Statistical Learning Abilities and Language Acquisition

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ABSTRACT

Humans' high sensitivity to the structure in their environment is explained as statistical learning. During the past few decades, there have been many discussions on how humanity, including infants, use their ability to extract the structure in their surrounding which is often referred as statistical learning and how it can impact language acquisition. This article aims at investigating the way humans acquire regularities along with different levels of language and integrate them into different situations. Current directions in linguistics require to study statistical learning within a context, first observing within language comparing it within the infant learner and within the whole environment.

KEYWORDS: *Statistical learning, distributional information, sensory environment, word class categories, behavioral evidence, transitional probabilities.*

Statistical learning

Discovering distributional patterns in the language and extracting them is regarded as one type of statistical learning ability (see the overview by Safran, 2003, Erickson and Theissen 2015). Researches on "behavioral evidence" show that statistical learning plays an important role in different aspects of language learning which is supported by findings of Maye, et al 2002 on phonology, Safran and her colleagues 1996, Safran 2001, Smith and Yu 2008 on vocabulary learning, Thompson and Newport 2007 on morphological and syntactical development in language.

The type of patterns that can be tracked by an infant learner through a statistical learning mechanism can be in different complexity levels ranging from a simple frequency count to more sophisticated conditional probability, transitional probability, adjacent elements.

Statistical learning has become an interesting topic of neurolinguistics in recent decades and findings on this field have already concluded that infants can extract patterns in linguistic input as good statistical learners. However, the way how they accomplish this should be investigated in this field. The human ability to extract regularities in their sensory environment is well supported by empirical work done in SL. For example, one of the key studies was carried out by Safran and her colleagues with 8-month-old children finding that they can extract world-like units in continuous input in the speech stream alone using statistical learning mechanism (Saffran, Aslin, & Newport, 1996). In their follow-up study, they designed a task (sometimes called "embedded pattern paradigm" or simply as "the SL task") with two different stages: the first is familiarization phase, the other is a test phase. During the first phase, participants listen to a continuous stream of speech (bidakugolabupadotibidakutupiropadoti) that consists of several repeated patterns all of which is unknown to them. The original materials to which participants are exposed compose of four tri-syllabic words that are randomized to form a continuous speech-like stream. Here, the only way of dividing the stream to its composing syllables is to discover co-occurrences between elements extracting the syllable tu, realizing that it is followed by pi, then learning ro which is referred as TPs (transitional probabilities). In the second test phase, participants' ability to track repeated patterns is measured with two-alternative-forced-choice (2-AFC) trials as the researches suggests. In each trial with older children grouped as adults in the study, the participants are asked to select the most familiar patterns according to the familiarization phase after they are exposed to elements with higher TP level and a foil with a lower TP level in the familiarization phase. The importance of this study lies in the fact that it can examine to what extent participants are able to assimilate statistical probabilities embedded in the input. According to the hypothesis, the performance rate would be at most 50 % if no statistical learning happens. Safran and colleagues, on the other hand showed that humans really possess the ability to extract patterns from the input with statistical learning mechanism demonstrating the above-average performance of participants.

Likewise, a study by Jessica Maye and her colleagues investigated how distribution of models within an acoustic continuum affects the acquisition of phonetic regularities. Findings of the study suggest that the structure of native language shapes speech perception relying on distributional and acoustic information. Other recent findings show that infants are able to develop surface structure into deeper structure first extracting syllables from words then tracking grammar and other word-level computations to acquire phrasal units.

A large body of empirical work that has been done to prove these basic findings. Although modified, studies on the "embedded input pattern paradigm" showed that statistical learning is observed in auditory, visual, verbal, non-verbal environments.

Languages consist of a number of separate units being learned under syntactic categories such as nouns, adjectives, verbs. Formation of new sentences depends on how well we, humans combine these categories within language development. Otherwise, linguistic production would be impossible if we operate on word-by-word producing. Subcategories including gender categories (division of words into feminine, masculine and neutral nouns) in a number of languages are really difficult to master. Gender categories in grammar are filled with semantic irregularities (Bock 1982). While a noun is united under feminine category in one language being a masculine category in another one, gender identification of nouns is often related to some morphological or phonological signs as -at, -ent, -ett (masculinity in German), -й (masculinity in Russian). Therefore, it has been concluded that ability to track distributional information is of high importance in learning gender classification (Karmiloff-Smith 1979) as it is in other broader categories such as nouns and verbs (Minz 2003).

A number of different studies have been conducted to examine the role of statistical learning in language acquisition. But most of them have been exclusively based on word extraction in a flow of speech (McNealy et al, 2006, 2009, 2010, 2011, Karuza et al, 2013, Plante et al, 2015).

Though some studies with purposefully created syntactical rules for research purposes have been done, they still lacked scanning procedure during learning period being involved in only a test phase and test-phase related findings have been shared. In one study by Tettamanti et all in 2002, two research cycles with grammatical and ungrammatical word categories presented to participants were compared. They shared a report on "inferior frontal-prefrontal supramarginal/angular network" for grammaticality.

However, in one study that by Michelle Sandoval et al, at Arizona State University, researchers used magnetic resonance imaging (MRI) to discover neural correlation with learning word classification through statistical learning. In order to provide validity of a test not allowing participants to use their existing knowledge, they examined a learning phase of gender classification in an unfamiliar Russian language. They have found that after a brief introduction to Russian root words and gender marking suffixes, participants were able to produce accurate results in tests. Similarly, the participants could easily generalize double-marked words rather than single-marked words as it has been concluded in a study by Gerken et al, 2005, Richardson et al, 2006, Eidswag et al, 2015 when they used Russian stimuli as well. The study concluded that statistical learning is a cognitive mechanism through which a language is encoded. The authors also suggested that the nature of input drives the statistical learning mechanism contrary to what is concluded that statistical mechanism that participant build is the driver of their learning.

Within the field of neurolinguistics, statistical learning has fueled many discussions. A large body of experience has been made to examine the role of statistical learning in language learning opening a way for further discussions in the field. Though a number of studies have been done to prove the effect of SL in language acquisition, personally different statistical abilities which has been recognized as computational abilities, further methodologies are still needed to better understand the nature of statistical learning.

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