Effects of Communicative Pressures on Novice L2 Learners' Use of Optional Formal Devices

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Abstract

We conducted an **Artificial Language Learning** (ALL) experiment to examine the **production behavior** of language learners in a **dynamic communicative setting**. Participants learned a miniature language with **two optional formal devices** and then used the language in a **cooperative game**.

The results showed that language learners **optimize** their use of the optional formal devices to transfer information efficiently and that they **avoid** the production of ambiguous information.

These results could be used within the context of a language model such that the model can more accurately reflect the production behavior of human language learners.

Introduction

- Grice's (1975) **Maxim of Quantity**: language users avoid the use of redundant or ambiguous information in cooperative situations.
- **Uniform Information Density** (UID) hypothesis (Jaeger, 2010): language users keep information density close to channel capacity.
- Previous work using the ALL paradigm has suggested that language learners **diverge from the statistical properties** of the input language data to make the language more efficient (Fedzechkina, 2012}.

We conducted a novel ALL study, to observe efficient linguistic behavior in a **dynamic communicative setting** involving a **cooperative game**.

Three options were considered:

- Speakers prefer efficient structures, *regardless of the communicative setting* or the learning process.
- Speakers are *sensitive to the learning process* and strictly follow (during production) the frequency patterns to which they were exposed (during learning).
- Speakers *dynamically adjust their linguistic behavior* according to changes in the communicative setting, such as acoustic noise or ambiguities against the visual context.

We presented participants with an **miniature artificial language** with **optional overt subjects (OS)** and **optional agreement affixes (AA) on the verb**, and examined the usage of these optional devices within a cooperative situation in a dynamic setting.

Materials and Methods

The Artificial Language

- **8 nouns**:
  - **4 subjects** (man, woman, men and women)
  - **4 objects** (apple, cheese, carrot and cake)
- **2 verbs** (eat and drop)
- **One determiner** ("ha")
- **4 Agreement Affixes** [gender + number] that could be attached to the verb

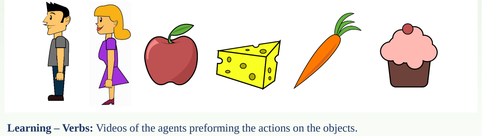
All sentences in the artificial language had **SVO** constituent order.

The subjects and the affixes were both optional and equally distributed during learning. Thus the translation for the sentence "**The man drops[Sg. Masc.] the apple**" could be said in four ways:

Sentence types	Overt Subject (OS) NP	VP (+ AA)	Object NP	Exposure % during learning
+OS +AA	Ha Dini	napal_ini	Ha tapu	25%
-OS +AA		napal	Ha tapu	25%
+OS -AA	Ha Dini	napal	Ha tapu	25%
-OS -AA		napal_ini	Ha tapu	25%

Visual Stimuli

Learning - Nouns:



Learning – Verbs: Videos of the agents preforming the actions on the objects.

- **During the cooperative game**, videos (1 target + 1 competitor) similar to those from the learning session were played.

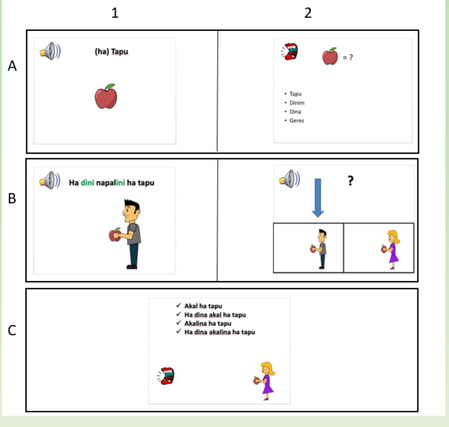
Audio Stimuli

Words and sentence recordings: visual stimuli aid (image or video) was accompanied by a recording of its description in the artificial language.

Background noise: During the game session, a recording of coffee shop background noise in two levels (high – 70dB, low – 40 dB) was played.

The Experiment

Language Learning Session



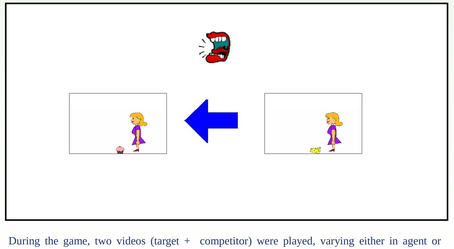
- **Line A** presents examples of **noun exposure**
- **line B** presents examples of **verb exposure**
- **line C** presents the **final test** of the language learning session.

Column 1 presents language exposure screens and column 2 presents test screens.

In cell 2A for example participants had to name the noun they had recently learned and in cell 2B they had to choose which of the two videos was describe in the audio playback.

In Line C participants had to describe the videos using the language they had just learned.

Game trial example



During the game, two videos (target + competitor) were played, varying either in agent or action. Participants had to describe the video that the arrow was pointing at to a confederate, using the language they had just learned. A varying degree of acoustic noise (high / low) was always present.

Results and Analysis

The raw counts of the occurrences of each sentence type by visual condition

Competitor video	-OS -AA	+OS -AA	-OS +AA	+OS +AA
DSDV	73	106	18	132
DSSV	26	136	30	206
SSDV	115	86	23	153
SSSV	118	88	25	166

The table suggests that visual communicative conditions affected the use of the optional formal devices.

The data was analyzed with linear mixed effects models constructed using the glmer() function of the "lme4"' package in R (Bates et al., 2015 ; R Core Team, 2015). One model was constructed for the OS variable and one for the AA variable.

Fixed effects - OS model

	Est.	Std. Error	P - Value
Intercept	0.2	0.92	
SO	-0.46	0.16	< 0. 01
VO	0.54	0.15	< 0.001
AN	-0.01	0.16	0.96
SO : VO	-0.87	0.3	< 0.01
SO : AN	-0.4	0.31	0.18
VO : AN	0.06	0.31	0.85
SO : VO : AN	-0.48	0.61	0.43

Subject Overlap (SO) , Verb Overlap (VO), Acoustic Noise (AN)

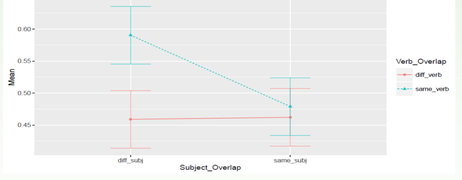
Fixed effects - AA model

	Est.	Std. Error	P - Value
Intercept	2.36	0.66	
SO	-1.33	0.16	< 0.001
VO	0.63	0.15	< 0.001
AN	-0.05	0.16	0.75
SO : VO	-1.22	0.3	< 0.001
SO : AN	-0.11	0.31	0.72
VO : AN	-0.33	0.31	0.28
SO : VO : AN	0.8	0.61	0.19

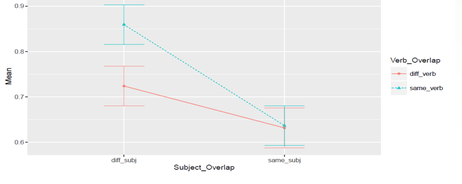
Subject Overlap (SO) , Verb Overlap (VO), Acoustic Noise (AN)

The interactions between the Subject Overlap and the Verb Overlap are visualized for each model.

SO : VO interaction - AA model



SO : VO interaction - OS model



Conclusions

Our participants' tendency to **avoid global ambiguity** (in the -OS-AA condition) is **consistent** with the "make your contribution as informative as is required" part of the Gricean Maxim of Quantity. However, **the most popular** sentence type (+OS+AA) **was redundant**, which does not conform to the "do not make your contribution more informative than is required" part. This suggest that language users are only **partly Gricean**.

Since the participants optimized usage of optional devices according to the presumed shared knowledge between the producer and comprehender, our experiment is consistent with models of language production that include **Audience Design**, such as **UID**. Had we found an effect of noise, this claim would be even stronger.

The confirmed bias towards redundant structures, sensitive to assumptions about the knowledge of the comprehender and the communicative setting, could be a useful behavior to exploit in both models of sentence processing and applied language models for technological applications.

Our results are informative about when language learners use these specific optional devices. It would be reasonable for computers to **leverage those expectations** when **processing human input**, and to conform to the same expectations when **producing linguistic output**.

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