

Dependency formation with subjective and objective adjectives in real-time processing

We report a webcam eye-gaze-tracking study showing that the idea of certain linguistic expressions triggering dependency formation/retrieval of previously-mentioned referents can – at least in certain communicative contexts – be extended to a new domain: adjectives.

In a sentence like “*Ben told Jon that the meal was {delicious/vegetarian},*” who thinks that the meal was delicious/vegetarian? You would probably say Ben. In this communicative event, the **source-of-information** (the agent of *told*) is naturally interpreted as the one who thinks the meal was delicious/vegetarian [2]. This intuition brings up the possibility of **source retrieval effects** during real-time processing; could comprehenders mentally retrieve the source (Ben) when they process the embedded clause, though Ben is not mentioned in it?

However, the information communicated by source referents can vary: Saying that a meal is delicious expresses the **source’s own subjective taste/opinion**, using a predicate of personal taste (PPT, e.g.[3]). But in saying that a meal is vegetarian, the source is stating a more **objective fact**. (One could disagree about what counts as *vegetarian*, but this involves matters of definition; debates about what is *delicious* are matters of subjective taste.) This distinction between subjective (e.g. *delicious*, *scary*) and objective adjectives (e.g. *vegetarian*, *wooden*) is well-established (e.g. [1,3,4]). Semanticists have proposed that subjective adjectives have as part of their meaning a special ‘**judge**’ argument/parameter that identifies *the person whose opinion/judgment the adjective expresses* (Ben in (1), e.g.[3]). On this view, subjective adjectives are always linked to a judge, unlike objective adjectives. If this is on the right track, and if the judge is at play during real-time processing, it raises the possibility that, when a person encounters a subjective adjective, they mentally retrieve the judge referent linked to the adjective (**judge retrieval**).

We used **webcam-based gaze-tracking** to test for evidence of comprehenders retrieving previously-mentioned source referents or judge referents during real-time processing of adjectival expressions that do not explicitly mention the source or the judge. Participants (117 native U.S.-English speakers) heard sentences like (2) while seeing displays like Fig.1a, as eye-gaze was tracked (using PClbex [6], Webgazer.js [5]). We manipulated adjective type (subjective/objective), and used voice (active/passive) to manipulate whether the subject or object is the source (2x2, 20 targets). After each trial, people saw a ‘who thought’ question on the next screen (ex.3, Fig.1b) and clicked the relevant person; the click responses yield the expected source bias, >90% in all conditions).

If **source retrieval effects** occur during online processing of adjectives, especially when source retrieval is encouraged by ‘who thought’-questions, both subjective and objective conditions should elicit *more looks to the source than the perceiver* when the adjective is encountered. Further, if **judge retrieval effects** occur in real-time (if presence of a judge argument triggers retrieval of the judge referent), subjective adjectives should elicit *even more looks to the source* than objective adjectives, since it is only with the former that the source is also the judge. (Objective adjectives are analyzed as lacking a judge argument.)

Results. Source-advantage scores (source minus perceiver looks) are plotted in Fig.2, which shows that soon after adjective onset (0ms), the source advantage scores increase steeply in all conditions (more looks to source than perceiver), suggesting that the adjective triggers **retrieval of the source**. Crucially, we also find an effect of adjective type: from adjective onset until the end of the trial, subjective adjectives trigger more looks to the source than objective adjectives ($t=2.15$, $p=0.033$), suggesting that subjective adjectives trigger **retrieval of the judge**. There is a marginal voice effect ($t=1.86$, $p=0.068$), suggesting subjects may be more easily retrieved than objects – but no interaction ($p>.9$).

In sum, in the right context even adjectives – not typically viewed as anaphoric – can trigger looks to previously-mentioned referents. This suggests referential dependencies, (very) broadly construed, may be more widespread than previously thought. Moreover, gaze patterns reveal rapid effects of source-of-information and adjective type: the dependency-building/retrieval processes triggered by adjectives are incrementally constrained in semantically principled ways. **Current work:** We ran a similar study testing subjective and objective adjectives in sentences about COVID; data analysis is ongoing. These results can shed light on how people’s own attitudes impact processing of subjective adjectives.

(1a) Ben: “The meal is delicious” (1b) Ben: “The meal is delicious_{BEN}” (*delicious to Ben*)

(2) Example (auditory, presented as eye-gaze was tracked. Items were 50/50 male/female):

(a) **Ben**_{SOURCE} told **Jon**_{PERCEIVER} that the meal at the event was {delicious/vegetarian}

(b) **Ben**_{PERCEIVER} was told by **Jon**_{SOURCE} that the meal at the event was {delicious/vegetarian}



Fig.1a Sample display. (L/R position of subject/object, and pairing of names and pictures, were randomized. The image of the thing being talked about, e.g. meal, appeared at determiner onset in the audio and remained on-screen until adjective onset, e.g. *the meal at the event was*, attracting eyegaze to a neutral location)

(3) Question (written): Who thought that the meal was {delicious/vegetarian}?

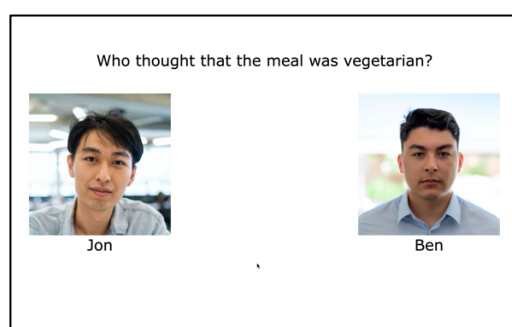


Fig.1b Sample ‘who thought’- question display (Participants responded by clicking on the relevant person)

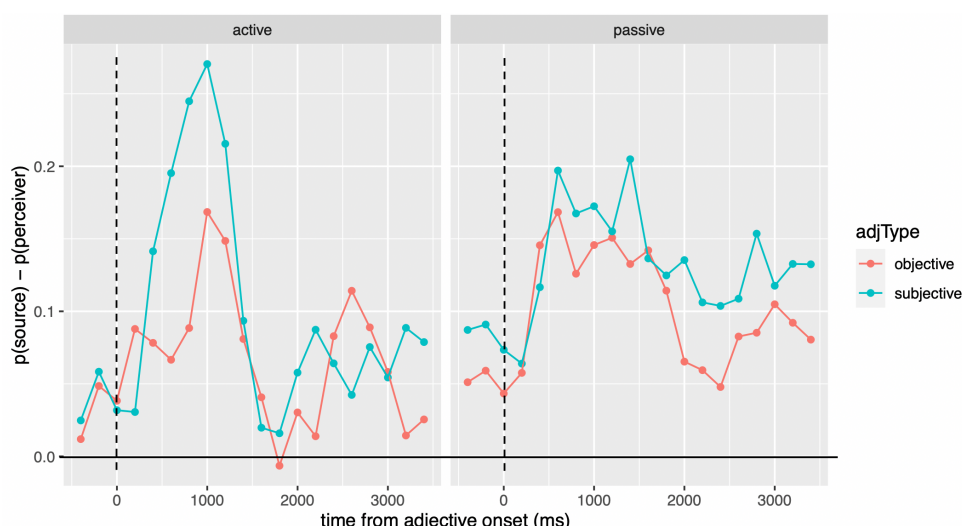


Fig.2: Eye-gaze patterns during the critical sentence (left panel: active voice; right panel: passive voice). Y-axis shows *source-advantage scores* (looks to source minus looks to perceiver). X-axis shows *time*: 0ms is the onset of the adjective; the source and perceiver images remained on-screen for 3 s after sentence offset (which is when the trial ended).

References [1] Bylinina (2014) The Grammar of Standards. [2] Kaiser (2020) Shifty behavior. [3] Lasersohn (2005) Context dependence, disagreement, and predicates of personal taste. [4] McNally & Stojanovic (2017). Aesthetic adjectives. [5] Papoutsaki et al. (2016). Webgazer: Scalable webcam eye tracking using user interactions. [6] Zehr & Schwarz (2018). PennController for Internet Based Experiments (IBEX).