

#### Introduction:

A wealth of experimental findings suggest the frequency-based accessibility of structural alternatives of particular verbs, also known as verb bias, plays an important role in online sentence comprehension [1, 2, 3]. The current experiment investigates continuous electrophysiological dynamics underlying the learning process of new verb bias. In second language and artificial language learning literature, available electrophysiology evidence shows distinctive neural signatures in response to anomalous forms at early and late stages of syntactic rule learning [4, 5, 6]. The presented study takes a similar approach to focus more on the mechanism of statistical learning during the time when learners are collecting the combinatorial facts from the language input.

#### Methods:

Participants completed two training sessions with 64 sentences in each and were tested with a picture-matching task at the end of training. EEG was recorded while participants read training sentences containing novel verbs in a rapid serial visual presentation with 500 msec of SOA. All the training sentences provide strong context promoting either modifier or instrument attachment interpretation, as in sentences (1) and (2).  
(1) *Instrument Ambiguous / Unambiguous: The suntanned farmer dakked the corn with / using the big tractor...*  
(2) *Modifier Ambiguous / Unambiguous: The suntanned farmer dakked the corn with / that has the high stalks...*  
In instrument-training sentence (1), it is obvious that the *tractor* is an instrument for an unknown action *dakking*, while in modifier-training sentence (2) *stalks* is clearly a property of the *corn* rather than an instrument used in *dakking*. Two verbs were trained in ambiguous sentences, while the other two verbs were trained in unambiguous sentences. Each novel verb was only presented in one of the four training structures. In the picture-matching task, each participant read 24 ambiguous sentences containing the 4 trained verbs and another 2 untrained verbs as control. Participants were asked to choose a picture between two options that was consistent with his/her interpretation of the sentence (Fig-1).

#### Results:

Behavior results of the picture-matching task suggest explicit learning of instrument verb bias only in ambiguous sentences. Reliably more instrument attachment choices were made for instrument-trained verbs (72.5%) than untrained control verbs (61.25%, Fig. 2). But no such difference was observed for other training conditions compared with the control. Electrophysiological data were collected for the disambiguating noun region. Mean amplitudes of N400 elicited by instrument nouns (e.g. *tractor*) are reduced relative to those elicited by modifier nouns (e.g. *stalks*) during the first training session, suggesting the confirmation of readers' semantic prediction about an upcoming instrument based on the newly learned instrument bias. In the second training session, the effect became a reduced P600 elicited by instrument nouns in relative to modifier nouns. This effect together with the behavioral data in the test session suggests an asymmetry in learning about instrument versus modifier verb bias. The transition from N400 to P600 mainly existed between the ambiguous conditions containing *with* phrases, rather than between the unambiguous conditions with *using* and *that has* phrases (Fig-3), indicating resolving ambiguity might be a necessary step for verb bias learning.

#### Conclusions:

The current experiment suggests an experience-dependent plasticity of language system, which continuously collects statistical information from linguistic input. Future experiment with testing sentences designed to contradict the trained bias will provide more evidence to address when and how people use the newly learned verb bias during conflict resolution.

#### Reference:

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Which picture can be described by the following sentence?



The angry teacher dakked the student with the low score.

Fig-1: An example trial of the picture-matching task. The left picture represents an instrument interpretation and the right picture represents a modifier interpretation of the sentence.

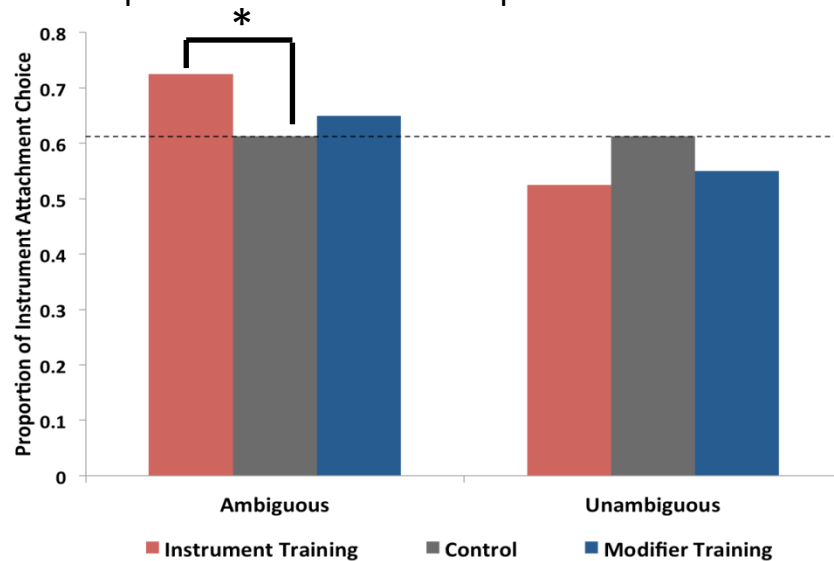


Fig-2: Average proportion of instrument interpretation choices in the picture-matching task. Instrument interpretation is more preferred in the ambiguous sentences with instrument-trained verbs, compared with untrained verbs.

First Training Session

Second Training Session

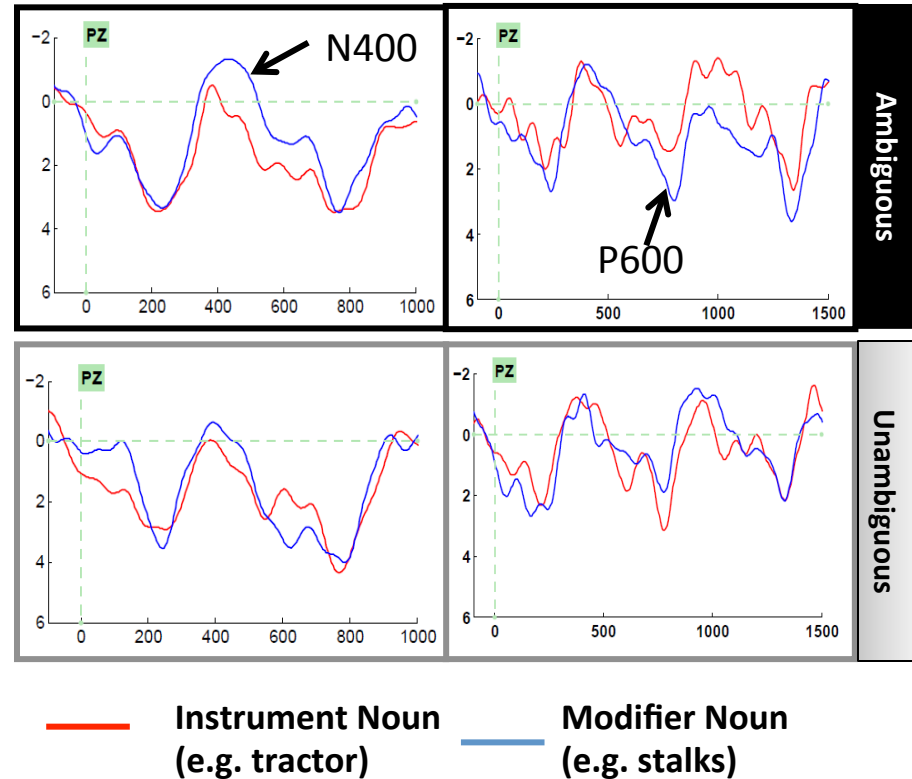


Fig-3: Grand average ERPs at posterior midline electrode (PZ) for disambiguating words. During the first training session, N400 responses to instrument nouns (red) are less negative than those to modifier nouns (blue) in ambiguous training sentences. During the second training session, instrument nouns elicit a smaller P600 responses in relative to modifier nouns in ambiguous sentences. However, waveforms from the instrument and modifier nouns were indistinguishable in unambiguous training.