

Exploring implicit causality effects on cataphora

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Cataphoric pronouns offer a window into the interaction between dependency construction and predictive processing [1,2]. Anaphoric pronouns trigger a backward antecedent search. With cataphors, comprehenders actively anticipate an antecedent to resolve the pronoun as early as possible [3,4]. Prior work shows anaphor resolution is sensitive to verb semantics [5,6,7], such as implicit causality (IC, e.g. [8]). In explanation configurations, **stimulus-experiencer** verbs (e.g. *to fascinate*, *to upset*) trigger the expectation that a pronoun refers to the **subject** (IC1 verbs); **experiencer-stimulus** verbs (e.g. *to treasure*, *to resent*) bias reference to the **object** (IC2). **Emotional Valence** (EV) also matters: negative events tend to be attributed to the subject, positive events to the object [7].

Testing how implicit causality influences cataphor resolution can inform the tension between (a) the ‘impatient’ mechanism with cataphora that seeks to resolve pronouns as early as possible, favoring the **subject** [3,4] and (b) verb semantics, encountered *after* the subject. To test this, we use sentence completion (Exp 1) and self-paced reading (Exp 2).

Exp1. Participants (n=35) filled in blanks (24 targets, 36 fillers). In targets, a *because*-clause (with a pronoun and a blank) is *followed* by a main clause with 2 same-gender names (Table 1). We manipulate IC bias (IC/IC2), emotional valence (EV, Pos/Neg) and Voice (Active/Passive). **Results:** IC effects persist with cataphora (Fig 1): IC1 verbs elicits more **subject** interpretations and IC2 verbs, **object**. Valence effects also obtain: IC2 with negative EV shows **weakened** IC effects ($p=0.01$), especially in active voice. Thus, in an offline task, even when the pronoun precedes its antecedent (the parser engages in an ‘impatient’ search to identify the antecedent) and the critical verb, the verb’s IC guides pronoun interpretation.

Exp 2. To test real-time processing, we use self-paced reading (24 targets, 36 fillers; moving-window SPR; PCibex, 80 participants planned). We manipulate (i) **IC bias** and (ii) whether, in the main clause, the **subject**, **object** or **both** gender-match the cataphoric pronoun (Table 2). RTs will be analyzed using *lmer*. **Predictions:** We expect RT slowdowns at the matrix subject when its gender mismatches pronoun gender (if the parser tries to resolve the pronoun as referring to the subject, as in [3]). Furthermore, we expect RT slowdowns following the verb, that we predict to spill over into the object, due to IC effects (Fig 2 for SPR predictions). And finally, we predict that there would be wrap-up effects that increase RT at the end of the sentences in the **AMB** condition. This work will thus shed light on the interaction and strength of ‘impatient’ active search with verbs’ semantic bias.

Table 1: Experiment 1 example item (fill-in-the-blanks task)

	Verb’s IC favors subject (IC1)	Verb’s IC favors the object (IC2)
Active	Because he _____, Jack _{STIM} {fascinated _{POS} /upset _{NEG} } Sean _{EXP} .	Because he _____, Jack _{EXP} {treasured _{POS} /resented _{NEG} } Sean _{STIM} .
Passive	Because he _____, Sean _{EXP} was {fascinated _{POS} /upset _{NEG} } by Jack _{STIM} .	Because he _____, Sean _{STIM} was {treasured _{POS} /resented _{NEG} } by Jack _{EXP} .

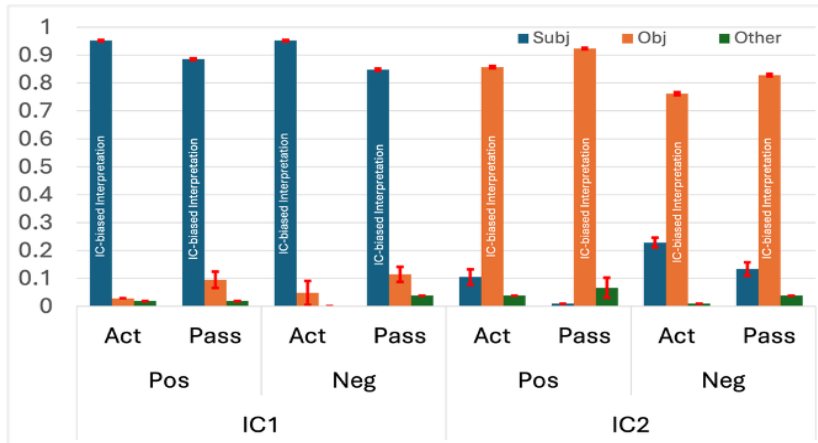


Fig.1: Exp 1 results. How often do people interpret cataphor as referring to subsequent **subject** vs. **object**? (In passive, referent in the by-phrase (e.g. **Jack**) is labelled as ‘**subject**’ to facilitate comparison with active (thematic role of **subject** in active voice is in **by-phrase** in = passive).

Table 2: Exp 2 example (SPR); Role nouns have F/M gender bias [9,10]; 50% items use *she*, 50% *he*; adjectives provide buffer and are gender-neutral. Neutral & positive IC verbs used.

<i>Critical cataphor-containing clause:</i> Because she was barely quintly,...	
Condition	Verb favors Subject/Object (IC1/IC2)
Pronoun matches subj gender (SPG)	... the gullible nurse , last Sunday, mesmerized _{IC1} /praised _{IC2} the intelligent firefighter at the circus.
Pronoun matches obj gender (OPG)	... the intelligent firefighter , last Sunday, mesmerized _{IC1} /praised _{IC2} the gullible nurse at the circus.
Matches both (AMB)	... the gullible nurse , last Sunday, mesmerized _{IC1} /praised _{IC2} the peculiar stylist at the circus.

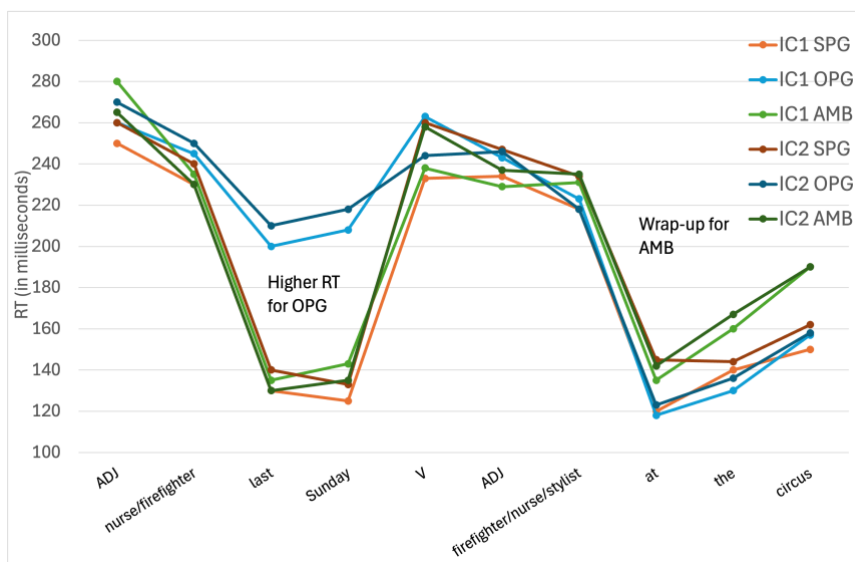


Fig2: Exp 2 Predictions/expected RTs for SPR based on Exp1 results (regions of interest: main clause subject + spillover; verb + main clause object).

References: [1] Badecker & Straub '02. *JEP*. [2] Sturt '03 *JML*. [3] van Gompel & Liversedge, '03 *JEP:LMC*. [4] Fedele & Kaiser '14 *PLC*. [5] Hartshorne '14. *LCN* [6] Ferstl et al. '11 *Beh.Res.Meth*. [7] Hartshorne & Snedeker '13. *LCP*. [8] Garvey and Caramazza '74 *LI*. [9] Misersky et al. '14. *Beh. Res. Meth*. [10] Scott et al. '18 *Beh. Res. Meth*.