Language learners determine alignment on the basis of which transitive argument type is zero-coded

Abstract

Greenberg's Universal 38 (U38; Greenberg, 1963, p. 56), states that if the distinction between agent-like (A) and patient-like (P) arguments of transitive verbs is coded by the presence or absence of some overt morpheme(s), then arguments of intransitive verbs (S) are zero-coded and thus are aligned with whichever of A and P is zero-coded. It is possible that pressure to conform to U38 determines alignment. In order to test this hypothesis, we had English-speaking participants learn a case-marking artificial language from input containing only transitive clauses, and then elicited intransitive clauses in the artificial languages from the participants. Participants coded S by zero, using an ergative pattern (dissimilar from that of English), in a condition where P was zero-coded in the transitive clauses, and coded S overtly, using an accusative pattern (similar to that of English), in a condition where neither A nor P were zero-coded in the transitive clauses. The result confirms that language learners are capable of determining alignment on the basis of which transitive argument type is zero-coded.

Introduction

A recent development in linguistic typology has been the use of artificial language learning experiments as a means of studying learning biases which might underlie observable typological pattern (Pycha, Nowak, Shin & Shosted, 2003; St. Clair, Monaghan & Ramscar, 2009; Culbertson, Smolensky & Legendre, 2012). In this paper, we use the artificial language learning paradigm to investigate the causes of a cross-linguistic typological rule identified by Joseph Greenberg:

> *Universal 38.* Where there is a case system, the only case which ever has only zero allomorphs is the one which includes among its meanings that of the subject of the intransitive verb. (Greenberg, 1963, p. 59)

Universal 38 (henceforth U38), although stated absolutely by Greenberg, has been shown to have rare exceptions ("marked-S languages"; Handschuh, 2012), but it is a strong statistical universal. It is one of a number of Greenberg's universals concerning cross-linguistic asymmetries in which of the values of a grammatical category may be uniformly (i.e. in all environments) coded by zero. For example, Universal 35 (p. 58) prohibits uniform zero-coding of plural number. Different explanations have been given for universals of this type. For example, Jakobson (1965: 29–30) suggested that iconicity is involved: just as plural quantities are greater in number than singular ones, so plural words are greater in length than singular ones. Haspelmath (2008), however, argues that these asymmetries can be reduced entirely to an effect of frequency and economy, zero-coding being most economical for the highest-frequency category value.

A special feature of the category U38 concerns is that there is substantial cross-linguistic variation in how the boundaries between its values are drawn. One of the primary functions of case-marking is to distinguish the agent-like (A) and patient-like (P) arguments of transitive verbs. Case-marking languages therefore almost always have different cases for A and P arguments. Making this distinction by some means is probably necessary for effective communication, given that most transitive verbs are asymmetric (switching their arguments changes their meaning; *dog bites man* means something different from *man bites dog*). However, languages also have intransitive verbs, which take only a single argument (S). There is no need to distinguish S from A and P, given that S occurs in an entirely different syntactic environment. Therefore, case-marking languages generally "align" S with either A or P by having S take the same case as either A or P (exceptions, which are said to have *tripartite* alignment, are rare, but see Rude, 1986). If S is aligned with A, then the language, and the case of P, are said to be *accusative*, and the case of S and A is called *nominative*. If S is aligned with P, then the language, and the case of A, are said to be *ergative*, and the case of S and P is called *absolutive*. Accusativity is more prevalent than ergativity, but not overwhelmingly so (Comrie, 2013).

Therefore, U38 is special among the zero-coding asymmetry universals in that it does not describe a zero-coding asymmetry between the two argument types it is necessary to distinguish in order to disambiguate meanings (A and P). Rather, it describes an asymmetry in which argument type is aligned with S if one of A and P is zero-coded. Regardless of which of A and P is zero-coded, U38 says that S is also zero-coded, and therefore the language is accusative if A is zero-coded and ergative if P is zero-coded. It is therefore possible that U38 has a somewhat different cause from the zero-coding asymmetry universals. Indeed, from the formulation of U38 above we can see that the alignment of a language is predictable on the basis of whether it zero-codes A or P. So, rather than seeing the regularities in the coding of different cases as determined by the frequency and iconicity properties of those cases (in the "alignment determines coding" view), we may see the make-up of the cases themselves—the aligment—as being determined by the coding patterns of the individual argument types A and P (in the "coding determines alignment" view).

The "alignment determines coding" (ADC) and "coding determines alignment" (CDA) formulations of U38 are equivalent with respect to the synchronic correlations they describe. However, they suggest different hypotheses about what the underlying cognitive biases resulting in conformance to U38 are. The ADC formulation is compatible with a frequency-based explanation such as that of Haspelmath (2005, p. 11): the case aligned with S is more frequent (as it covers two argument types, rather than one) and therefore more economical to zero-code (Haspelmath, 2005, p. 11). In other words, the bias is for zero-coding of nominative or absolutive case, given the pre-determined alignment. The CDA formulation, on the other hand, suggests a different sort of economy pressure is at work: given that S must align with one of A and P, but it can align with either, it is most economical for it to align with the one which is zero-coded (Comrie, 1989, pp. 126–127). This is the same sort of economy pressure that has been suggested as the cause of another case-related phenomenon, differential object marking (DOM) (Aissen, 2003; Fedzechkina, Jaeger & Newport, 2012). The bias resulting from this pressure, which we shall call *Economical Alignment Bias (EAB),* can be described as follows:

EAB. If A is zero-coded, accusativity is favoured. If P is zero-coded, ergativity is favoured.

Note that EAB is different from a simple preference for zero-coding of S, because it does not say anything about which alignment is favoured if both A and P are overtly coded. Although it would be more economical in terms of quantity of phonological material to zero-code S even in this condition (resulting in tripartite alignment), it would be less economical in terms of requiring language learners to learn an extra code.

In order to find evidence for EAB, we carried out an artificial language experiment designed to demonstrate its effect in an artificial language setting, making use of the "poverty of the stimulus method" (Wilson, 2006; Culbertson & Adger, 2014). Participants were trained on transitive sentences only, so that no alignment was presupposed; their production of intransitive sentences was then examined at test, and thereby the alignment they chose was deduced. In the absence of any cue of alignment during training, participants were expected to choose alignment based on a combination of transfer effects from the natural languages they speak and general learning biases, such as EAB. In order to isolate the effect of EAB, the coding pattern in the training sentences was altered between two conditions: one (Condition 1; C1) with either A or P zero-coded, so that EAB, if it exists, encourages the alignment opposite from that of the participants' spoken natural languages; and another (Condition 2; C1) with both A and P overtly coded, so that EAB has no effect even if it does exist. If EAB is sufficiently strong compared to the transfer effects, it could result in participants choosing different alignments in Conditions 1 and 2 (or, in concrete terms, choosing zero-coding of S in Condition 1 and overt coding of S by the A-coding suffix in Condition 2).

Although the experiment could in principle be carried out with participants speaking either accusative or ergative languages, our participants spoke an accusative language. Therefore, the following two conditions were used:

C1. The artificial language codes A by an overt suffix and P by zero.

C2. The artificial language codes both A and P by distinct overt suffixes.

Our prediction was that accusative alignment (overt coding of S by the A-coding suffix) would be less frequent in C1 than in C2, due to the presence of EAB in C1 but not in C2.

Method

Participants

The participants were 50 undergraduate students at the University of Edinburgh, each given £12 compensation.

All participants were monolingual speakers of English, a language in which case is coded on first- and third-person pronouns only, by suppletion, with accusative alignment. It was expected that this would be enough for a transfer effect favouring accusative alignment to exist, but that the transfer effect would also be relatively weak compared to that which might be exhibited by speakers of other languages such as German with case coding on nouns as well as pronouns or by means of zero-coding vs. overt coding rather than suppletion.

Design

In order to minimize learning difficulty, the artificial language was similar to English wherever possible. Its verbs were therefore identical in form and meaning to those of English. However, the language did have different nouns, in order to facilitate learning of unfamiliar morphology for these nouns. There were only 5 nouns (*bink* "policeman", *flimp* "burglar", *jed* "nun", *mog* "pirate" and *snib* "ballerina"), the small number being chosen to further minimize learning difficulty. Each of these nouns denoted a set of humans so that participants were unable to use differential animacy as a cue of argument type (which would make it less necessary for them to learn the case-marking system).

In addition to these nouns there were one or two case-marking suffixes, depending on the condition. In C1, *-low* coded A and zero coded P. In C2, *-low* and *-ray* coded A and P respectively. To make it as easy as possible for participants to learn the meanings of these suffixes, a short article was presented to them at the start of the experiment introducing the artificial language, telling them that the language made use of suffixes rather than word order in order to distinguish the meanings of sentences such as "the dog bites the man" and "the man bites the dog", and that their objective was to figure out how these suffixes worked.

Procedure

The experiment had four phases, each involving participants encountering a sequence of stimuli via a computer program.

Each stimulus consisted of one or two pictures depicting a person or action, possibly accompanied by an artificial language sentence describing one of the pictures together with audio of the sentence's pronunciation. Audio was played once automatically as soon as a participant viewed the stimulus; afterwards the participant could choose to play it again any number of times. Participants were encouraged (via text on the screen, and by the words “repeat after me” spoken at the start of the audio playback) to repeat the words they heard.

Phase 1 consisted of a “passive” subphase, with stimuli consisting of both artificial language nouns and pictures of their referents, and an “active” subphase, in which only pictures of referents were shown and participants were asked to supply the nouns (via typed input). Participants supplying wrong nouns were told the correct noun. There were 5 stimuli shown in each phase, one for each noun.

Participants’ knowledge of the artificial language nouns was reinforced further during phase 2. However, phase 1 served to allow participants to focus on learning the nouns alone (rather than together with the grammar of transitive sentences), and to signal to the participants that they should devote some attention to learning the nouns.

During **phase 2**, participants were again shown both “passive” and “active” stimuli in alternating groups of size 10 (10 passive, 10 active, 10 passive, and so on). Passive stimuli consisted of single pictures depicting actions involving two people (see figure 1), accompanied by artificial language sentences describing those pictures. No input from participants was required. Active stimuli consisted of pairs of pictures depicting the same action between two people but with the A and P switched between each picture (e.g. the policeman scolding the ballerina in one picture, the ballerina scolding the policeman in the other picture), accompanied by a single artificial language sentence describing one of these pictures. Participants were asked to select the picture the sentence described, and told the correct picture if they gave the wrong answer.

The sentences in these stimuli each consisted of a verb followed by two nouns. Half of the sentences had A before P and half of the sentences had P before A, so word order was not a cue of argument type. Argument type was instead coded by suffixes, as described above.

In total, 80 stimuli were shown during this phase. 10 different verbs were involved (“arrest”, “chase”, “frighten”, “help”, “hug”, “kick”, “nudge”, “push”, “scold”, “teach”), each verb appearing four times, twice with PA order and twice with AP order. Each of the 5 nouns appeared as exactly 8 of the A arguments and exactly 8 of the P arguments, so no noun more frequently occurred as A than as P or vice versa. Stimuli involving the same verb also had a different A argument each time and a different P argument each time, so that no noun more frequently occurred as A than as P with any particular verb.

Figure 1: A picture in a stimulus during phase 2. The sentence describing this picture could be scold binklow snib *or* scold snib binklow *(C1), or* scold binklow snibra *or* scold snibra binklow *(C2).*

Phase 3 was a repetition of the active subphase of phase 1, intended to jog the participants' memories of the artificial language nouns before phase 4 in which they would be required to produce them. The phase was repeated until the participant gave the correct answer in all 5 trials, or until 3 iterations had passed and the participant opted to progress to phase 4 rather than repeat again.

During **phase 4**, stimuli consisted of single pictures depicting actions which were either transitive (involving two people) or intransitive (involving a single person). These pictures were accompanied by sentence fragments consisting of the verb describing the action, followed by an ellipsis (see figure 2). Participants were asked to supply the rest of the sentence as typed input.

The pictures in this phase involved novel verbs, even the ones depicting transitive actions. There were 10 new transitive verbs ("carry", "follow", "insult", "kiss", "love", "phone", "punch", "salute", "slap", "tickle") and 10 intransitive verbs ("cry", "dance", "jump", "laugh", "run", "sit", "sleep", "smile", "sneeze", "speak") distributed across 40 sentences, with each verb appearing twice, with different arguments each time. Each of the 5 nouns appeared as A in the transitive sentences at the same rate as it appeared as P, just as in the previous phases. In order to ensure that participants' memories of the artificial language nouns were constantly jogged, each of the 5 nouns was depicted at least once among every set of 5 consecutive stimuli.

Figure 2: A picture depicting an intransitive action in a stimulus during phase 4, accompanied by the sentence fragment laugh...

Results

For every participant, we assessed the degree of learning of the case system in transitive clauses by calculating the proportion of complete transitive sentences elicited during phase 4 that were coded correctly (i.e. with *-low* on A and zero on P in C1, with *-low* on A and *-ray* on P in C2), which we call the *accuracy rate*. By a *complete* transitive sentence we mean one for which both arguments were supplied; incomplete sentences were excluded from the calculation because their inaccuracy was due to non-learning of nouns rather than non-learning of the case system. The minimum number of complete transitive sentences over which this proportion was calculated was 11 (C1) or 17 (C2). Participants for whom the accuracy rate was ≤90% were excluded from the analysis, reducing the effective sample sizes to 22 in C1 and 19 in C2. The rationale for this exclusion was to ensure that all participants included in the analysis could be assumed to have learnt more or less the same grammar in transitive sentences.

For each remaining participant, we calculated the proportion of complete intransitive sentences elicited during phase 4 with overt coding of S by *-low.* The minimum number of complete intransitive sentences over which this proportion was calculated was 17 in C1, 19 in C2. As predicted, the average proportion across participants was much lower (mean 32.4%, median 30.0%) in C1 than in C2 (mean 81.6%, median 100.0%). The means were closer together than the medians, reflecting the skewed distribution of the datapoints towards categorical proportions of either 0 (in C1) or 1 (in C2).

Discussion

The results are consistent with the prediction of the EAB that overt coding of S by the A-coding suffix *-low* would be significantly more common in C2, in which both A and P were overtly coded, than in C2, in which A was overtly coded and P was zero-coded, even though the participants' spoken natural language was one with accusative case alignment, which we would expect to encourage coding of S by *-low*.

Although these results comprise evidence that EAB exists in some form, the question remains of how widely it is applicable outside of the artificial language setting. Perhaps EAB sheds some light on the nature of the cognitive biases underlying U38, but does it have any advantages over other explanations in terms of explaining observable linguistic data? We believe there are two significant advantages.

First, the EAB-based explanation for U38 leads to a natural explanation for the observable cross-linguistic variation between accusative and ergative alignment. Variation in which of A and P is zero-coded has a natural explanation: grammaticalization theory shows that newly-grammaticalized overt case-marking morphemes may code for either A or P status, depending on the source of the morpheme, e.g. instrumentals can come to code for A status and allatives can come to code for P status (Heine & Kuteva, 2002, pp. 38, 180). The EAB implies that the former pathway will generally result in ergativity and the latter pathway will generally result in accusativity (unless both pathways are followed concurrently, in which case the language will presumably up with overt coding of both A and P). Explanations of U38 with alignment determining coding rather than coding determining alignment suffer from the lack of any similar motivation for the initial variation in alignment.

Second, the EAB can explain the difference between the distribution of alignment of case-marking, specifically, and alignment of other phenomena. Languages may treat S like A or like P with respect to syntactic phenomena such as word order or relativization, and we may therefore speak of the alignment of these phenomena as well as alignment of case-marking; different phenomena of the same language may have different alignments. One particular pattern which has been noticed is that most or at least many languages with ergative alignment of case-marking are syntactically accusative (Dixon, 1994, p. 172; Polinsky, in press). As Comrie (1989, p. 127) alludes to, this is naturally explicable by the fact that EAB applies only to alignment of case-marking specifically, and therefore it constitutes an extra pressure for ergativity of the case-marking phenomenon which does not exist with respect to other phenomena.

This is not to say that frequency effects are entirely irrelevant in an explanation of U38. Once an alignment is in place, and the nominative and accusative or ergative and absolutive category values exist, frequency effects may bolster the tendency for ergative and accusative to be overtly coded, by e.g. encouraging phonological erosion of the nominative and absolutive markers if they are also overt. However, it is EAB which results in U38-conformance in situations where a case-marking system is coming into being (so that no case alignment is pre-determined). It may also be observable in the manner in which diachronic changes of alignment occur.

Conclusion

The results of our experiment suggest the existence of a functional, economically-motivated bias (which we have called the EAB) that encourages determination of alignment by the coding of argument type in transitive sentences: accusativity arises if A is zero-coded and ergativity arises if P is zero-coded. We suggest that EAB is the main factor resulting in cross-linguistic conformance to Greenberg's Universal 38 (U38). This particular explanation of U38 also helps illuminate why cross-linguistic variation in alignment exists, and why it exists most strongly with respect to case-marking in particular.

References

Aissen, J. L. (2003). Differential object marking: iconicity vs. economy. *Natural Language and Linguistic Theory, 21*(3), 435–483.

Comrie, B. (1989). *Language Universals and Linguistic Typology: Syntax and Morphology* (2nd edition). Chicago: University of Chicago Press.

Comrie, B. (2013). Alignment of case marking of full noun phrases. In Dryer, M. S. & Haspelmath, M. (Eds.), *The World Atlas of Language Structures Online*. Leipzig: Max Planck Institute for Evolutionary Anthropology. Retrieved from http://wals.info/chapter/98.

Culbertson, J., Smolensky, P., & Legendre, G. (2012). Learning biases predict a word order universal. *Cognition 122*(3), 306–329.

Culbertson, J., & Adger, D. (2014). Language learners privilege structured meaning over surface frequency. *Proceedings of the National Academy of Sciences, 111*(16), 5842–5847.

Dixon, R. M. W. (1994). *Ergativity*. Cambridge: Cambridge University Press.

Fedzechkina, M., Jaeger, T. F., & Newport, E. L. (2012). Language learners restructure their input to facilitate efficient communication. *Proceedings of the National Academy of Sciences, 109*(44), 17897–17902.

Greenberg, J. H. (1963). Some universals of grammar with particular reference to the order of meaningful elements. In Greenberg, J. H. (Ed.), *Universals of Human Language* (pp. 73–113). Cambridge, Massachusetts: Massachusetts Institute of Technology Press.

Handschuh, C. (2014). *A typology of marked-S languages*. Berlin: Language Science Press.

Haspelmath, M. (2005). Argument marking in ditransitive alignment types. *Linguistic Discovery, 3*(1), 1–21.

Haspelmath, M. (2008). Frequency vs. iconicity in explaining grammatical asymmetries. *Cognitive Linguistics 19*(1), 1–33.

Heine, B., & Kuteva, T. (2002). *World Lexicon of Grammaticalization*. Cambridge: Cambridge University Press.

Jakobson, R. (1965). Quest for the essence of language. *Diogenes 13*(51), 21–37.

Polinsky, M. (in press). Syntactic ergativity. In *The Blackwell Companion to Syntax* (2nd edition). Blackwell Publishing Ltd.

Pycha, A., Nowak, P., Shin, E., & Shosted, R. (2003). Phonological rule-learning and its implications for a theory of vowel harmony. In Garding, G. & Tsujimura, M. (Eds.), *Proceedings of the 30th Annual Boston University Conference on Language Development* (pp. 464–475). Somerville, Massachusetts: Cascadilla.

Rude, N. (1986). Topicality, transitivity, and the direct object in Nez Perce. *International Journal of American Linguistics 52*(2), 124–153.

St. Clair, M. C., Monaghan, P., & Ramscar, M. (2009). Relationships between language structure and language learning: the suffixing preference and grammatical categorization. *Cognitive Science 33*(7), 1317–1329.

Wilson, C. (2006). Learning phonology with substantive bias: an experimental and computational study of velar palatalization. *Cognitive Science, 30*(5), 945–982.