Predictive processing is affected by linguistic complexity of cue-preceding input

Johannes Gerwien (Heidelberg University), Yuxia Wang, & Fuyun Wu (Shanghai Jiaotong University)
gerwien@idf.uni-heidelberg.de

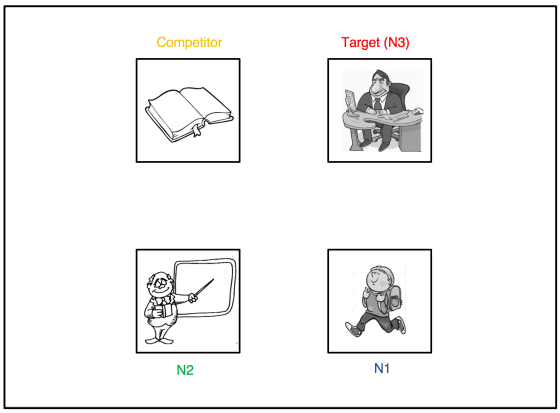
Few previous studies have explored in how far prediction, as reflected in anticipatory eye movements, can be affected by the cognitive demands imposed by syntactic, semantic, and pragmatic processing of linguistic input up to the point when the linguistic cue under investigation is perceived. In the current study, we first show this complexity effect on prediction in Mandarin Chinese, and then, explore how it may be utilized to study cognitive demands that the processing of different linguistic structures may require. As a test case, we compare subject extracted (SRC, Exp 1) and object extracted relative clauses (ORC, Exp 2) against simple coordinated noun phrases (CoorP), which - as we assume they are easiest to process - serve as a baseline in both experiments.

For stimuli creation, we exploit the highly reliable Mandarin passive marker *bèi* in thematic role interpretation (cf. Li et al. 1993). This marker yields a patient-(*bèi*)-agent-verb structure, where *bèi* leads comprehenders to predict an animate referent following it. Importantly to note, our experimental manipulation concerned the internal structure of the complex phrase encoding the patient, preceding *bèi*. 18 sets of sentences were created, each consisting of an SRC, an ORC, and a coordinate phrase version of the same matrix sentence. All versions had the same basic word order: (N_1-N_2)-*bei*-N_3-V, with N_1, N_2, N_3 referring to animate referents, and N_3 as the target (*see examples*). Every version of a set was combined with an identical visual stimulus, showing 4 objects corresponding to N_1, N_2, and N_3 (target), plus one inanimate competitor object. To have a balanced design, inanimate referents were used as targets in filler stimuli (N=18). Here, instead of *bèi, bă*, a marker for an active resultative (N_1-N_2)-*bă*-N_3-V structure was used. Comprehension questions had to be answered after every trial. In both experiments, the two versions under investigation (SRC vs. baseline, ORC vs. baseline) were counterbalanced across two experimental lists, which subjects were randomly assigned to.

Our main focus is on the time course of the ratio of *anticipatory* (looks to referents not mentioned yet) and *regressive* eye movements (looks to referents already mentioned) between marker onset and a point in time shortly after target noun onset (N_3), assuming this measure reflects the 'readiness' of the system to engage in predictive processing. Growth curve analysis (Mirman 2014) shows significant differences between conditions in Exp 1, indicating a delay of anticipatory eye movements in the SRC condition. No comparable results were obtained in Exp 2. The between-experiment comparison of eye data between the SRC and ORC condition confirm the results: anticipatory looks during/after the processing of *bèi* occur later in SRCs. This effect is due to a relatively higher probability of looks to N_2-objects in the SRC condition (nouns perceived before the marker, head nouns in RCs), as well as a lower probability of looks to target and competitor objects (potential referents after the marker).

Results suggests that predictive processing can be modulated by the cognitive resources available (in line with Ito et al. 2017), with structures that are harder to process allowing to invest fewer resources into prediction (Exp 1). The comparison of SRC and ORC structures in this spoken language comprehension study indicates differences, surfacing *after* the relativizer and the head noun have been perceived. Our approach introduces a new tool to study the details of incremental language processing.

Stimulus examples

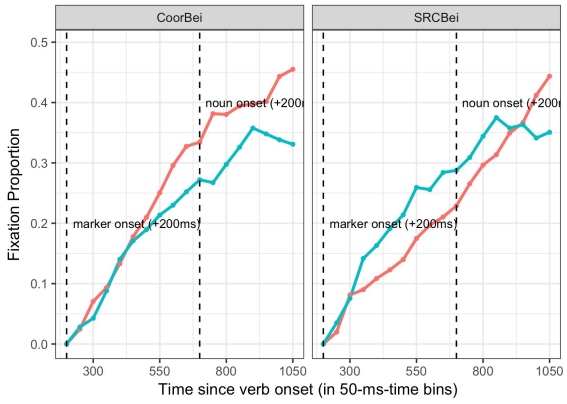


Example of visual stimulus: “N1”, “N2”, “Target N3”, “Competitor”; labels were not visible to subjects

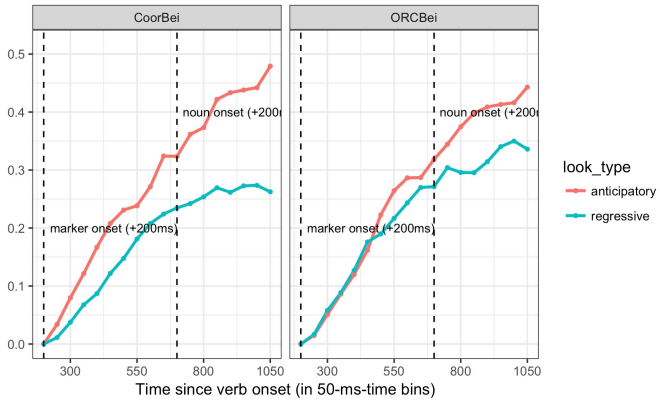
condition	Audio stimulus
Baseline	那位学生和那位老师被校长教育了很久。 that CL student and that CL teacher BEI headmaster scold ASP very long. “That student and that teacher were scolded by the headmaster for a long time.”
SRC	咒骂学生的那位老师被校长教育了很久。 insult student REL that CL teacher BEI headmaster scold ASP very long. “That teacher, that the student insulted, was scolded by the headmaster for a long time”
ORC	学生咒骂的那位老师被校长教育了很久。 Student insult REL that CL teacher BEI headmaster scold ASP very long. “The student, that that teacher insulted, was scolded by the headmaster for a long time”
Comprehension question	校长教育老师了吗？ Headmaster scold teacher Asp. QU-PART ? “Did the headmaster scold the teacher?”

Examples of audio stimuli in the critical conditions; baseline vs. SRC in Experiment 1, baseline vs. ORC in Experiment 2 (CL=classifier, ASP=aspect marker, REL=relativizer, QU-PART= question particle); comprehension questions followed every trial

Eye tracking data



Fixation proportions over time: anticipatory vs. regressive in Exp 1



Fixation proportions over time: anticipatory vs. regressive in Exp 2