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Visual contrast, discourse contrast and conceptual convention

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How standards of comparison for gradable adjectives like *large* or *small* are established based on contextual information has been an active area of research [1-5], but much of this work sets aside the question of what features of the context comprehenders rely on to determine an appropriate comparison class, and how different cues are weighed against each other. The present study uses the Visual World Paradigm [6] to investigate how comprehenders integrate visual and discourse context to referentially disambiguate an expression like *small square*. It builds on [7], which showed that a contrast set in the visual context (tall glass, short glass) increased listeners' expectation that a contrast set member would be described using a modifier (*tall*) due to the need to disambiguate from the other contrast set member, even when e.g. a taller object in terms of absolute height (pitcher) was also present in the display (visual contrast effect). This study extends this paradigm to include the prior discourse as an additional source of contrast.

Experiment1 asks to what extent contrast across discourse functions like visual contrast to aid referential disambiguation, and how discourse and visual contrast are integrated when both are present and provide conflicting cues to contrast. Participants listened to pairs of sentences like (1) accompanied by pairs of displays like (2). Target type (whether the target word, *square* in (1), was a part of a discourse or visual contrast set) was crossed with the presence of an additional contrast set (discourse contrast if the target a visual contrast set member, and vice versa). The visual contrast effect [7] was replicated: when a contrast set was in the visual context, fixations converged on the target referent in the 200-100ms preceding the onset of the target word (t=3.02, p <.0001).

There was also evidence that discourse contrast has a similar facilitative effect on resolving reference: when both visual and discourse contrast were present, the discourse contrast set member competed with the visual contrast set member, as indicated by later convergence on the target referent when both sources of contrast were present (100-200ms post target onset for discourse contrast targets, t=2.15, p <.05; 300-400ms post target onset for visual contrast targets, t=2.23, p <.05), than when only one contrast was present (300-400ms post target onset for discourse contrast targets, t=2.09, p <.05; see above for visual contrast targets). Target and competitor fixations were fit with mixed-effects logistic regression models in analysis windows aligned to linguistically-determined events (pre-adjective, adjective-to-target, post-target), with Target type (discourse, visual contrast), Number of contrast sets (one, two), Time, and their interactions as predictors. There were more competitor fixations for two-contrast than one-contrast conditions in the adjective-to-target (β=.042, SE=.0013, p <.0001) and post-target windows (β=.071, SE=.0027, p <.0001). However, discourse contrast was a less salient cue than visual contrast. Discourse contrast competitors gave rise to a weaker competitor effect than visual contrast competitors: there was a larger competitor advantage for visual contrast competitors in both adjective-to-target (β=.034, SE=7.25e^{-6}, p <.0001) and post-target windows (β=.047, SE=.0014, p <.0001). In addition, comprehenders recovered faster from discourse contrast competitors (100-200ms post target, t=2.15, p <.05) than from visual contrast competitors (300-400ms post target, t=2.23, p <.05).

While discourse contrast appeared to be a weaker cue than visual contrast in Exp1, in conversation, discourse contrast is often far more salient than visual contrast, simply because many conversations are not about the visual environment. In addition, richer discourses have

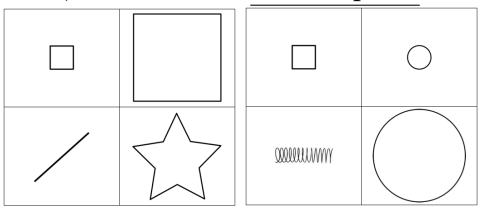
additional internal dependencies that the pairs of sentences in Exp1 do not. For instance, coherence relations [8] and Question Under Discussion structure [9] have been shown to influence online discourse interpretation [10-11], as has prosodically marked contrast [12]. The conceptual pact literature [13-15] also suggests that how something has been referred to in prior discourse influences how a listener expects the same item to be referred to subsequently. **Experiment2** asks whether prior experience describing classes of items in a particular way modulates the strength of discourse or visual cues to contrast.

Exp2 differed from Exp1 in two respects. First, test trials were preceded by a training block in which participants categorized one class of objects (2D shapes, e.g. square, circle) in terms of size (*large*, *small*), and another (3D shapes, e.g. cube, sphere) by whether they were *striped* or *solid*. Second, in addition to the four conditions from Exp1, the test block included two-context conditions where the competitor contrast item was from a different training category than the target, as in (3-4). If prior experience associating different category members with particular modifiers leads to expectations that the same conventions will continue to be followed, different category competitors (whether discourse or visual contrast) should be weaker competitors to the target referent than same category competitors.

To assess same v. different category competitor effects, target and competitor fixations from the two-contrast conditions were fit with mixed-effects regression models using the same analysis windows as for Exp1, with Target type (discourse, visual contrast), Competitor type (same, different category contrast), Time, and their interactions as predictors. There were more competitor fixations for same-category than different-category competitors in the adjective-to-target (β =.053, SE=.0034, p <.0001) and post-target windows (β =.053, SE=.0034, p <.0001), suggesting that unexpected modifier-category pairings were weaker competitors with target referents than expected ones. However, within different category conditions, comprehenders recovered more slowly from discourse contrast competitors (600-700ms post target onset, t =2.72,p <.01) than from visual contrast competitors (convergence on target 200-300ms post target onset, t =2.43,p <.05). The strong discourse competitor effect may be because this is the only condition that requires comprehenders to shift from one dimension of modification (e.g. *small/large*) to another (e.g. *striped/solid*) within a discourse (3-4); this suggests comprehenders may expect that, regardless of category-specific modification history, speakers will modify discourse referents in consistent ways.

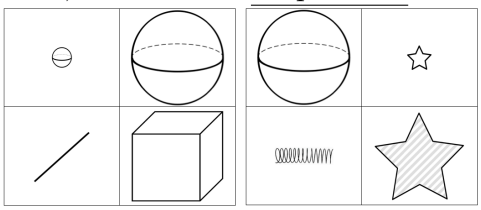
(1) Click on the large square.
Now, click on the small square.

(2)



(3) Click on the small sphere.
Now, click on the striped star.

(4)



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