Speakers balance production effort against message uncertainty: Evidence from cross-linguistic artificial language learning

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Artificial language learning experiments have become a standard method to study processing and communicative preferences during learning. These studies claim to have uncovered a variety of general processing biases [1–3] underlying the acquisition and use of human language. However, participants in these studies are typically adults who speak at least one language natively (their L1). Given that L1 influence on subsequent language acquisition is wide-spread in natural languages [4–6], learners' performance on artificial language tasks could be subject to L1 influence as well. This raises a possibility that some aspects of learners' performance are due to L1 influence rather than the general biases claimed to be at work. Consider a bias to balance message uncertainty against production effort shown by [7, 8]. In this work, learners exposed to artificial languages with optional case marking and either fixed or flexible constituent order restructured the languages to maintain case marking when it was informative about grammatical function assignment (flexible order language) and to drop case when it was redundant (fixed order language), thereby efficiently trading off the effort required to produce case against message uncertainty. However, since all participants were adult monolingual L1 English speakers, using less case marking in the fixed order language is also consistent with L1 influence: Learners could have dropped case to bring the artificial language closer to their L1, which has fixed order and no case. Here, we ask whether speakers of structurally different languages–English (a fixed order language without case marking) and German (flexible order language with a rich case system)–restructure artificial language input in the same way following the bias to balance message uncertainty against production effort (which would suggest a general bias at work) or show different preferences in using case and constituent order (which would suggest an L1 influence).

Method: We exposed English and German speakers (20 per artificial language) to artificial languages over 2 sessions spread across 2 consecutive days. The languages had either flexible (VSO/VOS 50/50%) or fixed (VSO 100%) constituent order. Both languages had optional case marking on the object (67% present); subjects were never case marked. Participants first learned alien character-name pairings and then learned the grammar by watching videos of transitive actions accompanied by artificial language descriptions. At the end of each session, participants described previously unseen transitive action videos using the artificial language. We assessed the use of case and constituent order in production.

Results: We analyzed learners' case and (for the flexible order language only) VSO use in production using generalized linear mixed effects models (with maximal random effects structure). Learners of the flexible order language used significantly more case compared to the learners of the fixed order language ($\hat{\beta}$=1.31, z=5.62, p<0.001). L1 had no significant effect on case use ($\hat{\beta}$=-0.22, z=-0.97, p=0.33) and did not interact with constituent order flexibility ($\hat{\beta}$=0.22, z=0.94, p=0.34; Fig.1). Additionally, L1 had no significant effect on constituent order use in the flexible order language ($\hat{\beta}$=0.03, z=0.16, p=0.85; Fig.2), with both English ($\hat{\beta}$=-0.27, z=-0.75, p=0.44) and German ($\hat{\beta}$=-0.53, z=-1.48, p=0.13) speakers matching the input proportion. Thus, we found no difference in how English and German speakers follow the bias to balance uncertainty against production effort: Both groups matched the input constituent order and used more case in the flexible order language compared to the fixed order language.

Conclusion: To our knowledge, this is the first cross-linguistic investigation of preferences in artificial language learning that have been attributed to abstract general biases. Our findings suggest that the bias to balance message uncertainty against production effort is unaffected by L1 influence. Despite having structurally different L1s, English and German speakers expressed this bias in the same way in our experiment. We show that by collecting data from participants with structurally different L1s, we can begin to ask questions about the precise circumstances of L1 influence and its interactions with more abstract universal biases in miniature artificial language learning.

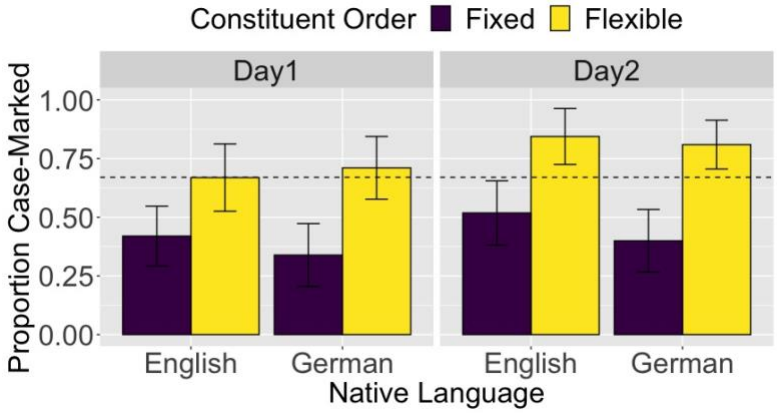

Figure 1: Case marker use in production by day of training and L1 backgrounds. The dashed line represents the input proportion (same across fixed and flexible order artificial languages). Error bars are bootstrapped 95% confidence intervals.

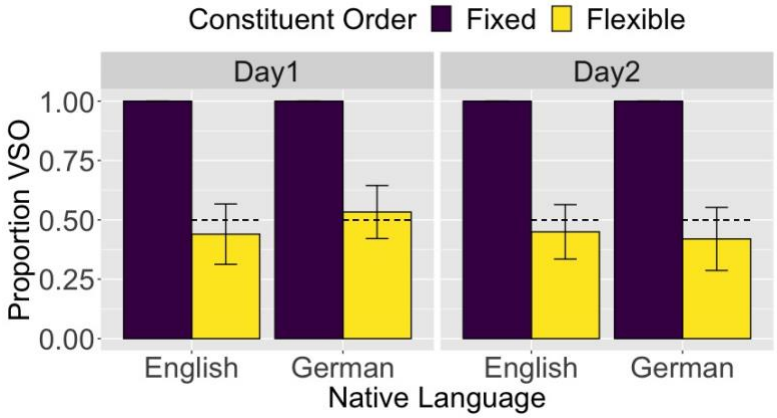

Figure 2: VSO use in production by day of training and L1 background. The dashed line represents the input proportion for the flexible order language (VSO input for the fixed order language is 1.0). Error bars are bootstrapped 95% confidence intervals.

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