

Processing of plural pronouns in set-subset context

Previous corpus studies have shown disagreements on the interpretation of anaphoric references to plurals in natural texts (cf. Versley, 2008). One systematic example of disagreements among annotators is illustrated in (1) and involved a set (e.g., track athletes) and one subset (e.g., shot putters). The pronoun *they* in (1) can refer to either (a) the entire set of track athletes (i.e., track athletes + shot putters), or (b) only shot putters.

(1) It was a hot and humid day. The Summer Olympics were very spectacular. **The track athletes** had worked very hard. **The shot putters** had worked incredibly hard. **They....**

One possible hypothesis for such disagreements among annotators is that since there is a large overlap between these candidate antecedents, annotators may not be sure whether the interpretations are distinct or not. Some annotators may think of shot putters as a subset of track athletes, thus thinking that their completion refers to the whole set. Conversely, other subjects may think of track athletes and shot putters as different groups and so think that not every track athlete would be a shot putter. Within this context, two main questions arise: (a) What is the possible source of such disagreements? (b) Are disagreements due to an underspecified interpretation as in Frazier & Rayner (1999) or a processing difficulty because of less clear interpretation of pronoun? To answer these questions, we designed two experiments.

In Experiment 1 ($N = 14$), we contrasted the set-subset plural groups in (2a) with the disjoint groups in (2b) and asked participants to complete the given sentences starting with *they*. Our results are in line with the findings in Versley's study (see Figures 1 & 2). References to both groups with *they* in the joint group condition were significantly higher (i.e., set/subset condition) than those in the disjoint condition ($t = -2.987$, $p = .011$). References to a single group were higher in the disjoint group condition than those in the joint group condition ($t = 4.673$, $p = .001$). Participants used *they* with ambiguous verbs more often than unambiguous verbs. These results could come about in two ways: (i) joint group references would lead to shorter fixations and thus faster processing than the disjoint condition because participants could use the whole group as an underspecified interpretation in the joint group condition. (ii) Alternatively, in the joint condition, there would be longer fixations and thus greater processing difficulty than in a disjoint condition because participants would be uncertain about the interpretation of the pronoun when subset references are part of a group-inclusion relation.

In eye-tracking reading Experiment 2 ($N = 56$), we used the same stimuli from Experiment 1. We included conditions (3a, 3b) as well as two nearly-identical conditions (3c, 3d) that included an 'unambiguous verb' instead of an 'ambiguous verb'. This resulted in a 2x2 design crossing groups (disjoint vs. joint groups) with verbal ambiguity (ambiguous vs. unambiguous). Linear mixed effect regression (LMER) analyses (i.e., centered predictors with random slopes and intercepts) and multiple eye-movement measures in regions at or following the verb region showed that (irrespective of group types) processing of ambiguous context was faster than that of an unambiguous context (see Figures 3 & 4) (e.g., total reading: $t = -3.97$ at "verb"; total reading: $t = -2.63$ at "adverbial"; regression path: $t = -2.57$ at "adverbial"). In addition, irrespective of verbal ambiguity (and in line with an annotators' judgements), in online reading joint plural references led to longer reading times and consequently more reading disruptions. (e.g., regression path times at "adverbial": $t = 2.61$; joint group: 412ms, $SE = 21.17$; disjoint group: 370ms, $SE = 18.18$). The slower processing time when alternative interpretations are clearly joint (an unambiguous case), might be due to the fact that the pronoun gets fully interpreted and the discourse model updated. By contrast, when the alternative interpretations are not clear, subjects may not fully resolve the pronoun. Specifically, we observed an ambiguity advantage (Borowsky & Masson, 1996) in processing of joint groups. Such joint group effect in the adverbial region/latter region might be related to previous findings on underspecification in the processing of plurals (Frazier & Rayner, 1999) or perhaps to shallow representations in the sense of Ferreira et al.'s good-enough interpretations (2016). Clearly, further studies are needed. Overall, our results from the two experiments show that annotators' disagreements are due to less clear interpretations of plural pronoun but not underspecified representation.

Experiment 1 (Sentence completion):

(2a) Disjoint group condition: The Summer Olympics were spectacular. **The track athletes** had worked very hard. **The journalists** had worked incredibly hard. **They...**

(2b) Joint group condition: The Summer Olympics were spectacular. **The track athletes** had worked very hard. **The shot putters** had worked incredibly hard. **They...**

Experiment 2 (an eye-tracking reading experiment):

(3a) Disjoint group in the ambiguous verbal condition: The Summer Olympics were very spectacular. **The track athletes** had worked very hard. **The journalists** had worked incredibly/ hard. **They/ had prepared/ well/** and were very happy/...

(3b) Joint group in the ambiguous verbal condition: The Summer Olympics were very spectacular. **The track athletes** had worked very hard. **The shot putters** had worked incredibly/ hard. **They/ had prepared/ well/** and were very happy/...

(3c) Disjoint group in the unambiguous verbal condition: The Summer Olympics were very spectacular. **The track athletes** had worked very hard. **The journalists** had worked incredibly/hard. **They/had reported/well/**and were very happy/...

(3d) Joint group in the unambiguous verbal condition: The Summer Olympics were very spectacular. **The track athletes** had worked very hard. **The shot putters** had worked incredibly/ hard. **They/ had thrown/ well/** and were very happy/...

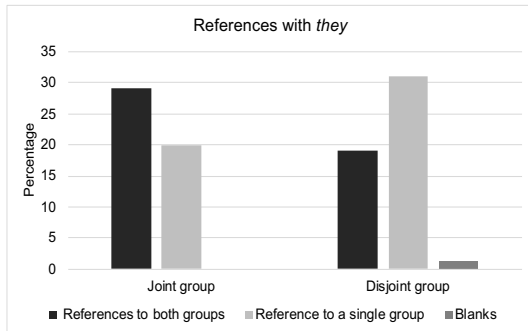


Figure 1. Percentage of *they* referring to a single or both groups.

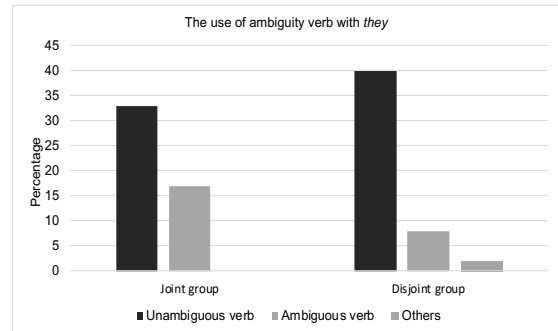


Figure 2. Percentage of unambiguous and ambiguous verbs after the use of *they*.

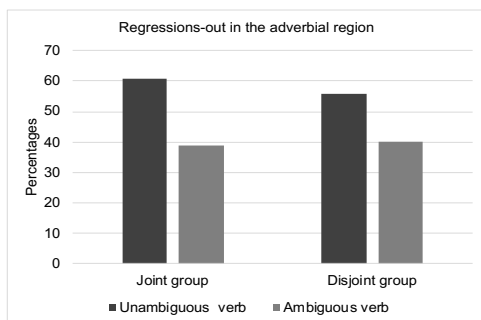


Figure 3. First regressions-out in the adverbial region. The logistic mixed effect model was run.

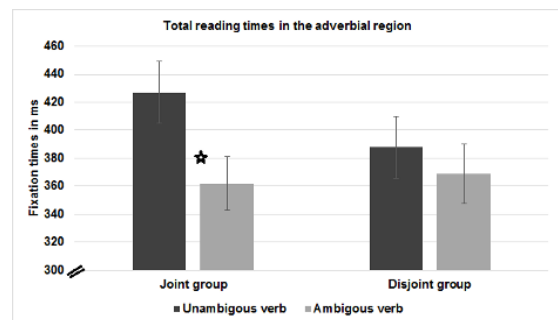


Figure 4. Total reading times in the adverbial region.

References

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