Psycholinguistics: Real-Time Language Processing in Context

Thi Thu Huong Nguyen, Camilo Rodríguez Ronderos,
Katja Münster & Pia Knoeferle

Research focus of the Psycholinguistics Group:
The research focus of the group is on real-time context effects in language comprehension across the lifespan (in children, young, and older adults). We examine the cognitive and brain mechanisms underlying language processing and learning, also across different languages. We are interested in how rapidly comprehenders can exploit different linguistic and non-linguistic contextual cues while processing language in real time but also in protracted context effects.

Specific research foci are: language processing in relation to
- (past, present, and future) events
- the emotional, spatial, social and linguistic context
- visual perception, including perception of objects, action events and speakers (e.g., visual gender cues, eye gaze, facial expressions)

Methods used:
- To examine real-time effects of (non-)linguistic context on language processing we use Reaction Time measures (see Panel A), Eye tracking while reading (see Panel B), Eye tracking while listening (see Panel C) and Event-Related Brain Potentials.
- To measure off-line effects of (non-)linguistic context and effects of cognitive differences between age groups on language processing we use post-sentence comprehension questions, memory tests and cognitive tests (e.g., on fluid and crystallized intelligence and verbal fluency).

Panel A: Reaction Times

Research Question: How does visual context, e.g., event photograph presence and language context, e.g., language mappings, affect accuracy and reaction times on second language learning?

Data obtained: After a training phase, in the test phase, participants were asked to press a button indicating which one of two photographs refers a heard (verb-noun) sound. Accuracy and reaction times were measured for each item. (Figures 1).

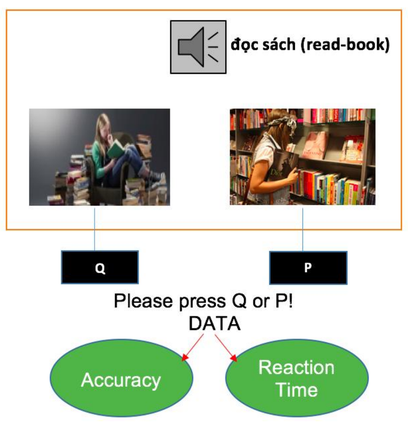

Figure 1: Testing procedure

Participant	Itemcode	Part	Visualcode	Langcode	RT	lnRTs
H1P1	5	1	1	1	1168	7.06
H1P1	2	1	2	1	3063	8.03
H1P1	9	1	1	2	1036	6.94
H1P1	14	1	2	2	2567	7.85
H1P1	3	3	1	1	1706	7.44
H1P1	11	3	1	2	2926	7.98
H1P1	14	3	2	2	1776	7.48
H1P1	12	3	2	2	2158	7.68

Figure 2: Raw and transformed reaction time data without outliers for correct responses of a participant

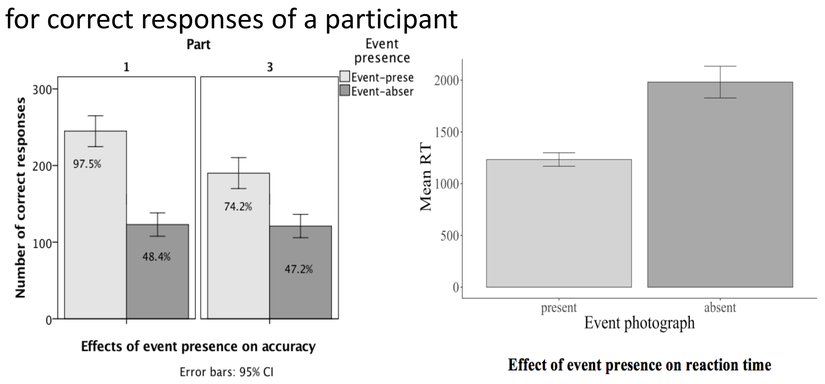

Figure 3: Bar graphs showing the effects of visual context (event photograph-present compared with event photograph-absent condition) on the accuracy and reaction times over participants and items

Panel B: Eye tracking while reading

Research Question: How do animated visual depictions of concrete events affect reading times of abstract words?

Data obtained: three reading measures for every word in the sentence. Measures are linked to distinct processing stages:
Gaze duration: First time a word is read. Associated with initial lexical access.
Regression path duration (RPD): the sum of all backward fixations during initial reading of a word. Associated with integration of a word into the preceding context.
Total reading times (TT): sum of all fixation times of a single word. Commonly understood as final word interpretation.

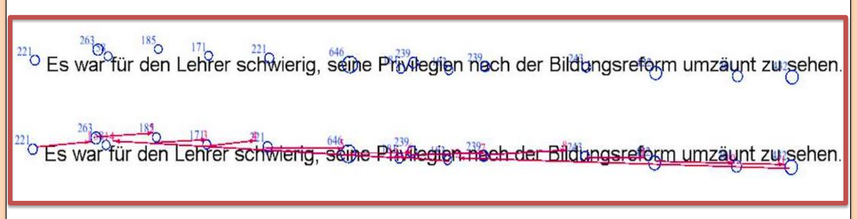

Figure 1: Reading patterns of one participant showing single fixations (above) and fixations + saccadic movements (below)

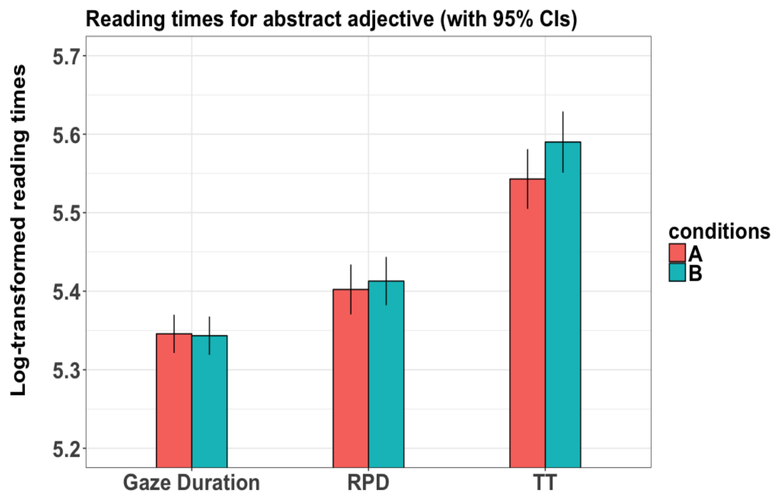

Figure 2: mean log-transformed reading times of 48 participants during reading of the word *'schwierig'* after being exposed to 2 different visual primes.

Panel C: Eye tracking while listening

Research Question: How does extralinguistic socially interpreted context, e.g., a speaker's emotional facial expression, mediate real-time language processing across the lifespan?
Data obtained: fixations which can be time-locked to a stimulus event (e.g., a word onset) to predefined (not visible for participants) areas of interest (Figures 1-3).

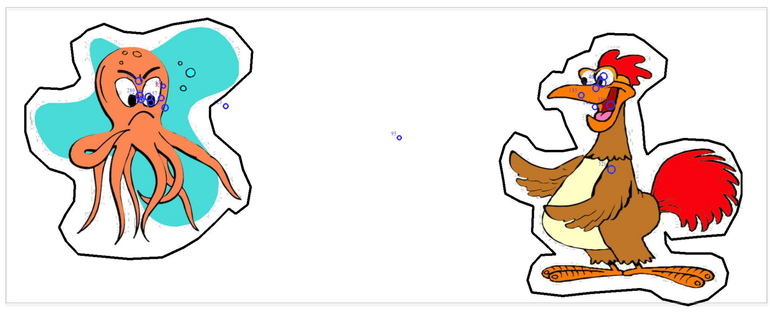

Figure 1: Raw fixations on one item for one participant

part	item	cond	np1on	np1off	verbon	verboff	advon	advoff	np2on	np2off	FIX_START	FIX_END	AOI
1	1a		0	860	994	1694	2093	2850	3520	4229	463	859	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	1403	1863	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	1889	2193	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	2387	2513	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	2537	3151	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	3413	3599	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	3789	4007	ag
1	1a		0	860	994	1694	2093	2850	3520	4229	4071	4327	ag
1	2b		0	863	1122	1756	1948	2909	3498	4204	2789	2989	ag
1	2b		0	863	1122	1756	1948	2909	3498	4204	3281	3527	ag
1	2b		0	863	1122	1756	1948	2909	3498	4204	4069	4305	dis
1	2b		0	863	1122	1756	1948	2909	3498	4204	4571	4863	ag

Figure 2: Raw fixation report containing start and end fixation times for all participants and items to the defined areas of interest

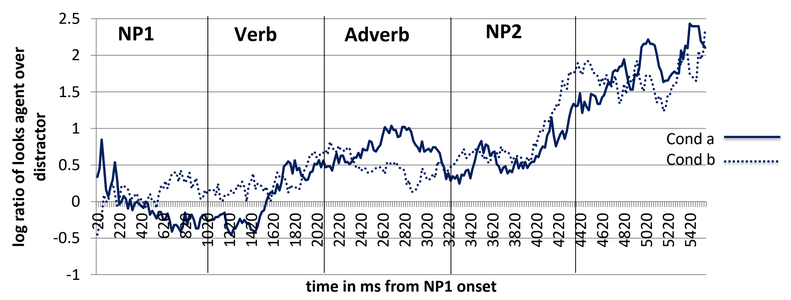

Figure 3: Descriptive time course graph showing the fixations to one area of interest relative to the other over participants and items for two experimental conditions across an experimental sentence

Data processing and analysis:
- We prepare our data by first carefully inspecting the raw data, removing outliers, defining time windows and (if necessary) transforming it from a categorical into a continuous outcome variable.
- We use IBM's SPSS and the free programming language R for (descriptive and inferential) data analysis.
- Depending on the type of data and the assumptions met by the data, we analyze the data using repeated measures ANOVAs, Mixed Effects Models or non-parametric tests.

Ethics approval and participant information:
- Our lab has an ethics approval from the DGfS for testing participants between 18 and 65 years.
- For studies testing children and participants above 65 year of age, we have to apply for ethics approvals (DGfS) separately for each new line of studies.
- Before taking part in an experiment, participants are required to read an information sheet about the procedure of the experiment, data protection, their rights and potential risks involved in taking part in the experiment. They are in addition required to read and sign an informed consent form, stating that they have understood the provided information regarding their rights as participants and agree with our data handling policy.

Data protection:
- In addition to the ethics approval, we have a data protection concept approved by HU's data protection officer.
- All our data is anonymized and information which could be used to identify the participants (e.g., name/signature) are kept separately from the participant's data.
- The anonymized data is encrypted and saved in a password-protected folder on our HU server.
- Only people involved in the specific project are granted access to this data.
- We are allowed to store the data for 10 years, then it has to be deleted.

Open Questions regarding (psycholinguistic) data handling:
- data publication?
- the (dis?)advantages of pre-registering studies