The interpretation of singular nouns in the scope of an event-distributive quantifier

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ABSTRACT Singular nouns in the scope of a distributive operator have been shown to be treated as conceptually plural (Patson and Warren, 2010). The source of this conceptual plurality is not fully clear. In particular, it is not known whether the concept of plurality associated with a singular noun originates from distributing over multiple objects or multiple events. In the present experiment, iterative expressions (distribution over events) were contrasted with collective and distributive sentences using a Stroop-like interference technique (Berent, Pinker, Tzelgov, Bibi, and Goldfarb, 2005; Patson and Warren, 2010). A trend in the data suggests that event distributivity does not elicit a plural interpretation of a grammatically singular noun, however the results were not statistically significant. Possible causes of the non-significant results are discussed.

Keywords: collective, distributive, events, number, Polish, singular

1 Background

Sentences with plural arguments often have two or more possible readings.

(1)   *Three students* lifted a piano.

A **collective reading** arises when the plural argument is understood as referring to a plural object (group, set, collection, etc.) as a whole. Under a collective reading, sentence (1) may be used to describe a situation where three students acted together (as a whole group) to lift a piano. The students cooperated and none of them was singlehandedly responsible for accomplishing the task. A **distributive reading** depends on highlighting the individual constituents (members, parts, etc.) of the plural objects. Under this interpretation, sentence (1) can be truthfully uttered if each of the three (exceptionally strong) students managed to lift a piano (potentially the same, although not necessarily).[1]

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[1] A third possible reading is argued to exist for sentences with more than one plural argument.

(i) *Three professors* corrected *twenty term papers*.

In addition to the distributive reading (each of the three professors corrected a different set of twenty papers) and the collective reading (the professors evaluated every paper together) it is possible that one of the professors was more diligent than her colleagues and corrected twelve papers while the other two corrected together only eight. Still, between them they managed to correct twenty term papers overall. This interpretation is known as a

The issue of distributivity traditionally attracted a lot of attention from formal and theoretical linguists (Champollion, 2010, 2015; Dowty, 1987; Scha, 1984; Tunstall, 1998), but it also offers topics of interest for psycholinguistics. In particular, a distributive reading may present comprehenders with an interesting cognitive problem. Under the distributive reading, sentence (2) entails the existence of three different cookies. This conceptual plurality has to be reconciled with the grammatical singularity of the noun phrase.

(2)   *Three children ate a cookie.*

An interesting question is whether language users include this information in the mental representations they create when comprehending such sentences. Results of some experiments suggest this is the case. Humphreys and Bock (2005) used prepositional phrases modifying a singular noun to bias the participants towards either a collective or distributive interpretation. The critical words in this experiment were so called collective nouns (e.g., *gang*), which are always ambiguous between referring to a group and referring to constituent parts. The context makes one of the meanings more salient. When the following phrase contained a preposition suggesting a spatially distributed group (*A gang on the motorcycles…*), the participants provided more plural agreement continuations than when the preposition suggested that the group was gathered in one place (*A gang near the motorcycles…*).[2] However, the type of materials (singular collective nouns followed by a distributive/collective phrase) and the technique employed in the study (sentence continuation) leave it unclear whether the plural (distributed) representation can be created immediately after encountering any singular noun in a distributive context or whether comprehenders need some time to do this.

A more direct measure of the interpretation of a singular noun in the scope of a distributive operator has been provided by Patson and Warren (2010). The authors used a Stroop-like[3] number interference technique based on a method described previously in Berent et al. (2005). The subjects read sentences displayed in the self-paced reading format in one- or two-word chunks. Their task was to count the number of words in the final chunk of each sentence. The final chunk of critical sentences was always one word, while for fillers it was always two words. In the first experiment, the critical noun was either plural or singular. The results showed that plural nouns were significantly more difficult (longer response times) to recognize as visually single than singular nouns. In the second experiment the critical noun was singular and it was placed either in the scope of a distributive (e.g., **Each of** the men carried a *box*) or collective operator (e.g., **Together** the men carried a *box*). The participants took longer to decide that there was one word on the screen when the noun was in a distributive expression than when it was in a collective expression. This result provides more evidence that a singular noun in the scope of a distributive quantifier can be construed by the comprehenders as having a plural meaning and this, in turn, can lead to a conflict between the visual (one word) and conceptual (multiple objects) information in the counting task. The

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cumulative reading (Scha, 1984; Sternefeld, 1998; Ussery, 1998; Winter, 2000). Cumulative reading depends on dividing a plural object denoted by the noun into sub-groups.

[2] Plural agreement with singular collective nouns is more common in some varieties of English than in others. For instance, in an investigation of the agreement patterns for collectives presented in Bock et al. (2006), British English respondents used plural verbs in approximately 20% of unambiguous continuations for collective nouns, while American English speakers used plural verbs only in 2.3% of unambiguous continuations in this condition.

[3] A classic Stroop effect can be observed in tasks involving color words (MacLeod, 1991; Stroop, 1935). When the color of the font is incongruent with the meaning of the word (e.g., the word *blue* written in green font), it is more difficult to name the font color (ignoring the meaning) than when the meaning and the color are congruent (e.g., the word *blue* in blue font).

results suggest also that assigning a distributivity-induced plural meaning to a singular noun happens relatively early during the comprehension process.

2 Present study

2.1 Research question and predictions

The source of the conceptual plurality of a singular noun in a distributive context is not fully clear. Participants may interpret the singular noun as conceptually plural because they assume the existence of many different objects denoted by the noun (e.g., several different boxes, each brought by a worker). Alternatively, the concept of plurality associated with the noun may originate from multiple events.[4] Even if the same object is involved in all events, the comprehenders may count its instances (e.g., the same box at different moments, different uses of the same box, etc.).

To determine whether event plurality alone is enough to cause a plural interpretation of a singular noun, three different types of expressions were contrasted in the present experiment:

(3)   *Robotnicy   wspólnie   przenieśli   pudło.*   [**Collective:** one object, one event]
       workers   together   carried   box
       'The workers carried the box together.'

(4)   *Każdy   robotnik   przeniósł   pudło.*   [**Distributive:** many objects, many events]
       each   worker   carried   box
       'Each of the workers carried the box.'

(5)   *Robotnik   kilkakrotnie   przeniósł   pudło.*   [**Iterative:** one object, many events][5]
       worker   several_times   carried   box
       'The worker carried the box several times.'

Sentences (3) and (4) correspond to the stimuli used in Patson and Warren (2010). Sentence (3) is disambiguated towards a purely collective reading by the word *wspólnie* 'together', so there is no reason to assume that the singular noun at the end refers to more than one box. Sentence (4), because of the distributive force of the quantifier *każdy* 'each', strongly implies the existence of several different boxes possibly involved in several box-carrying events. Sentence (5), in contrast to sentence (4), is likely to be interpreted as referring to just one box which is involved in multiple box-carrying events.

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[4] Some theoretical approaches use event semantics to account for distributivity. For instance, Tunstall (1998) argues that the English distributive quantifiers *each* and *every* involve a reference to "distributive event structures" (p. 90) and, in effect, characterize multiple (sub)events. A further discussion of event distributivity can be found in, among others, Cable (2014), Krifka (1990), Landman (2000) and Oh (2005). For a discussion of pluractionality (verbal number), see, for instance, Durie (1986), Corbett (2000) and Hofherr (2010).
[5] As noted by an anonymous reviewer, a potential problem with the examples is that they have more interpretations than indicated in the brackets. For instance, sentence (4) can be felicitous in a scenario where there is one object involved in many carrying events. Similarly, sentence (5) does not exclude a situation in which a worker carried multiple different boxes (on different occasions). However, according to my own native intuition, the interpretations in the brackets are clearly dominant and all other readings require effort or special context.

Assuming that an effect of distributivity in comprehension observed by Patson and Warren (2010) can be replicated in Polish, participants should take significantly more time to decide that one singular noun is on the screen in distributive expressions (sentence (4)) compared to collective expressions (sentence (3)), as the distributivity-induced conceptual plurality of the noun should create an incongruous stimulus (visual singularity vs. conceptual plurality). If the effect can be created by event plurality alone, iterative expressions (sentence (5)) should pattern like distributives, because in both cases the singular noun would be associated with a plural meaning. If, on the other hand, event plurality is not enough to force a plural interpretation on the grammatically singular noun, iteratives should pattern like collectives.

2.2 Design

2.2.1 Participants

Thirty-one students of the University of Wrocław took part in the experiment in exchange for partial course credit.

2.2.2 Materials

One hundred and eighty critical sentences were used in the study:

- 60 sentences with the collective operator *wspólnie* 'together' (e.g., *Robotnicy wspólnie przenieśli pudło* 'Together the workers carried the box')
- 60 sentences with the distributive operator *każdy* 'each' (e.g., *Każdy robotnik przeniósł pudło* 'Each worker carried the box')
- 60 sentences with the iterative operator *kilkakrotnie* 'several times' (e.g., *Robotnik kilkakrotnie przeniósł pudło* 'The worker carried the box several times')

Half of the critical sentences (30 of each type) ended with a singular noun (e.g., *pudło* 'box') and the other half – with a plural noun (e.g., *pudła* 'boxes').

One hundred and eighty more sentences were added as fillers necessary for the counting task (see section Procedure below). Ninety filler sentences were created such that they corresponded closely to the structure of the collective, iterative and distributive critical sentences with an equal number of singular and plural nouns in the final position. Ninety additional filler sentences were taken from a different experiment. They represented three types of generic expressions:

- 30 generic sentences with the quantifier *każdy* 'each' (e.g., *Każdy słoń ma trąbę* 'Each elephant has a trunk')
- 30 generic sentences with the quantifier *wszystkie* 'all' (e.g., *Wszystkie słonie mają trąbę* 'All elephants have a trunk')
- 30 generic sentences without any quantifier (e.g., *Słoń ma trąbę* 'The elephant has a trunk')

Again, exactly half of the generic fillers ended with a singular noun (e.g., *trąba* 'trunk') and the other half – with a plural noun (e.g., *pasy* 'stripes').

This choice of items resulted in 360 trials. Half of them ended with a singular object and the other half with a plural object.

2.2.3 Procedure

The procedure was based on the experiment described in Patson and Warren (2010). Each sentence was introduced by a fixation cross, which remained on the screen for 300 ms. Sentences were presented in one- or two-word chunks displayed at the center of the screen. Participants moved to the next chunk by pressing the space bar. The last chunk was always displayed with blue font. Participants were instructed to decide how many blue font words they see on the screen at the end of each sentence by pressing left arrow (one word) or right arrow (two words). The blue item(s) remained on the screen until the participant responded with the left or right arrow key.
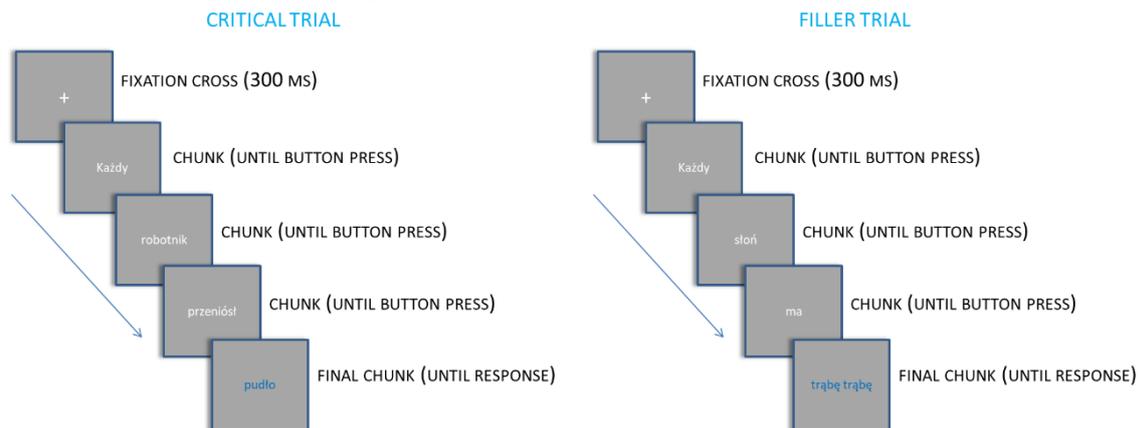
Figure 1: The structure of a trial

In all critical sentences, the last blue fragment was always a single word (e.g., pudło 'box'). In all filler sentences (generic and non-generic) the blue fragment was the same word repeated twice (e.g., trąbę trąbę 'trunk trunk').

Thirty critical sentences and 18 fillers were followed by a comprehension question displayed in green font, with two possible answers displayed below the question on the left and right side of the screen. The participants indicated their choice by pressing the left or right arrow key.

The experiment proper was preceded by a training session consisting of 14 sentences with four comprehension questions. After every counting and comprehension decision, there was a feedback display (1000 ms) informing the participant whether the answer was correct ("DOBRZE") or incorrect ("ŹLE"). During the experiment proper a feedback was displayed after a counting decision only when it was incorrect. The training session ended with a message informing about the number of correct and incorrect responses. No training item appeared later in the experiment proper.

Twice during the experiment (after every 120 trials) there was a message informing about a break time. The participant could proceed when ready by pressing the space bar.

2.3 Results

For the reaction time (RT) analysis, the data were cleaned by removing first all incorrect trials and then all trials 2 standard deviations above and below the mean in each condition for every participant. This resulted in removing 279 data points, which constituted approximately 5% of

correct trials. The remaining data were subjected to tests performed with the SPSS software (Version 22).

In order to determine the interpretation of a singular noun in the scope of different operators, a 3×2 ANOVA was conducted with RT as the dependent variable and the following independent factors:

- Expression Type (collective, distributive, iterative)
- Grammatical Number (singular, plural)

There was a trend in the data consistent with the effect of distributivity in comprehension reported by Patson and Warren (2010). The participants were slightly faster to identify singular nouns as visually single in the collective condition (596 ms) than in the distributive condition (603 ms). In the collective condition responses to singulars were also faster than to plurals and the pattern was opposite in the distributive condition. Responses to singulars in the iterative condition fell between the other two conditions (598 ms) and singulars were faster than plurals, resembling the collective condition (Figure 2).

Unfortunately, this trend was not supported by the statistical analysis. There was no main effect of Expression Type ($F_1(2,60)=0.077$ $p=.926$; $F_2(2,174)=0.101$ $p=.904$) and no main effect of Grammatical Number ($F_1(1,30)=0.339$ $p=.565$; $F_2(1,174)=0.643$ $p=.424$). The interaction of Expression Type with Grammatical Number also did not reach the level of statistical significance ($F_1(2,60)=0.346$ $p=.709$; $F_2(2,174)=0.397$ $p=.673$).
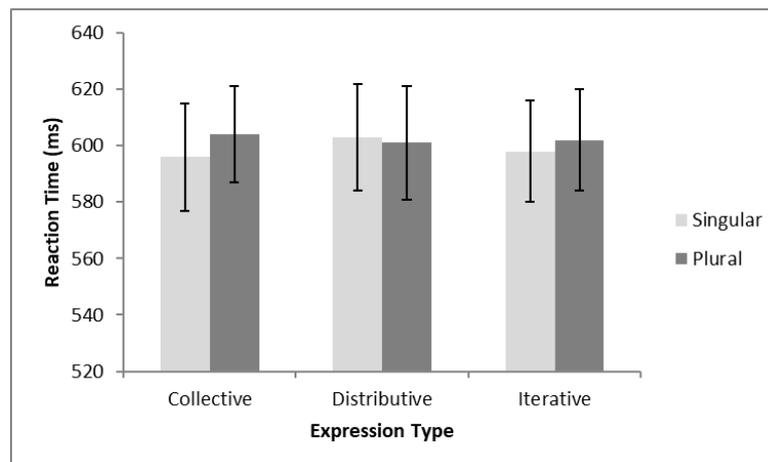
Figure 2: Mean reaction times (ms) in the counting task for singular and plural nouns in collective, distributive and iterative expressions. The bars represent standard errors

An inspection of the accuracy of responses for comprehension questions for each condition (Table 1) indicates that participants were attentive and had no problems with understanding the sentences (over 90% of correct answers in all conditions).

Table 1: Mean accuracy (percent of correct responses) in the counting task for singular and plural nouns in collective, distributive and iterative expressions (standard errors in parentheses)

Expression Type		Grammatical Number	
		Singular	*Plural*
COLLECTIVE	*Together the workers…*	99.7% (0.2)	99.0% (0.4)
DISTRIBUTIVE	*Each worker…*	99.1% (0.3)	99.1% (0.4)
ITERATIVE	*The worker … several times*	99.0% (0.3)	98.3% (0.5)

3 Summary and discussion

The experiment failed to replicate for Polish the influence of a distributive quantifier on the conceptual representation of singular nouns in a Stroop-interference counting task found previously for English (Patson and Warren, 2010). The participants were predicted to be faster to recognize that only one noun is present on the screen when the noun occurred in a collective expression than in a distributive expression. Although a trend towards this result was indeed observed, the difference did not achieve statistical significance. This made it impossible to answer the main research question concerning the interpretation of singular nouns in iterative expressions with pure event distributivity.

One possible explanation for the discrepancy between the results of the present experiment and that of Patson and Warren (2010) might be morphophonological differences. Whereas singular nouns used by Patson and Warren (2010) had (like basically all singular nouns in English) no overt number marker, the singular forms used in the present experiment had a case/number suffix (e.g., *piłk-ę* 'ball-ACC.SG'). It is possible that this strong visual cue for grammatical singularity made it more difficult to think of the noun's referent in terms of multiple objects, even when the context favored this interpretation. This could mask the effect of distributivity or iterativity.

A potential methodological issue concerns the chosen technique.[6] Applying a numerical Stroop effect to studying grammatical number is a relatively recent research method. The relation between the visual and semantic dimensions for counting singular and plural nouns is less direct than for determining the color of color words in a traditional Stroop experiment. The effect may be weaker or sensitive to specific conditions. More studies are needed to fully determine the validity of the technique.

Finally, it can be argued that, according to standard formalizations of collective and distributive meanings (e.g., Champollion, 2015, 2016), it is not the semantics of the object noun phrase which contributes the plurality inference in distributive expressions, but the whole construction. No effect of context should, therefore, be expected on the object itself. However, it should be noted that formal descriptions are not typically developed as models of psychological processes associated with language comprehension, and it is far from clear how and when the actual processing mechanisms make use of the information afforded by

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[6] I am grateful to anonymous reviewers for bringing the issues discussed in the following paragraphs to my attention.

quantifiers and similar scope-taking elements. There is evidence, for instance, that the interpretation of sentential negation is delayed until the sentence is complete (Fischler, Bloom, Childers, Roucos, and Perry, 1983; Lüdtke, Friedrich, De Filippis, and Kaup, 2008). On the other hand, the results of Patson and Warren (2010) suggest that quantifiers may exert an influence on the interpretation of a singular noun quite early. This result was not replicated here.

Acknowledgments

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