

## Conceptual content and real-world coreference.

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Traditional approaches to discourse reference have assigned a central role to linguistically evoked concepts. For example, in File Change Semantics [1] and Discourse Representation Theory [2] (see Fig. 1), the interpretation of "*The woman bought a black car*" draws on a representation that indexes

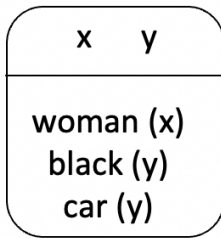


Fig 1. Partial discourse representation structure for referential expressions in *The woman bought a black car*.

relevant entities in the universe of discourse, which in turn are understood to fall within the evoked conceptual categories and bear the stated properties. However, equally "classic" work has often noted that the nominal expressions used to achieve linguistic reference can in fact bear a loose relationship to real-world circumstances or abstract notions of truth. For example, the utterance "*Who is the woman drinking the martini?*" can be readily interpreted even when the addressee happens to know that the woman in question is in fact drinking plain water out of a cocktail glass. Thus, conceptual elements evoked in linguistic expressions are in some cases better understood as cues to reference rather than fully accurate characterizations of an entity's conceptual category or properties (cf. [3-7]). In the present work, we explore this theme

further in the context of real-time referential processing. Critically, we employ manipulations where aspects of the referential context are altered between initial and subsequent expressions in a way that affects the validity of an earlier expression's linguistic content. The key question is whether or how these "updates" influence aspects of real-time interpretation. Our experiments use variants of the Visual World methodology in which gaze patterns are used to reveal listeners' moment-to-moment referential hypotheses at the millisecond level.

**Experiment 1** tests the assumption in the psycholinguistic literature that a pronoun preceded by an antecedent is interpreted via a process of retrieval (accessing the semantics of its antecedent in



Fig 2. Example display. Accompanying instructions:  
i. *Move the house on the left to [area 12]/[area 9]*  
ii. *Now, move it to area 4.*

discourse memory). Listeners (N=24) followed a sequence of instructions relating to objects in a grid display (see Fig. 2). On critical trials, the initial instruction was of the type "*Move the house on the left to area 12*". Importantly, the outcome of this instruction is that moved house is now the rightmost one. If a subsequent instruction contains a pronoun (e.g., "*Now, move it to area 4*"), then a process that retrieves the semantics of the antecedent expression should entail processing difficulty because the expression no longer accurately describes the intended referent. (Even if intuitions suggest there is no confusion as to the referent's identity, gaze measures should capture some difficulty.) The key comparison case involves a

condition where the antecedent semantics continue to be viable following the first instruction (e.g., house is initially moved to area 9). The results showed that not only did listeners select the

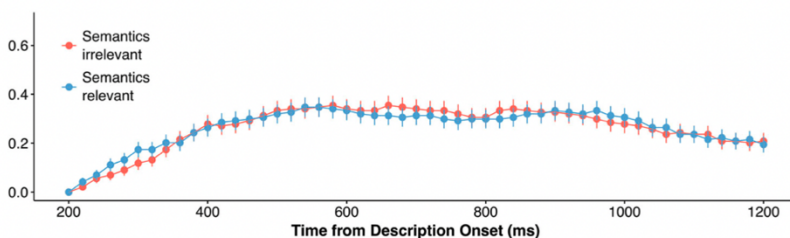
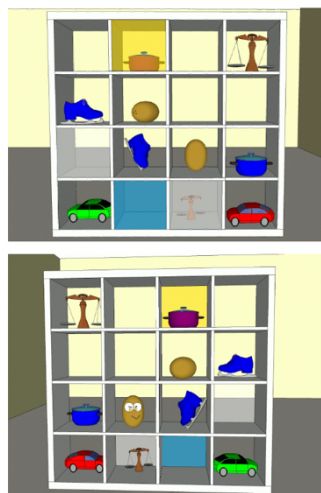


Fig 3. Fixation patterns over time at the pronoun is heard

previously-moved object with no difficulty regardless of whether antecedent semantics continued to be viable when the pronoun was heard, but also that fixation profiles were identical (Fig. 3). This similarity was corroborated by Bayesian parameter

estimation, taking into account fixations at each individual time step. These analyses showed that 100% of possible parameter values for the cross-condition difference fall within the region of practical equivalence. Thus, the properties evoked in the antecedent term appear to have little effect on pronoun interpretation, highlighting the notion that linguistic content is not relied on in an especially strong way (in turn making the notion of "retrieval" somewhat vacuous).

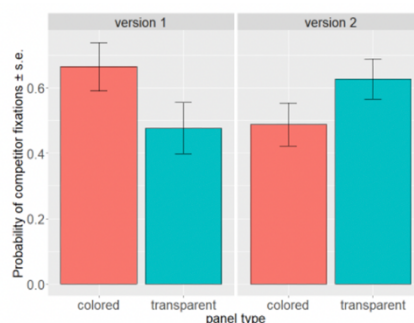
**Experiment 2** (N=48) explored the extent to which the conceptualization expressed in an earlier referring description continues to influence referential processing after listeners' belief state is updated to reflect that the initial conceptualization was incorrect. Listeners heard descriptions



**Fig 4.** Example display showing shelf from opposite sides (at top: yellow translucent panel makes purple pot appear red)

referring to objects that were located behind panels that were either transparent or were a translucent color that distorted objects' actual color. For example, given the shelf display shown at the top in Fig. 4, listeners might hear *Click on the red pot*. At some point, the shelf display was rotated (Fig.4, bottom), which in turn updated participants' beliefs about selected objects (e.g., the red pot is in fact purple). The display is then rotated back to the original view (Fig. 4, top). The key question is how listeners' new knowledge influences their interpretation of a downstream description. To discourage listeners from recognizing the goal of the experiment, this was achieved by referring to an as-yet-unmentioned object (e.g., the red car in Fig 4). If, upon hearing "red" in "*Now click on the red car*", listeners' eye

movements show strong temporary consideration of the pot (relative to a condition with a genuinely red pot and a transparent panel), this outcome would indicate that listeners prioritize entities' in-the-moment depiction/state rather than their (newly-learned) actual nature. We also included an analogue condition ("version 2") where, e.g., the car was purple. If listeners genuinely prioritize the in-the-moment depiction/state rather than their actual nature, then, upon hearing "purple" in "*Now click on the purple car*", listeners' eye movements should show little consideration of the pot (relative, once again, to a condition with a genuinely red pot and a transparent panel). These are the patterns observed (see Fig. 5).



**Fig 5.** Likelihood of making a temporary fixation to earlier mentioned object.

Together, the results show that listeners' expectations for linguistic reference seem to prioritize a notion of "in-the-moment expediency" over "truth". This is reflected in both referential dependencies (Expt. 1) and in cases where listeners' knowledge is at odds with the apparent features of objects at the time of utterance (Expt 2). The processing patterns are nonetheless compatible with a range of theoretical studies that, to date, are arguably underappreciated in mainstream psycholinguistics [3,4,5,6,7,8].

1. Heim, 1982;
2. Kamp & Reyle, 1993, *From Discourse to Logic*;
3. Donnellan, 1966, *Philosophical Review*;
4. Hobbs, 1987, *CSLI Report No. CSLI-87-99*.
5. Reimer, 1998, *Linguistics & Philosophy*,
6. Roberts, 1993, *How reference works*;
7. Sperber & Wilson, 1986, *Relevance: Communication and cognition*
8. Barwise & Perry, 1983, *Situations and Attitudes*.