Perceptual contrast as a visual heuristic in the formulation of referential expressions

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We propose that speakers rely on perceptual contrast as a visual heuristic to produce efficient referential expressions *efficiently*. That is, to produce referential expressions that may facilitate the listener's visual search, while requiring limited effort on the speaker's part. Under a contrast perception heuristic, significant perceptual contrast will trigger modification, even when it may be redundant. We understand this visual heuristic as a form of 'low-cost pragmatics' in line with Victor Ferreira's *feedforward audience design* [1]: according to this mechanistic framework, speakers need not engage in reflective processes to be sensitive to their listeners' needs; instead, they can make use of contextual cues prior to utterance onset and rely on previously learned strategies that facilitate communication (see also [2,3]). A number of psycholinguistic studies have shown that redundant modification can facilitate the listener's visual search for a referent [4-9], confirming that over-specification can be efficient [10,11]. **Here we report two language production experiments testing whether perceptual contrast triggers efficient over-specification.**

Experiment 1: Koolen et al. [12] (see also [13]) have argued for an alternative account in which color over-specification is triggered by 'scene variation' (i.e. the number of dimensions along which the objects in a scene vary). Their results support their predictions, but they tested high scene variation in polychrome displays and low scene variation in monochrome displays, so their results could have been driven by color contrast rather than by scene variation. Here we pitched scene variation against color contrast (see Fig. 1). UCL students (n=31) requested a target in two blocks of monochrome and polychrome displays (lab task). An LMER model of Over-specification with Scene Variation level (high vs low) as FE and maximal RE structure revealed more over-specification in low scene variation (polychrome) than high scene variation (monochrome) (ß=8.7, 95%CI=[4.8-13.8]), contra to [12,13]. The perceptual contrast hypothesis was tested in another LMER model with Modifier Type (Color vs Other: size, border type and border weight), Display Type (Monochrome vs Polychrome), and Block as FE and maximal RE structure. Supporting our hypothesis, we observed more color over-specification in polychrome than monochrome displays (ß=7.1, 95%CI=[4.1-10.5]), and more over-specification of size, border type and border weight in monochrome than polychrome displays (ß=-17.8, 95%CI=[-31.0 – -10.6]) (see Fig. 2).

Experiment 2: Previous studies have shown that speakers over-specify atypical colors (e.g., 'pink banana') more than typical colors (e.g., 'yellow lemon') [13-15], which some have interpreted as a cooperative strategy to aid the listener's visual search [10]. We predicted that atypical colors would be over-specified in polychrome displays, but not in monochrome displays. According to the alternative view that atypical colors are salient because they violate world knowledge, color contrast should not make a difference. MTurk participants (n=38) had to instruct a virtual partner to click on a target object in a series of displays (see Fig. 3). We ran an LMER model of Over-specification with Display Type and Target Typicality (Atypical, Typical, Variable) as FE and maximal RE structure. Replicating [10], we found higher over-specification in atypical polychrome compared to typical polychrome (ß=-8.7, 95%CI=[-16.7 – -4.6]) or variable polychrome (ß=-3.9, 95%CI=[-6.4 – -1.9]). As predicted, we found a decrease in over-specification in atypical monochrome compared to atypical polychrome (ß=-19.9, 95%CI=[-42.0 – -7.7] and no effect of target typicality across monochrome displays (see Fig. 4). These results suggest that over-specifying atypical colors is an efficient, cooperative strategy [10].

Our findings support the view that speakers use perceptual contrast as a visual heuristic for efficient referential communication [1,11]. In this view, deciding whether to use modification in referential communication need not be costly (e.g., speakers need not identify competitors in the visual context prior to producing an efficient referential expression; see [16,17]). **Relying on perceptual contrast as a visual heuristic would allow speakers to adapt their referential expressions to their listener's needs with minimal expenditure of cognitive resources, in line with Ferreira's feedforward audience design**.

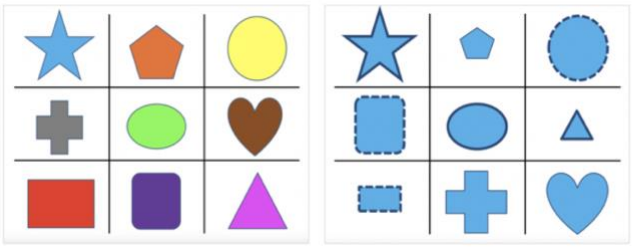

Figure 1. Sample polychrome display with low scene variation (shape and color vary) and monochrome display with high scene variation (shape, size, border type and border weight vary) from Exp. 1.

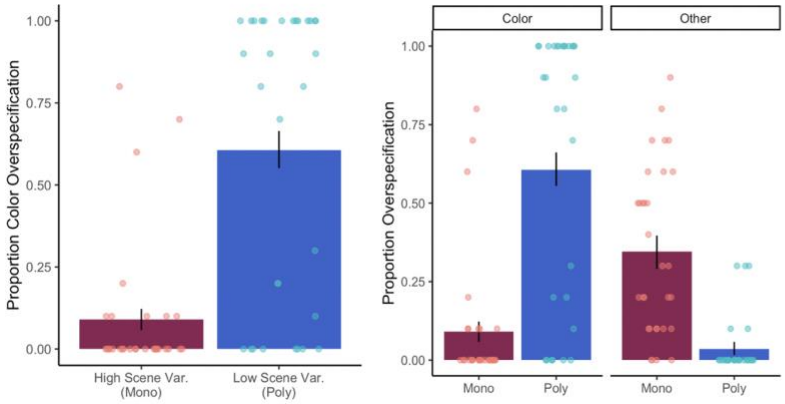

Figure 2. Mean proportion of over-specification from Exp. 1 testing the scene variation hypothesis (left panel) and the perceptual contrast hypothesis (right panel), aggregated by display type (both panels) and response type (right panel). Line ranges reflect 95% bootstrapped CIs and points reflect participant means.

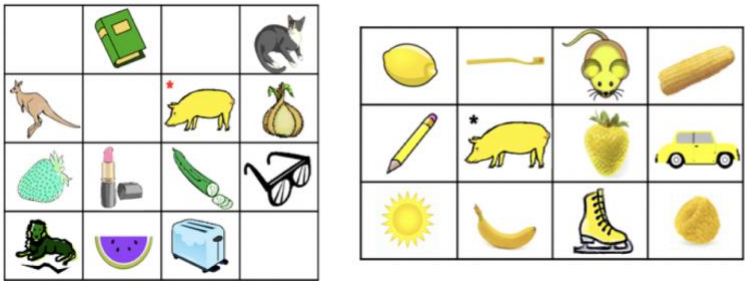

Figure 3. Sample polychrome and monochrome displays from Exp. 2. The polychrome displays were taken from Rubio-Fernandez (2016).

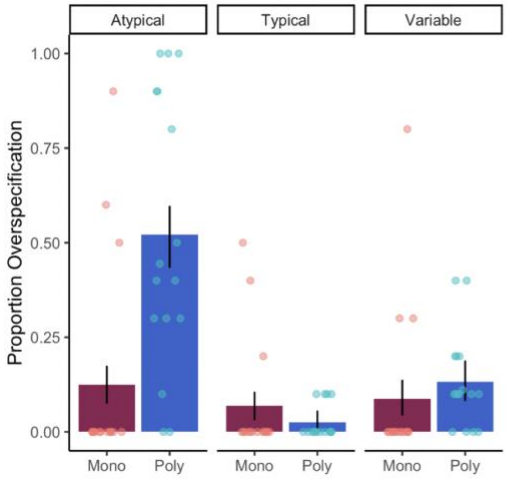

Figure 4. Mean proportion over-specification from Exp. 2 by display type and target typicality. Line ranges reflect 95% bootstrapped CIs and points reflect participant means.

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