

Many studies on the influence of prior expectations on the use of vague quantifiers

Anthea Schöller & Michael Franke — University of Tübingen

Abstract. We investigate prior expectations as one source of variability in the denotation of vague quantifiers like *few* and *many*. In a series of experiments we identify prior expectations of the quantities in the respective context as a significant predictor of participants’ behaviour. This insight that has been acknowledged by psychologists but has not received much attention in formal semantics.

Landscape. One key property of vague quantifiers like *few* and *many* and also of gradable adjectives like *tall* and *expensive* is that their denotation can vary extremely across contexts and domains of applications. The number of spectators described by *many* in (1a) will be much larger in a conversation about the final of the European Champions League than for a match of the local football club. The same variability can be found in *few* in (1b) as well depending on whether we talk about a cocktail party or a barbecue.

- (1) a. Many people watched the football match on Sunday.
- b. Few of the guests at the party drank beer.

Literature in psychology informally suggests that world knowledge influences the use of vague quantifiers or gradable adjectives (Clark, 1991; Moxey and Sanford, 1993). These insights have not been incorporated in formal semantics yet. Especially theories based on a degree semantics like Hackl (2000), Kennedy (2007), and Solt (2009) and also Partee (1989) only suggest that the cardinality described by the quantifiers and adjectives must be higher than a contextually given threshold. How exactly this threshold is influenced by the context is not spelled out. We set out to identify one aspect of the context to which we ascribe a major role in the production and interpretation of these vague expressions.

Hypothesis. Following Clark (1991), Fernando and Kamp (1996), and Frank and Goodman (2012) we assume that the context is integrated into the reasoning about language use in the form of prior expectations. The way we use vague quantifiers like *few* and *many* is influenced by the quantities we expect and consider to be normal in the respective situation.

Experimental investigation. In a series of experiments we explore this hypothesis by applying various paradigms and investigating different uses of *many*. We present contexts in written and visual form and use recent experimental methodology to measure prior expectations. Furthermore, we investigate participants’ behaviour in rating and interpretation tasks and make use of statistical data analysis. In the following we report selected findings.

Proportional *many*. In its proportional use as in (2), *many* is assumed to express that a set of entities, for example muffins eaten by Ed, makes up a considerable proportion of its superset, say all muffins on the table. Since it has been speculated that *many* expresses a fixed proportion, it might be considered implausible that prior expectations have an influence on interpretations. We set out to manipulate prior expectations and measure proportional interpretations of *many*. We recruited 160 participants on Amazon’s Mechanical Turk and for each item presented one sentence introducing the context and the amount of objects under discussion. The AMOUNT was

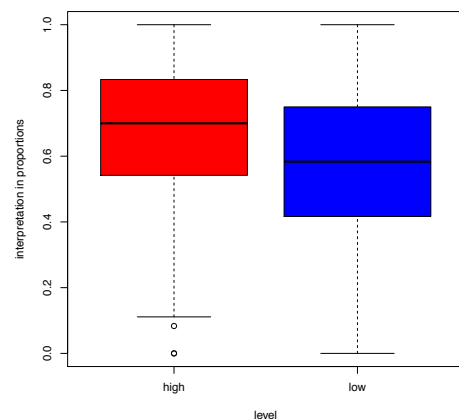


Figure 1: Proportional interpretations of *many* in high and low probability contexts

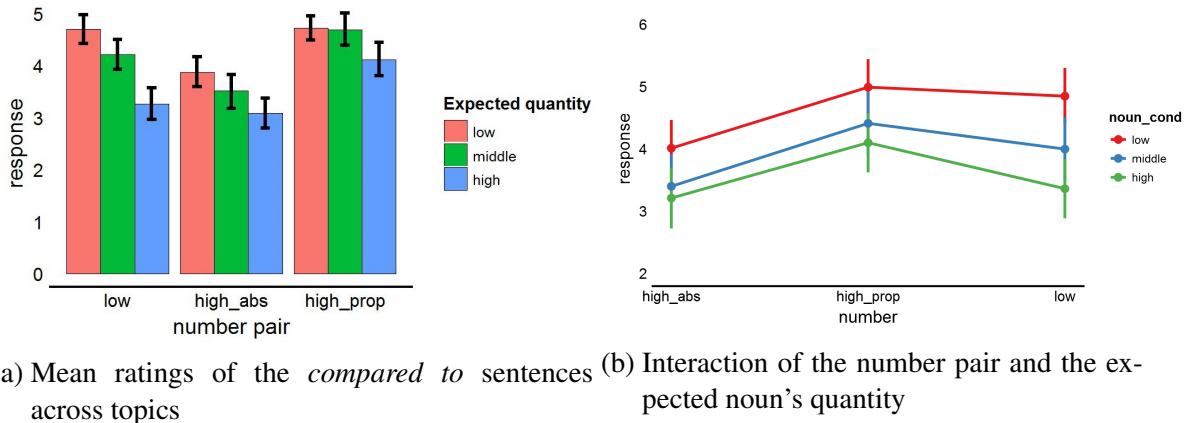


Figure 2: Study on *compared to* and *many*

chosen from one of two numbers, $[3/4N|N]$. A sentence containing the quantifier was randomly chosen from two conditions of factor LEVEL [HP|LP], high probability or low probability. We set the level in a way that we expect higher answers in high probability contexts. In a free production task, participants were asked to guess the number that they think *many* refers to.

- (2) There were [AMOUNT: 9 | 12] muffins on the kitchen table in Ed's flat.
 [LEVEL: HP] Ed, who arrived feeling hungry, ate many of the muffins.
 [LEVEL: LP] Ed, who arrived feeling full, ate many of the muffins.

A linear mixed effects regression revealed that only the factor LEVEL is a significant predictor of the participants' behaviour. Their proportional interpretations of *many* were significantly lower in the low-level condition ($\beta = -0.128, SE = 0.013, p < 0.001$), see Figure 1. The factor AMOUNT did not make a significant difference. This suggests that proportion matters less to proportional uses, while expectations matter more than is expected from the previous literature.

Compared to and many. In the presence of the frame setter *compared to*, the cardinality described by *many* in the matrix clause is compared to the cardinality ascribed to the individual in the *compared to* phrase, see (3). To our knowledge, the influence of world knowledge and prior expectations on *compared to* phrases has not been investigated. In this experiment, we manipulated the NUMBERS and their difference [low|high+same absolute|high+same proportional difference as low] as well as the expected cardinality of the NOUN [low | middle | high]. 183 participants were recruited via Mechanical Turk. 7 items were presented in a random order and in a random NOUN and NUMBERS condition. We asked for judgements of the *compared to* sentence on a 7 point scale and whether the presented cardinalities are PLAUSIBLE.

- (3) Chris and Martin are men from the US. Martin has [NUMBER: 5|12|12] [NOUN: siblings|friends|Facebook friends] and Chris has [NUMBER: 8|15|19] [NOUN: siblings|friends|Facebook friends].
 Compared to Martin, Chris has many [NOUN: siblings|friends|Facebook friends].

A linear mixed effects regression revealed that the ratings of the *compared to* sentences can be explained by the fixed factors NUMBERS, NOUN and PLAUSIBILITY of the higher number. High numbers with the same absolute distance as the low number pair were rated lowest ($\beta = -0.83, SE = 0.158, p < 0.001$), see Figure 2. Even though number pairs with the same proportional difference received similar ratings, the factor NUMBERS is not sufficient to explain all of the variability in the data. Contextual factors like PLAUSIBILITY and expected cardinality

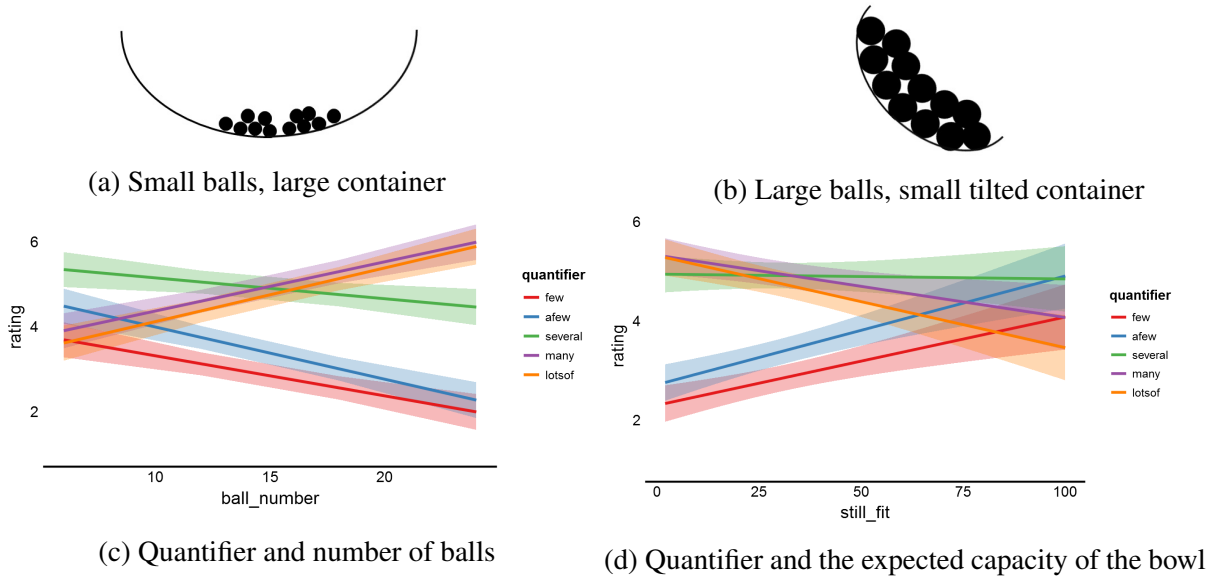


Figure 3: Stimuli of the superbowl replication and significant interactions

of the NOUN are significant predictors, too. These results are a first piece of evidence that even frame setters can be influenced by prior expectations.

The Superbowl. In a replication of Newstead and Coventry’s (2000) study we investigate the influence of the size and position of visual stimuli on the acceptability of the QUANTIFIERS *a few*, *few*, *several*, *many* and *lots of*. In such an abstract setting it might not be expected that world knowledge plays a role. We presented participants with a varying NUMBER of balls in a bowl. The BALL SIZE was [small|large], just as the BOWL SIZE was [small|large]. The BOWL POSITION was either [normal|tilted]. When the bowl was tilted and contained a large number of balls, the balls appeared to not fall out. For this reason Newstead and Coventry (2000) call it a "superbowl" and move on to explain some of their results with this concept. The number of balls we presented was [6|12|18|24] and a sample of the stimuli is shown in Figure 3. On a 7 point scale, participants were asked to rate sentences of the form

(4) There are [QUANTIFIER] balls in the bowl.

Additionally, we asked the participants for their guess of the EXPECTED CAPACITY of the bowl. A mixed linear effects regression model identified only the factor QUANTIFIER as a significant predictor. Additionally we found significant interactions of QUANTIFIER and NUMBER and of QUANTIFIER and EXPECTED CAPACITY, see Figures 3c and 3d. Interestingly, including the factor EXPECTED CAPACITY prevents the necessity of the factors BOWL SIZE, BOWL POSITION, BALL SIZE which Newstead and Coventry (2000) adduce to explain their findings. Once again we find that expectations matter because even the superbowl could be disenchanting.

Discussion. Manipulating expectations has a significant effect on participants’ ratings and interpretations of sentences containing vague expressions. Prior expectations of the context turn out to be a significant predictor of the results in all three studies. This confirms the hypothesis that contextual information can be integrated in the form of prior expectations. However, this insight is only a first step and more work is necessary. A straightforward next step is to investigate how exactly language use and expectations interact. We aim at formulating quantitative predictions about language use based on experimentally measured prior expectations.

Selected references. Clark: *Words, the World, and their Possibilities* (1991). Fernando & Kamp: *Expecting Many* (1996). Frank & Goodman: *Predicting Pragmatic Reasoning in Language Games* (2012). Moxey & Sanford: *Prior Expectations and the Interpretation of Natural Language Quantifiers* (1993). Newstead & Coventry: *The Role of Context and Functionality in the Interpretation of Quantifiers* (2000). Partee: *Many Quantifiers* (1989).