

Processing conditionals in context: reading time and electrophysiological responses

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Background: The concept of conditionality is central to human thought and action. In the formal semantic literature, it has been long debated how to compositionally derive the different meanings that conditionals in natural language convey (e.g., Kratzer 1986, von Stechow 2011). In this paper, we focus on the role of conditional connectives from a semantic and processing perspective. We compare conditionals of the form ‘If P, Q’ to conditionals of the form ‘Only if P, Q’ based on the literature of conditional perfection (Geis & Zwicky, 1971; Van der Auwera, 1997; Horn, 2000) and that of ‘*only if*’ (Herburger 2015, 2019). Conditional perfection describes the observation that an *if*-conditional (e.g., ‘If you mow the lawn, I will give you 5 dollars.’) can receive a stronger – biconditional (i.e., *if and only if*) – interpretation. Following this conception, ‘If P, Q’ triggers a pragmatic inference of ‘If not-P, not-Q’ or ‘Only if P, Q’.

For the case of ‘Only if P, Q’, Herburger (2015, 2019) questions whether comprehenders generally draw the inference “If P, Q”. For sentences such as “Only if you work hard do you succeed.”, she argues that they do not presuppose that “all (normal) instances of hard work will be rewarded by success” in contrast to their *if*-counterparts. We tested the comprehension of contextually embedded conditionals with ‘If’ versus ‘Only if’ in a self-paced reading experiment (Experiment 1) and a follow-up EEG experiment (Experiment 2) in German.

Experiment 1: In the self-paced reading experiment, 29 participants (mean age (sd) = 28.5 (8.1) years) read 108 critical short scenarios of four sentences such as (1).

- (1) Sentence 1: *DE: Leon besuchte seine Eltern und dachte sich:*
(EN: Leon visited his parents and thought:)
- Sentence 2: **Wenn / Nur wenn** die Blumensträuße hübsch sind, bringe ich einen mit.
(If / Only if the bouquets are pretty, I will take some with me.)
- Sentence 3: *Wie sich zeigte, waren die Blumensträuße nicht hübsch.*
(As became apparent, the bouquets were not pretty.)
- Sentence 4: *Von denen brachte er **einen** / **keinen** mit und ging weiter.*
(Of those he took one / none and went on.)

After an initial context sentence (S1), participants read a conditional sentence with the conditional connective *If* or *Only if* (S2), followed by a sentence negating the antecedent P (S3), followed by a sentence either confirming or negating the consequent Q (S4). The materials thus yield a 2 x 2 design, with Conditional Connective (‘If’ vs. ‘Only if’) and Consequent (true or false) as factors. S1 to S3 were presented sentence-by-sentence, while S4 was presented word-by-word. Participants could move on to the next sentence or word by pressing the space bar as soon as they were finished with reading the current sentence or word. Reading times on the positive or negated quantifier (*ein* / *kein* ‘one / no’) in S4 served as the critical measure. Following the logic presented in the background above, we predicted reading times of the negated quantifier (i.e., the negated consequent) to be shorter in the case of ‘*Only if*’ compared to ‘*if*’, as ‘If not-P, not-Q’ is a semantic inference in ‘*Only if*’ and only potentially a pragmatic one in ‘*if*’. Reading times of the positive quantifier are predicted to be either identical between ‘*if*’ and ‘*only if*’, since readers should not expect the positive quantifier in either of them, or to be longer in ‘*only if*’ compared to ‘*if*’ (Herburger 2015, 2019).

Reading times for the critical positive quantifier were statistically equivalent between conditional connectives ($\beta=0.13$, $CI=[-8.6, 8.86]$, $BF_{10}=0.99$), reading times for the negative quantifier were shorter for ‘Only if’ conditionals than for simple ‘if’ conditionals ($\beta=-12.06$, $CI=[-20.41, -3.81]$, $BF_{10}=121.45$) (Figure 1). These findings indicate that the negative quantifier is processed faster after ‘Only if’ than after ‘if’ conditionals, in line with their semantics.

These results show that comprehenders form distinct predictions about discourse continuations based on differences in the lexical semantics of the tested conditional connectives, shedding light on the role of conditional connectives in the online interpretation of conditionals in general.

Experiment 2: The study aimed to investigate whether the differences in reading times described above may be reflected at the level of brain responses by employing electroencephalography (EEG). To this end, we used an extended set of experimental materials (144 critical items) in an adapted procedure, where both S1 to S3 as well as words in S4 were presented for a fixed duration for participants to silently read for comprehension (1600 ms for S1 to S3; 150 ms for the words in S4, with 500 ms blank in between each sentence/word). In line with the semantics of ‘Only if’-conditionals, the negated quantifier should be pre-activated to a higher degree as compared to simple ‘if’-conditionals, and processing of the negated quantifier should thus be easier in ‘Only if’-conditionals. Hence, we expect greater amplitudes in the N400 component for the negative quantifier in ‘if’ conditionals than ‘Only if’ conditionals, reflecting the varying degrees of discourse expectations (Kutas & Federmeier, 2011). Informed by the results of the self-paced reading experiment, we predict no difference in the amplitude of the N400 component for the positive quantifier.

Testing of 38 subjects (mean age (sd) = 25.5 (4.9) years) had been delayed due to lab-closures and has only recently been finished, so that final analyses were not ready by the time of submission but will be presented by the time of the conference.

References:

- von Fintel, K. (2011). Conditionals. In C. Maienborn, K. von Stechow, & P. Portner (Eds.), *Semantics: An international handbook of natural language and meaning*. 1515–1538. Berlin: de Gruyter.
- Geis, M. L., & Zwicky, A. M. (1971). On Invited Inferences. *Linguistic Inquiry*, 2(4), 561–566.
- Herburger, E. (2015). Only if: If only we understood it. *Proceedings of Sinn Und Bedeutung*, 19, 304–321.
- Herburger, E. (2019). Bare conditionals in the red. *Linguistics and Philosophy*, 42(2), 131–175.
- Horn, L. R. (2000). From if to iff: Conditional perfection as pragmatic strengthening. *Journal of Pragmatics* 32(3), 289–326.
- Kratzer, A. (1986). Conditionals. *Chicago Linguistics Society*, 22(2), 1–15.
- Kutas, M., & Federmeier, K. D. (2011). Thirty Years and Counting: Finding Meaning in the N400 Component of the Event-Related Brain Potential (ERP). *Annual Review of Psychology*, 62(1), 621–647.
- Van der Auwera, J. (1997). Pragmatics in the last quarter century: The case of conditional perfection. *Journal of Pragmatics*, 27(3), 261–274.

