Efficient coding in speech sounds: Cultural evolution and the emergence of structure in artificial languages

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Appendix C: Meanings

C.1 Instructions

Help the aliens repair their space ship!

Welcome!

In this experiment, an alien from a distant planet is going to ask you for help. The alien has crashed with his space ship on our planet and he needs your help to repair his space ship. Therefore, the alien will teach you alien words for space ship parts from the language these aliens speak on their planet. Humans can imitate these sounds with the use of a slide whistle. You will use a computer program to listen to these alien whistles and record your imitations of them. First, you will get some time to practice using the slide whistle.

During the actual experiment you are going to learn alien whistle words for twelve different space ship parts. There will be three rounds in which you will be asked to imitate all twelve whistles once while you have to remember which word belongs to which space ship part. At the end of each round you will be asked to play 'guessing games' with the alien. One of you will whistle a word, and the other will guess which space ship part it belongs to. In other words, you will be asked to recall and reproduce all words you learned for the space ship parts, so pay attention to the whistle-object relations! This is not an easy task! So, please don't worry if you can remember only a few and don't give up!

Four things to keep in mind:
- If you don't remember the whistle in the recall phase, you still have to record a whistle for each object, so then you record your best guess at that moment.
- In the recall phase, the "oops retry" button should not be used to perfect the previously recorded whistle, but only to correct accidents or interruptions of the recording.
- Before recording you are allowed to practice your whistle ONCE, but not more than that.
- Pay attention to remember which whistle belongs to which object. Each object is related to a unique whistle.

Good luck and have fun!

Figure C.1.1: Written instructions given to participants in the whistle experiment with meanings (described in chapter 6).
C.2 User interface

Figure C.2.1: Screenshot of the user interface for the whistle experiment with meanings (described in chapter 6). The instructions appeared in the speech bubble as well as the current topic (one of the space ship parts) in both the imitation phase (in a random order) and in the recall phase (in the order chosen by the participant by using the buttons at the bottom). In the guessing phases and in the recall phases the objects were chosen by clicking on the buttons at the bottom.
C.3 Transmission chains

The tables printed on the following pages, spanning two pages each, display the transmission chains that resulted from the whistle experiment with meanings (described in chapter 6). The first four tables represent the languages that emerged in the intact condition. Here, the first row shows the meanings (the objects) and each row represents the last recalled output of the participants in the chain where whistles are printed as pitch tracks on a semitone scale. The first row of whistle sounds shows the initial input and then each row shows what the consecutive participant produced for the object in each column. The following four tables represent the languages that emerged in the scrambled condition. Here, the objects are not shown since these were randomly reassigned and replaced from generation to generation. The first row shows the initial input set of whistle sounds and each following row represents the last recalled output of consecutive participants in the chain. Columns represent the transmission of the specific whistle sounds: even though these were paired with different objects in the experiment, the next row shows what the next participant produced for the object that got paired with the whistle from the previous generation in the same column.
Appendix C: Meanings

**Figure C.3.1:** Transmission chain one of the intact condition in the whistle experiment with meanings (chapter 6). The first row shows the meanings (the objects) and each row represents the last recalled whistles in each generation. The first row of whistle sounds shows the initial input and then each row shows what the consecutive participants (P 1 to 8) produced for the object in each column.
C.3. Transmission chains

Figure C.3.2: Chain one of the intact condition continued
Figure C.3.3: Transmission chain two of the intact condition in the whistle experiment with meanings (chapter 6). The first row shows the meanings (the objects) and each row represents the last recalled whistles in each generation. The first row of whistle sounds shows the initial input and then each row shows what the consecutive participants (P 1 to 8) produced for the object in each column.
C.3. Transmission chains

Figure C.3.4: Chain two of the intact condition continued
Figure C.3.5: Transmission chain three of the intact condition in the whistle experiment with meanings (chapter 6). The first row shows the meanings (the objects) and each row represents the last recalled whistles in each generation. The first row of whistle sounds shows the initial input and then each row shows what the consecutive participants (P 1 to 8) produced for the object in each column.
Figure C.3.6: Chain three of the intact condition continued
Appendix C: Meanings

**Figure C.3.7:** Transmission chain four of the intact condition in the whistle experiment with meanings (chapter 6). The first row shows the meanings (the objects) and each row represents the last recalled whistles in each generation. The first row of whistle sounds shows the initial input and then each row shows what the consecutive participants (P 1 to 8) produced for the object in each column.
C.3. Transmission chains

Figure C.3.8: Chain four of the intact condition continued
Figure C.3.9: Transmission chain one of the scrambled condition in the whistle experiment with meanings (chapter 6). The first row shows the initial set of whistle sounds (W 1 to 12) and each following row shows the last recalled output of consecutive participants (P 1 to 8) in the chain. Columns represent transmission of specific whistle sounds: even though these were paired with different objects in the experiment, the next row shows what the next person produced for the object that got paired with the whistle from the previous generation in the same column.
Figure C.3.10: Chain one of the scrambled condition continued
Appendix C: Meanings

Figure C.3.11: Transmission chain two of the scrambled condition in the whistle experiment with meanings (chapter 6). The first row shows the initial set of whistle sounds (W 1 to 12) and each following row shows the last recalled output of consecutive participants (P 1 to 8) in the chain. Columns represent transmission of specific whistle sounds: even though these were paired with different objects in the experiment, the next row shows what the next person produced for the object that got paired with the whistle from the previous generation in the same column.
Figure C.3.12: Chain two of the scrambled condition continued
Figure C.3.13: Transmission chain three of the scrambled condition in the whistle experiment with meanings (chapter 6). The first row shows the initial set of whistle sounds (W 1 to 12) and each following row shows the last recalled output of consecutive participants (P 1 to 8) in the chain. Columns represent transmission of specific whistle sounds: even though these were paired with different objects in the experiment, the next row shows what the next person produced for the object that got paired with the whistle from the previous generation in the same column.
Figure C.3.14: Chain three of the scrambled condition continued
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**Figure C.3.15:** Transmission chain four of the scrambled condition in the whistle experiment with meanings (chapter 6). The first row shows the initial set of whistle sounds (W 1 to 12) and each following row shows the last recalled output of consecutive participants (P 1 to 8) in the chain. Columns represent transmission of specific whistle sounds; even though these were paired with different objects in the experiment, the next row shows what the next person produced for the object that got paired with the whistle from the previous generation in the same column.
Figure C.3.16: Chain four of the scrambled condition continued