

# Transparency in the Processing of Temporal Ambiguity: The Case of Embedded Tense

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**Summary.** We report the results of one acceptability rating study and two self-paced reading studies on the form-meaning mismatch in the interpretation of past-under-past in complement clauses in English. Across the three experiments, we find an offline and online preference for the backward-shifted interpretation, in line with predictions of the structural approach to the ambiguity when assuming a processing preference for morphological transparent interpretation.

**Background.** In English, embedded tenses in certain configurations give rise to ambiguities (but see Altshuler & Schwarzschild 2013, Altshuler 2016), as in the case of past tense in a stative complement clause (CP) embedded under a past-marked verb of reported speech, in (1). Structural approaches to the ambiguity (prominently, Ogihara 1996) derive SIM from the Logical Form for BACK by additional morpho-syntactic technology, such as a deletion operation like (2) that is licensed in this kind of configuration.

- (1) *Oliver said*<sub>past</sub> [<sub>CP</sub> *that Amber* [<sub>AUX</sub> *was*<sub>past</sub>] [<sub>ADJ</sub> *sick* ] ]
- a. Oliver said: “Amber is sick.” (simultaneous reading, SIM)  
 b. Oliver said: “Amber was sick.” (backward-shifted reading, BACK)
- (2) a. SIM-LF: [ PAST<sub>t\*</sub> [ λt Oliver say<sub>w@,t</sub> [ λw λt' PAST<sub>t'</sub> [ λt'' John sick<sub>w,t''</sub> ] ] ] ]  
 b. BACK-LF: [ PAST<sub>t\*</sub> [ λt Oliver say<sub>w@,t</sub> [ λw λt' PAST<sub>t'</sub> [ λt'' John sick<sub>w,t''</sub> ] ] ] ]  
 with t\* the utterance time and w@ the actual world

Previous experimental findings are overall inconclusive (in particular, Dickey 2001). The data from one of the adult-control groups in Hollebrandse (2000) suggests a slight acceptability preference for SIM; Gennari (2004) observes an advantage for overlapping temporal intervals in reading times, but employs a design that relies on additional manipulations.

**Experimental Hypotheses.** The three experiments Exp1-3 reported below investigate two competing processing hypotheses H1 and H2 derived from structural approaches, WYSIWYG and Structural Simplicity. Under H1, comprehension is driven by morphological transparency, and an embedded past tense in a configuration like (1) should initially always be interpreted as such, favouring BACK. Under H2, comprehension is driven by structural simplicity at Logical Form (also keeping the number of times in the semantic representation low), favouring SIM.

**Experiments 1 and 2** both adopted the same 2x2 design, with factors EvalT (past vs future) and interpretation (BACK vs SIM). Participants (N<sub>Exp1</sub>=43, N<sub>Exp2</sub>=40) saw 88 trials, consisting of 40 experimental items embedded within 40 fillers. Each trial had a context picture of the type in Fig.1 establishing the EvalT and the intended reading, followed by a sentence like (1), which was presented word-by-word in Exp1, and rated on a scale from 1-6 in Exp2. H1 predicts an acceptability preference for BACK over SIM, which should also be reflected in longer reading times for SIM over BACK on the embedded auxiliary AUX or adjective ADJ in (1). H2 predicts a preference and reading time advantage for SIM over BACK.

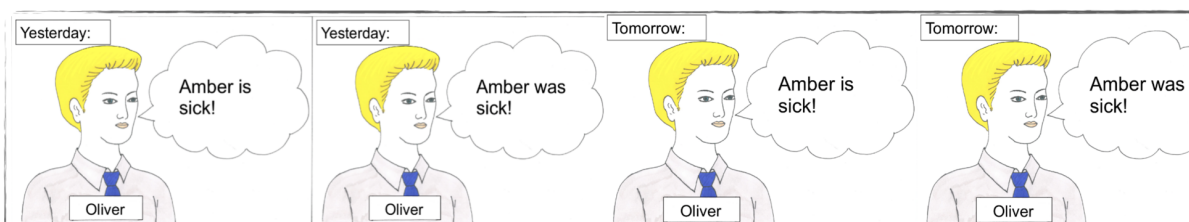


Figure 1: Sample context pictures used in the Self-Paced Reading Experiment (Exp1) and the Rating Study (Exp2).

The results from Exp1 show no significant reading-time difference between BACK and SIM for past context at AUX, but a marginal effect at ADJ ( $t(42) = 1.939, p = .059$ ), with longer reading times for SIM; see also Fig.2 below. In Exp2 we observed higher ratings for BACK compared to SIM ( $M_{\text{BACK,fut}} = 5.54, M_{\text{SIM,fut}} = 4.16, M_{\text{BACK,past}} = 5.98, M_{\text{SIM,past}} = 5.38$ ). For the control conditions (BACK,fut vs SIM,fut) this is expected, since SIM readings are unavailable when embedded under a matrix predicate that is not in the past tense. For the experimental conditions, this statistically significant difference ( $t(39) = 4.921, p < .001$ ) supports the WYSIWYG hypothesis.

**Experiment 3** relied on disambiguation by continuation rather than context. A 2x2 design was adopted, with factors SoT (BACK vs SIM) and ambiguity (+amb vs -amb). Participants (N=68) saw 64 trials, consisting of 16 experimental items with 48 fillers. Experimental trials such as [BACK,+amb] in (3) involved a context sentence establishing two time intervals, followed by the target, where the continuation disambiguated the locally ambiguous embedded past. Assuming incremental processing, H1 predicts longer reading times for SIM over BACK for the critical region, bolded in (3), and potentially the spillover region. H2 predicts that BACK forces a revision of a previously assigned SIM, resulting in longer reading times in those regions.

- (3) Context: After last week's final rehearsal,  
last night, John's band finally gave a concert, where I spoke to him about Mary...  
Target: John | said | that | Mary | was sick, |  
so | that's why | she | missed | **the concert**<sub>SIM</sub> / **the rehearsal**<sub>BACK</sub> | with | great | regret.

A repeated-measures ANOVA in SPSS reveals a marginally significant interaction between SoT and amb for the critical region ( $F_{1,67} = 3.127, p = .082, \eta^2 = .045$ ), resulting from longer reading times for SIM as opposed to BACK against the [-amb] baseline condition (see Fig.2).

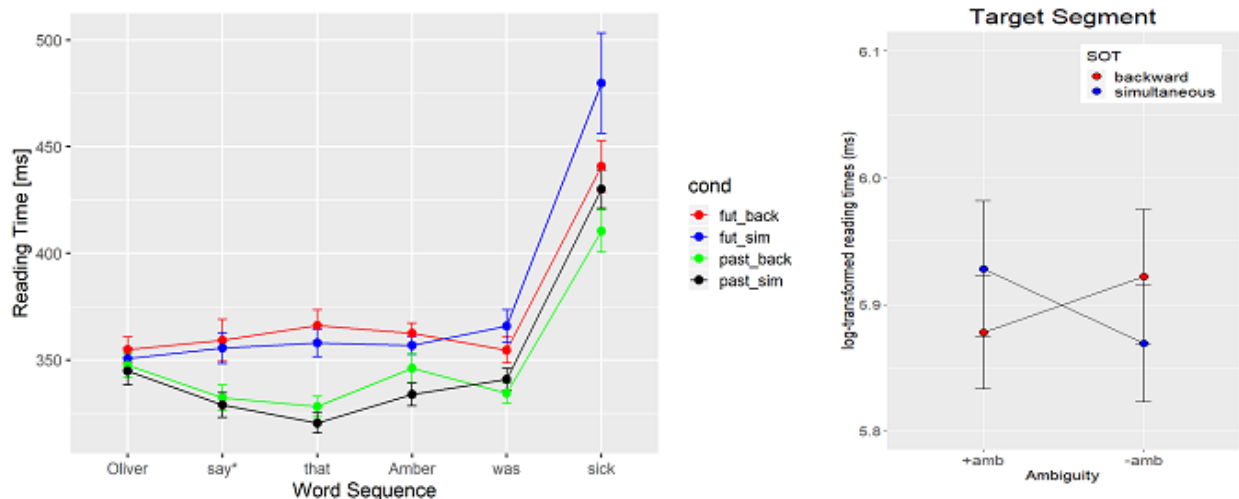


Figure 2: Reading-Time Results from Experiments 1 and 3.

**Discussion.** We find an acceptability preference for BACK over SIM, which is also reflected in the reading times in Exp3, contra some of the findings in the previous research literature. Taken together, Exp1-3 provide preliminary but converging evidence in favour of the WYSIWYG hypothesis and a processing strategy that is guided by morphological transparency, rather than Structural Simplicity. While further research into the processing of the sequence of tenses is needed, these findings are also relevant for other cases of ambiguity processing that involve form-meaning mismatches (in the interpretation of phi-features of pronouns, for instance).

**References.** D. ALTSCHULER & R. SCHWARZSCHILD (2013), "Moment of Change, "Cessation Implicatures and Simultaneous Readings", *Sub Proceedings* 17, 45-62. ::: D. ALTSCHULER (2016), *Events, States and Times* (Berlin: De Gruyter). ::: M. W. DICKEY (2001), *The Processing of Tense* (Dordrecht: Kluwer). ::: S. P. GENNARI (2004), "Temporal References and Temporal Relations in Sentence Comprehension", *Journal of Experimental Psychology* 30(4), 877-890. ::: B. HOLLEBRANDSE (2000), "The Acquisition of Sequence of Tense", UMass dissertation. ::: T. OGIHARA (1996), *Tense, Attitudes, and Scope* (Kluwer: Dordrecht).