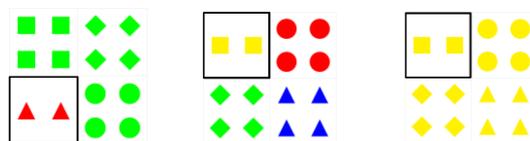


Overspecification of number in reference production

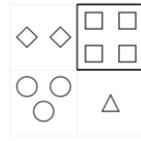
It has been acknowledged that color is more often overspecified in reference production than other attributes, such as size, shape, material and pattern, cf. Belke and Meyer (2002), Brown-Schmidt and Konopka (2011), Tarenskeen et al. (2015), Rubio-Fernandez (2016) a.o. There have been proposed 2 factors which explain the variation in overspecification of attributes: (i) relativity (or context-dependency) vs. absoluteness (or the lack of context-dependency), and (ii) salience vs. the lack of salience. The idea is that attributes which are absolute and/or salient (e.g., color) are more likely to be overspecified than attributes which are relative and/or non-salient (e.g., size). Both factors play a crucial role in overspecification of attributes and seem to be independent of each other. According to Brown-Schmidt and Konopka (2011), number seems to be absolute and salient. However, this fact has not directly and systematically been addressed in the literature. The current paper aims to fill this gap.

The paper studies number overspecification in reference production compared to color and size overspecification. More precisely, the study involves small numbers (till 4) and shows that they are salient and absolute due to the *subitizing effect*. Subitizing is a phenomenon of immediately grasping the quantity of few elements in a given set, cf. Kaufman et al. (1949) a.o. The paper reports on 3 production studies in spoken standard Russian.

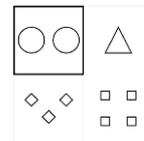
The 1st experiment tests *Hypothesis A*: small numbers (till 3) are overspecified in reference production and are not affected by color overspecification (which has been claimed as the key phenomenon in the research on overspecification in reference production due to its absoluteness and salience). We verified *Hypothesis A* using 4 pictures/cells, each of which contains geometric figures (squares, circles, triangles, or diamonds) of 4 colors (red, green, yellow, or blue) and of 4 quantities (1, 2, 3, or 4). The geometric figures were identical within each cell but are different among all cells, whereas color was either identical or different among all cells depending on a condition. There were 3 conditions. *Bichrome* (B) condition involved color contrast between 1 cell vs. the other 3 cells. *Polychrome* (P) condition involved cells of different colors. *Monochrome* (M) condition involved cells of the same color. See Picture 1 for the 3 conditions. In all the conditions, there was a quantity contrast between 1 cell (which was bold) vs. the other 3 cells.



Picture 1. B, P, and M conditions (exp1)



Picture 2. U condition (exp2)



Picture 3. S condition (exp2)

A neutral linear word order of a numeral phrase in Russian is numeral (+ adjective) + noun. There were 4 possible ways to make a reference to a particular set of objects: a plural noun (e.g. 'squares'), a numeral + a noun (e.g. 'two squares'), an adjective + a noun (e.g. 'red squares') or a numeral + an adjective + a noun (e.g. 'two red squares').

Each condition consisted of 24 stimuli and 24 fillers (human faces) which were counterbalanced. 30 people participated in the experiment, 10 participants per condition (age 18-27, mean age=24, 24 females). The participants had to explain the bold cells to the person who had the same set of pictures but did not know which cell is bold.

A linear mixed-effects model with a random effect on the speaker indicated that there was no significant difference in number overspecification between B and P conditions ($p=0.806$), between P and M conditions ($p=0.808$) and between B and M conditions ($p=0.998$). This confirmed *Hypothesis A*. As for color overspecification, a linear mixed-effects model with a random effect on the speaker showed that the color overspecification was significantly different in M and P conditions ($p=1.13e-06$) and in M and B conditions ($p=8.64e-07$). However, it did not significantly differ between P and B conditions ($p=0.904$). The results for color overspecification met the expectations circulated in the literature.

The number overspecification was independent from the color overspecification in the 1st experiment. Its occurrence was not affected by any type of the colored environment. Regarding this, *Hypothesis B* stated that number overspecification is preserved even if the environment is uncolored. This led to the 2nd experiment, where number overspecification appeared in an *uncolored* (U) condition, cf. Picture 2. Moreover, in the 2nd experiment there was no quantity

contrast: each cell contains a unique number of figures. The materials consisted of 9 stimuli and 15 fillers (human faces) which were counterbalanced within each of the 2 experimental lists (the lists differed only in the order of stimuli and fillers). 16 people participated in the experiment (9 people answered the 1st list, 7 people answered the 2nd list, age 18-70, mean age=35, 10 females). The procedure was very similar to the one used in the 1st experiment.

A linear mixed-effects model with a random effect on the speaker revealed that there was no significant difference in number overspecification between the uncolored and each of the 3 conditions of the 1st experiment: *U* vs. *B* conditions ($p=0.886$), *U* vs. *P* conditions ($p=0.92$), *U* vs. *M* conditions ($p=0.888$).

Both experiments revealed the role of subitizing in number overspecification. Subitizing seems to make the numbers salient. In this respect, number resembles color which has been argued to be salient (Brown-Schmidt and Konopka 2011, Tarenskeen et al. 2015 a.o.). Moreover, in both experiments, numerals were produced in exact meanings 'exactly *n*' (cf. Papafragou and Musolino 2003, Musolino 2004, Breheny 2008 a.o.). A possible explanation for this is again subitizing. It seems natural to assume that subitizing yields the exact meanings of the numerals. This finding has the following consequence related to color. Like color and unlike size, number (at least in the subitizing domain) is absolute.

Moreover, Tarenskeen et al. (2015) demonstrated that a relative attribute (e.g., size), even when made more salient, is still significantly less often overspecified than color, which is an absolute and salient attribute. Brown-Schmidt and Konopka (2011) showed that when size, number and color are tested together, size is significantly less often overspecified than number and color. Both studies seem to accord with the idea that when number and size are tested together, size will be less often overspecified than number and, moreover, size will be quite rarely overspecified if number is not overspecified. *Hypothesis C* verified in the 3rd experiment was that size overspecification is enabled by number overspecification. Accordingly, the predictions were as follows: (i) number alone would be overspecified to a greater extent than number and size together; (ii) size alone would be overspecified rarely.

The 3rd experiment included 18 stimuli which were similar to the materials of the 1st and 2nd studies. They formed a size (*S*) condition and consisted of 4 cells with squares, circles, triangles, or diamonds, one of the 2 sizes (big and small, with a proportion 3:1 respectively) and one of the four quantities (1, 2, 3, or 4) per cell, cf. Picture 3. The objects were different among the cells, whereas their size and number varied. All the stimuli were uncolored. Each cell contained a unique number of objects. The objects in 2 cells were big and the objects in 2 other cells were small. A targeted cell might have any of the quantities 2, 3 or 4 (but not 1), as in the 2nd experiment. Fillers were the same as in 1st and 2nd studies. 29 people participated in the 3rd experiment (age range 18-70, the mean age=21, 16 females).

The Wilcoxon signed-rank test ($V=53301$, $p<0.001$) showed that size overspecification is enabled by number overspecification. This confirmed *Hypothesis C*. Moreover, size alone was never overspecified. The results suggest that making size more salient by increasing the proportion between big and small objects up to 3:1 does not yield a considerable overspecification of size together with number or alone. Together with color and distinct from size, number is not context-dependent and is intrinsically salient.

The 3 experiments demonstrated that small numbers (till 4) are overspecified in reference production because of the 2 factors: absoluteness and salience. A possible explanation for the salience and absoluteness of number is subitizing which has been observed for small numbers till 4. Subitizing makes numbers salient and forces the corresponding numerals to be used in exact meanings.

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