Different Determiners, Different Algorithms: Two Majority Quantifiers in Cantonese Bias Distinct Verification Strategies

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Lidz et al. (2011) propose that meanings provide canonical strategies for evaluation, and that specific proposals about a meaning can be tested by identifying such default strategies. They argue on this basis for specifying the meaning of *most* in terms of cardinality and subtraction. We show that the predictions of this account are borne out in Cantonese.

On Lidz et al.'s view, a verification strategy that transparently reflects the meaning under evaluation will be preferred, sometimes even when superior alternatives are available. For example, Pietroski et al. (2009) show that participants perform Approximate Number System (ANS) comparisons to evaluate statements like *most of the dots are blue*, even given displays for which a one-to-one correspondence strategy would lead to faster and more accurate performance. And Lidz et al. (2011) argue that participants are biased to calculate the answer using a superset subtraction strategy (e.g., $\#BLUE > \#TOTAL - \#BLUE$) even on displays with only one distractor set, where a direct comparison (e.g., $\#BLUE > \#YELLOW$) would be simpler and more accurate.

Following work on Polish by Tomaszewicz (2011), we provide cross-linguistic support for these hypotheses by testing two Cantonese determiners. *Daai-do-sou* (*big-many-number*) has the meaning of the English determiner *most*. *Zeoi-do* (*superlative-many*) has a "largest subset" meaning, which need not imply more than half (e.g., (2) is true given 4 blue dots, 3 yellow, and 2 red).

(1)	**daai-do-sou** ge dim hai laam-sik	(Proportional *most*)
	most POSS dot is blue	'Most of the dots are blue'
(2)	**zeoi-do** ge dim hai laam-sik	(Largest subset *most*)
	most POSS dot is blue	'The blue dots are the largest subset'

We showed brief (200ms) dot displays to 14 Cantonese-speaking participants and asked them to judge the truth of the statements in (1) and (2). In both blocks, we varied the number of distractor sets (for a total of 2-5 colors per display) and the ratio of the target set to the competitor.

Given Lidz et al.'s account, we predict three results. First, both determiners should rely on the ANS, resulting in ratio-dependent performance. Second, proportional *most* should bias participants toward the superset subtraction strategy. This entails estimating the total number of dots directly (i.e., not by adding up each subset's cardinality), so performance for proportional *most* should be unaffected by the number of distractor colors. On the other hand, largest subset *most* should bias a strategy of serially comparing blue to the other colors ($\#BLUE > \#YELLOW$ & $\#RED$ & $\#...$). Because the visual system can enumerate only two subsets in parallel (Halberda et al., 2006), this strategy should be difficult to deploy as more distractor sets are added, and performance should suffer. Third, even on trials with only one distractor set – where displays and truth-conditions are identical – participants should nonetheless use distinct strategies to evaluate (1) and (2).

These predictions were borne out. We observe main effects of ratio in both the proportional ($F_{4,52}$=75.61, $p<.001$) and largest subset blocks ($F_{4,52}$=60.54, $p<.001$), but a main effect of distractor number only in the largest subset block ($F_{3,39}$=3.48, $p<.025$) (Fig.1). This is consistent with both determiners relying on the ANS but only largest subset *most* biasing serial comparison. In the one-distractor cases (Fig.2), we find an interaction between quantifier and whether the correct answer was true/false ($F_{1,13}$=10.59, $p<.0063$). The bias to respond "true" in the largest subset block is consistent with what Tomaszewicz (2011) found in Polish and is predicted if participants overestimate the size of the focused set. This difference further supports the idea that both quantifiers bias distinct strategies, even when displays are identical and either strategy could be used.

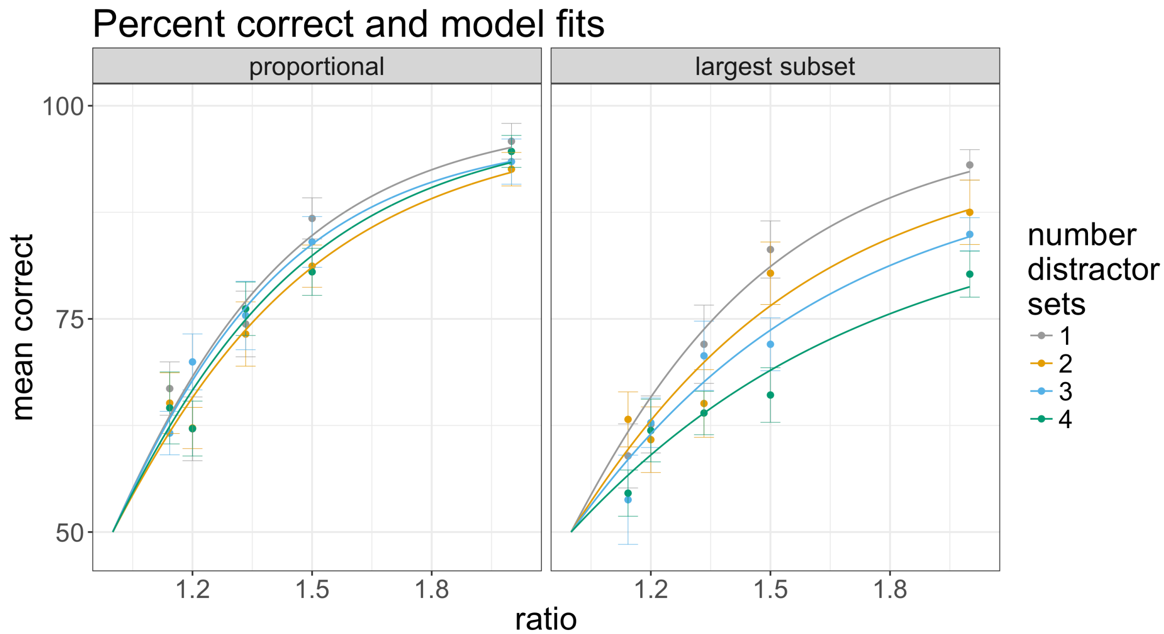

Figure 1: Overall performance in each block, separated by the number of distractor sets (colors in the display, aside from blue). Lines represent fitted psychophysical model of ANS comparison.

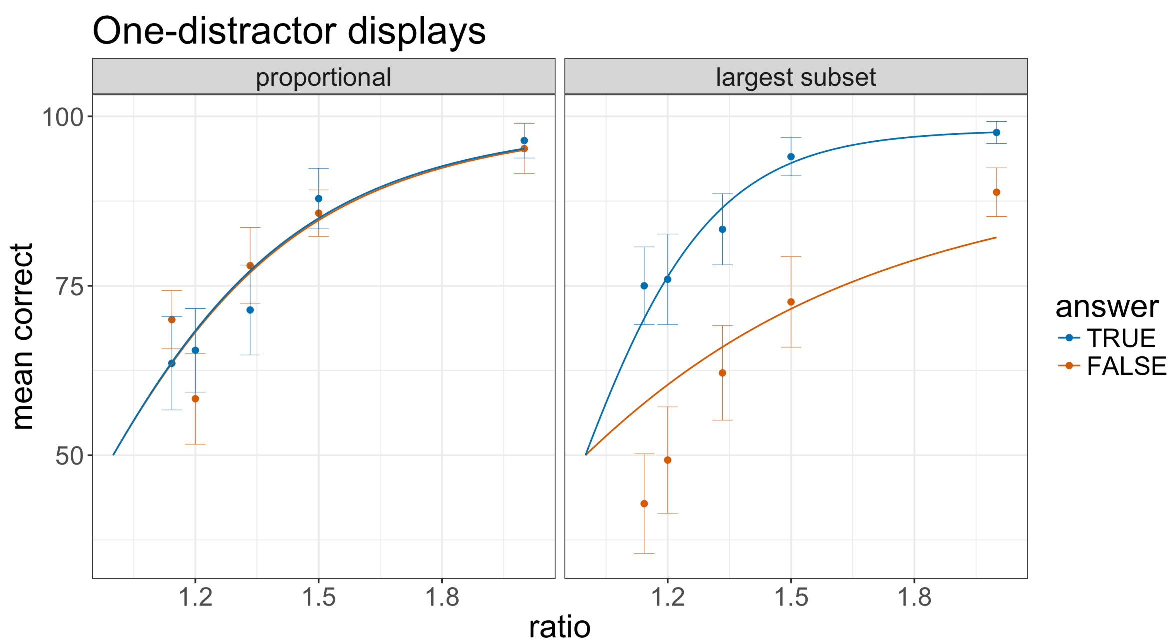

Figure 2: Performance on displays with only one distractor color, separated by whether the correct answer was true (more blue dots than non-blue dots) or false (more non-blue dots than blue dots). Performance differs as a function of quantifier despite displays and truth-conditions being identical.

References: Lidz, Pietroski, Halberda, & Hunter (2011) Interface transparency and the psychosemantics of most. *Nat. Lang. Semant.* • Pietroski, Lidz, Hunter, & Halberda (2009) The meaning of 'most': Semantics, numerosity and psychology. *Mind Lang.* • Halberda, Sires, & Feigenson (2006) Multiple spatially overlapping sets can be enumerated in parallel. *Psychol. Sci.* • Tomaszewicz (2011) Verification strategies for two majority quantifiers in Polish. *Sinn und Bedeutung.*