Processing of plural pronouns in set-subset context

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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., the bands and one subset (e.g., guitarists). The pronoun *they* in (1) can refer to either (a) the entire set of bands (i.e., bands + guitarists), or (b) only guitarists.

(1) The Fusion Music Festival was extremely eclectic. **The bands** had rehearsed consistently. The **guitarists** had extensively checked the stage. **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 guitarists as a subset of bands, thus thinking that their completion refers to the whole set. Conversely, other subjects may think of bands and guitarists as different groups and so think that not every bands would have a guitarist. 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 and normed our stimuli on AMT.

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 ($N = 58$), 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 Ferreira et al.'s good-enough interpretations (2016) and more in general the difference between shallow and deep processing (Stewart et al., 2007). 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 Fusion Music Festival line-up in Cofton Park, Birmingham was extremely eclectic. **The bands** had rehearsed consistently. **The builders** had extensively checked the stage. **They**...
(2b) Joint group condition: The Fusion Music Festival line-up in Cofton Park, Birmingham was extremely eclectic. **The bands** had rehearsed consistently. **The guitarists** had extensively checked the stage. **They**....
Experiment 2 (an eye-tracking reading experiment):
(3a) Disjoint group in the ambiguous verbal condition: The Fusion Music Festival line-up in Cofton Park was extremely eclectic. **The bands** had rehearsed consistently. **The builders** had extensively checked the stage. **They**/ **had prepared/** carefully/....
(3b) Joint group in the ambiguous verbal condition: The Fusion Music Festival line-up in Cofton Park was extremely eclectic. **The bands** had rehearsed consistently. **The guitarists** had extensively checked the stage. **They**/ **had prepared/** carefully/....
(3c) Disjoint group in the unambiguous verbal condition: The Fusion Music Festival line-up in Cofton Park was extremely eclectic. **The bands** had rehearsed consistently. **The builders** had extensively checked the stage. **They**/ **had repaired/** carefully/....
(3d) Joint group in the unambiguous verbal condition: The Fusion Music Festival was extremely eclectic. The bands had rehearsed consistently. **The guitarists** had extensively checked the stage. **They** had **strummed**/carefully...

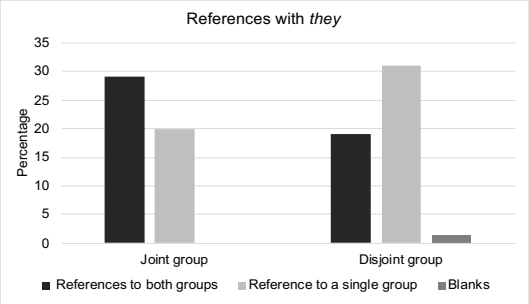

Figure 1. Percentage of *they* referring to a single or both groups.

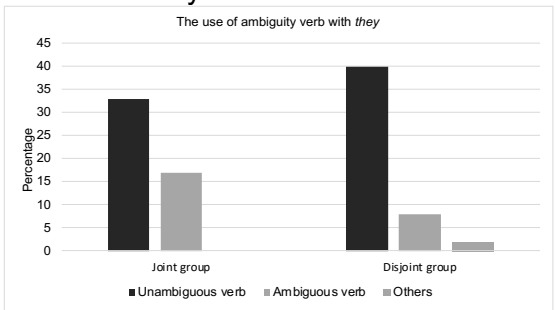

Figure 2. Percentage of unambiguous and ambiguous verbs after the use of *they.*

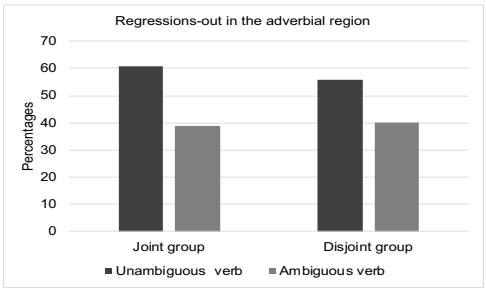

Figure 3. First regressions-out in the adverbial region. The logistic mixed effect model was run.

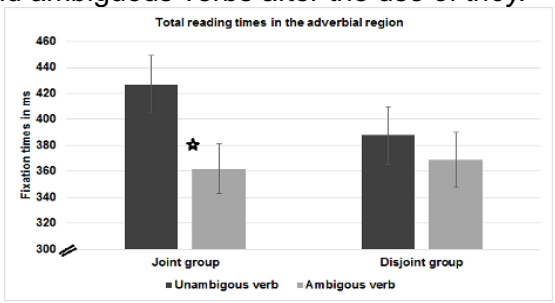

Figure 4. Total reading times in the adverbial region.

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