ABSTRACT

Human language processing must rely on a certain degree of abstraction, as we can produce and understand sentences that we have never produced or heard before. One way to establish abstraction in syntactic processing is by investigating structural priming. Structural priming is defined as the tendency to repeat aspects of syntactic structure from one trial to the next (see, e.g., Pickering & Ferreira, 2008). For example, after producing/understanding a double object sentence such as in [1], language users may find easier the production/comprehension of another sentence with the same structure as in [2] (Bock, 1986; Pickering & Branigan, 1998).

1. [1] Peter read the girl a book.

Thus, structural priming is efficient within a domain, that is to say the linguistic domain. But does priming still work across different domains?

In line with Scheepers et al. (2011), we decided to look at cross-domain structural priming from mathematical expressions to linguistic structures, particularly relative clause attachment.

RELATIVE CLAUSE ATTACHMENT : SHORT STORY

[3] Algien disparó contra la criada de la actriz [que estiven en el balcón].

Someone shot the maid of the actress [that was standing on the balcony]

Several factors can explain relative clause attachment:
- anaphoric resolution (Hemforth et al., 2000)
- length (Hemforth et al., 2015)
- prosody (Fodor, 1999a,1999b;2002)
- syntactical (pseudo-relatives, e.g., Grillo & Costa, 2014)

Independent of these factors, is it possible to force the relative clause attachment?

RELATIVE CLAUSE ATTACHMENT & MATHEMATICS

Mathematical expression with brackets
\[ (9 + 5) \times 6 \]
High attachment relative clause

Mathematical expression without brackets
\[ 9 \times (5 + 15) / 5 \]
Low attachment relative clause

PREVIOUS OFFLINE EXPERIMENTS : SCHEEPERS ET AL. (2011)

1. Experiment 1
- Completion tasks using a paper-and-pencil questionnaire
- 3 groups (mathematics, business, psychology)
- Materials : 8 items per condition, 51 fillers

Results:
- Target equations
- High attachment
- 50/67/125
- Low attachment
- 34/25/125
- Baseline equation
- 9 x 5

2. Experiment 2
- Same as experiment 1
- Participants in psychology
- Materials : the same with redundant brackets, like 90 (5x+15)/5 or 90/5 +(15/5)

Results:
- High attachment
- 200
- Low attachment
- 200

OUR EXPERIMENT : ONLINE STUDY IN FRENCH

1. Participants
- 36 French native speakers, living in Paris

2. Material
- 30 items : pairs of equations & pictures with spoken sentences (ambiguous relatives)
- 2 conditions: high attachment (90-9x+15) / low attachment (90-9x+15) / 56 fillers (equations & pictures with spoken sentences)
- Pictures composed of 6 objects/characters: NP1 referent, NP2 referent, NP1-related target object, NP2-related target object and two distractors

3. Procedure
- Eye-Tracking with visual world paradigm
- Participants had to solve the equation first and then had to look at the picture and listen to the sentence, see Figure (1)
- Protocol [(1+2)+3] in order to constitute 2 groups : 18 participants knowing the priority rules (Group 1) and 18 participants ignoring the priority rules (Group 2)

4. Hypothesis
If mathematical domain and linguistic domain share aspects of syntactic structure at a high level of abstraction:
- Participants should be looking at the NP1-related target object after high- rather than low-attachment priming when they listen to the ambiguous relative.
- Participants should be looking at the NP2-related target object after low- rather than high-attachment prime equations when they listen to the ambiguous relative.
- This should work mainly for Group 1.

5. Results
- Figure (2): Proportion of fixations on the NP1 object (related clause) every 90 ms starting at the NP1 (group 1)
- Figure (3): Proportion of fixations on the NP1 object (related clause) every 90 ms starting at the NP1 (group 2)
- Figure (4a): Logits for looks to NP1_object
- Figure (4b): Logits for looks to NP2_object
- Figure (5): Percentage of correct and incorrect answers to high-attachment prime equations
- Figure (6): Percentage of correct and incorrect answers to low-attachment prime equations

CONCLUSION

In line with Scheepers et al. (2011), our experiment suggests that mathematics and language share aspects of syntactic structure at a very high level of abstraction.

Importantly, we can see this cross-domain structural priming in direct processing.

Again, mathematically less adept participants did not seem to be influenced by this mathematical domain.

Finally, for mathematically skilled participants (Group 1), our experiment appears to indicate that mathematical priming influences the very earliest stages of integrating a relative clause into the prior sentence context.

REFERENCES