.

Applications of VIE

In regards to the question of whether or not VIE is a beneficial in terms of language acquisition, our results suggest a nuanced answer. Clear differences between the groups were apparent in our eta-squares analysis, showing that VIE affected how participants utilized cue interpretation strategies. However, this impact is not necessarily always positive. Depending upon cue difficulty and arrangement of the cue hierarchy, VIE can be beneficial (as observed in the one-color group in Experiment 1) or fail to provide any sort of positive effect (as observed in both VIE groups in Experiment 2).

From an applied standpoint, VIE appears to be an effective tool in facilitating language acquisition, but it may be limited in applicability. Our data suggests that VIE is only beneficial for cues that guarantee correct interpretation or are relatively simple to process. Thus, depending upon the idiosyncrasies of a given language, the ability for VIE to enhance language learning interventions may be limited. However, for languages that do possess decisive cues, VIE may serve as a beneficial and cost-effective technique to use that could be readily implemented into the existing environment of language instruction. For instance, in a language instruction textbook, grammatical markers used to indicate the conjugation of verbs (i.e. the cue of verb agreement) could be printed in a different color or style font than from the context in which they are presented, allowing students to receive the beneficial effects of VIE during the course of their normal studies. Teachers attempting to implement VIE into the classroom would need to exercise caution, however, in making sure VIE is an appropriate tool for what they are attempting to teach. If students are attempting to learn a nuanced language structure, or an element of language that places emphasis on non-morphosyntactic elements, then VIE may cause more harm than good.

Future directions in this line of research should attempt to apply this paradigm to real world languages that possess various cue hierarchies. In particular, the efficacy of VIE should be evaluated in languages with dominant cues (such as German and case marking) versus languages without a clear dominant cue (such as Italian). Furthermore, while this study compared VIE on morphosyntactic cues in the presence of semantic cues, more research is necessary to understand how VIE interacts with cue modality. For example, the present paradigm could be replicated, but with semantic cues marked in VIE, rather than morphosyntactic cues. Other cues, such as stress

and tone, also need to be investigated within a paradigm such as this to understand how they compete with other cues and interact with attention-enhancing manipulations, such as VIE.

Conclusion

This study approached the language acquisition process through the framework of the CM. By designing a paradigm around this model, we were able to track how participants respond to various cues within a novel language, and how these responses vary throughout the course of learning. We found that, although participants may originally attempt to use highly valid cues in their native language (i.e. transfer effects) or rely upon semantically based cues such as animacy, participants were able to utilize the morphosynactic based cues within our artificial language as learning progressed.

Furthermore, we investigated the potential ability for VIE to impact the language learning process through directing attention to particular cues within the language. It was found that VIE can indeed affect how participants' responded to cues. While these effects were not positive in all contexts, they were beneficial when VIE was applied to highly consistent morphosyntactic cues. By using discretion, language educators should be able to identify components of their instruction that can benefit from this tool. However, our results also suggest that VIE is only beneficial in particular contexts. We call for more research that investigates to what extent VIE facilitates (or fails to facilitate) language acquisition, expanding upon our results by investigating the effect of VIE when different cues are available, or when cues are not morphosyntactic nature. In addition to helping address concerns with VIE, such research would also help to illuminate the interactions between attention and language acquisition as well as how the relationship between these two factors can be used to facilitate language education.

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