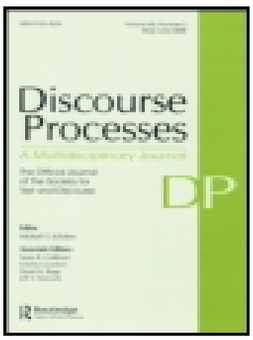

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Effect of Referring Expression on Antecedent-Grouping Choice in Plural Reference Resolution

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ABSTRACT

This article reports one eye-tracking and one sentence-completion experiment, examining the antecedent preferences for plural anaphora *they* and demonstrative *these*. Our results show that the antecedent-grouping preference depends on type of referring expressions: specifically, the preference for *they* is to refer to a smaller paired group within the context, whereas the preference for *these* is to refer to a larger (maximal) grouping. This points to limitations regarding the application of the Closure Strategy (Koh & Clifton, 2002), which would have predicted a more general maximal-grouping preference for the contexts investigated here. Previous findings comparing singular pronouns with demonstratives (*it* and *this*) show that, relative to pronouns, demonstratives prefer more inferentially complex antecedents. With this in mind, the current results could be explained if the preference for the demonstrative was to refer to a more complex referent than that of the pronoun.

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Introduction

A full model of plural reference processing should answer at least two fundamental questions: (a) What factors influence how entities are grouped together in the discourse representation? and (b) Given a plural referring expression and multiple potential groupings in the discourse representation, what factors influence the choice of a group as the antecedent? For example, consider the following short discourse (adapted from Koh & Clifton, 2002):

(1) Tom sang with Jim and Tony. They were happy because they did their best.

Question (a) above asks how the individuals mentioned in the first sentence of (1) are grouped together in the discourse representation: For example, does the discourse representation include a *maximal grouping* consisting of all three individuals (i.e., Tom + Jim + Tony) or a *paired grouping* (e.g., Jim + Tony, excluding Tom), or are these two groups represented simultaneously? Question (b) asks which of these groupings will be chosen as the antecedent of *they*. Previous studies, some of which are reviewed below, have made considerable progress toward answering question (a), whereas less is known about question (b), which is the focus of the present article.

There have been several proposals regarding the factors affecting the grouping of entities in the discourse representation. According to the *Scenario Mapping Principle* (Sanford & Moxey, 1995), the likelihood of a grouping depends on the extent to which the entities involved share common roles in the scenario. For example, in (1) above, a maximal grouping is likely because Tom, Jim, and Tony are all described as playing the same role in the singing scenario. Similarly, according to the

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Equivalence Hypothesis (Koh & Clifton, 2002), the three individuals would likely be grouped together due to the use of a symmetric predicate (i.e., "A sings with B" implies "B sings with A"). In fact, Koh and Clifton (2002) did find evidence that supports this claim: Reading time evidence and sentence completions showed the preference to group the three individuals together was greater for discourses such as (1) than for examples that used a nonsymmetric predicate (e.g., *Tom recognized Jim and Tony*).

In addition to the factors mentioned above, the use of the coordinating conjunction "and" is a strong influence on the grouping of individuals in the discourse representation (Albrecht & Clifton, 1998; Moxey et al., 2004; Sanford & Garrod, 1981; Sanford & Lockhart, 1990; Sanford & Moxey, 1995). For example, Moxey et al. (2004) examined the use of singular and plural pronouns in contexts such as (2a,b) both in a sentence-completion experiment and an eye-tracking experiment:

2a. John and Mary were painting the flat.
2b. John was painting the flat with Mary.
2c. John was painting the flat for Mary.

In the completion experiment, Moxey et al. (2004) found that sentence continuations using *they* were more frequent when following 2a than 2b and more frequent when following 2b than 2c, with the reverse pattern for singular pronouns. The two named individuals play different roles in the scenario in 2c, whereas they play the same role in both 2a and 2b. Therefore, assuming plural pronouns require a grouped antecedent in the discourse representation, the decreased proportion of plural continuations in 2c relative to (2a,b) is as predicted by the scenario mapping principle and the equivalence hypothesis. However, the increased proportion of plural completions in 2a relative to 2b suggests that the use of *and* has an influence on the formation of complex reference objects, over and above the effect of scenario roles. A consistent pattern was found in an eye-tracking experiment: There was evidence of processing disruption when (2a) was followed by a singular pronoun (e.g., *He really liked the color*) and also when (2c) was followed by a plural pronoun (e.g., *They really liked the color*). Overall, Moxey et al's (2004) findings are consistent with other studies that have also examined the use of *and* (e.g. Albrecht & Clifton, 1998; Carreiras, 1997; Sanford & Garrod, 1981; Sanford & Lockhart, 1990; Sanford & Moxey, 1995; but cf. Clifton & Ferreira, 1987).

In summary, previous studies have mainly examined the factors that affect the grouping of entities the discourse representation. In the current article we address the complementary problem of how the processor chooses an antecedent for a plural pronoun, when more than one possible grouping is available. As far as we are aware, the only proposal that addresses this question is the *Closure Strategy* (Koh & Clifton, 2002, p. 834): "if all the individuals in an interpretation domain belong to one group, select this group as the antecedent of a plural pronoun."

To illustrate the closure strategy, consider again example (1) above. Given the previous discussion, we assume the processing of the first sentence leads to the formation of a *maximal* group, consisting of all three individuals (Tom + Jim + Tony), because all three individuals are playing a similar role in the scenario, and the predicate is symmetrical. We also assume that a *paired grouping* will be formed, due to the use of "and" (i.e., *Jim and Tony*). If these two groupings are simultaneously available, then the reference of *they* is ambiguous. The closure strategy predicts the maximal grouping will be preferred as the antecedent of *they*, and, indeed, this is what Koh and Clifton (2002) found, using stimuli similar to (1) in self-paced reading and completion experiments.

In the present article we examine the closure strategy in more detail, by testing the effect of different referring expressions on disambiguation preference. Specifically, we test the generality of the closure strategy by comparing the plural pronoun *they* and the plural demonstrative *these*, in contexts such as (3):

(3) The table was next to the chair and the bookshelf. *They/These* ….

This example is similar to (1) in all relevant respects, except that the entities mentioned in the first sentence are inanimate, to allow for the felicitous use of *these*. Therefore, we again assume that the

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context in (3) leads to the representation of a maximal group (table + chair + bookshelf) as well as a paired group (chair + bookshelf). If the closure strategy generalizes across referring expressions, there should be a preference for both *they* and *these* to refer to the maximal grouping. However, previous work has shown differing preferences for singular pronouns and demonstratives (Ariel, 2001; Brown-Schmidt et al., 2005; Çokal, Sturt, & Ferreira, 2016; Cornish, 2008); therefore, we might also expect to find different antecedent-groupings for plural demonstratives (*these* in our case) and pronouns (*they* in our case). For example, Çokal et al. (2016) examined the singular referring expressions *it* and *this* in contexts such as (4):

(4) Charlotte wrote a book. *This/It* ….

The eye-tracking experiment reported by Çokal et al. (2016) demonstrated longer reading times when *it* referred to a proposition (a more complex and abstract referent) than when *this* referred to a proposition and the reverse effect when *it* or *this* referred to an entity (*a book*) (a simple referent consisting of a concrete entity). In addition, Çokal et al.'s sentence completion experiment consistently showed that people preferred *it* when referring to the concrete entity (*a book*) (a simple referent consisting of a concrete entity), whereas people preferred *this* when referring to the proposition that Charlotte wrote the book (a more complex and abstract referent). If analogous criteria apply to plural referential expressions, then we might also expect an antecedent-grouping preference for *these* to differ from *they* in (3). For example, if one of the relevant criteria is the complexity of the referent, then the demonstrative *these* should have a greater maximal-grouping preference than the pronoun, given that the maximal group (table + chair + bookshelf) is more complex than the paired group (chair + bookshelf).

Below, we report one eye-tracking and one sentence-completion experiment designed to examine this question. Although eye-tracking offers a sensitive index of information integration during comprehension, the sentence completion task is a sensitive indicator of the focus of a writer's attention and has been shown to be a reliable indicator of antecedent preferences for referential expressions (Çokal et al., 2016; Moxey, Sanford, & Dawydiak, 2001).

Experiment 1

Experiment 1 was an eye-tracking study that used a 2 × 2 within-subject design, crossing two levels of referring expression (*they* and *these*) and two levels of antecedent-grouping (a pair of entities and a maximal group), as in example (4) below:

- *Conditions 1 and 2: They/these referring to a pair of entities:*
  The table was next to the chair and the bookshelf. They/these were actually both made of walnut and looked very expensive.
- *Conditions 3 and 4: They/these referring to the maximal group of entities:*
  The table was next to the chair and the bookshelf. They/these were actually all made of walnut and looked very expensive.

We followed Koh and Clifton (2002) in manipulating a disambiguating quantifier (i.e. "both" vs. "all") to allow a test of the intended referent of the anaphor (see also Garrod, Freudenthal, & Boyle [1994] for the use of downstream disambiguators to examine referential preferences). For example, "***These*** *were actually* ***all*** *made of walnut*" disambiguates the referent of *these* toward the maximal grouping (i.e., table + chair + bookshelf), whereas "***These*** *were actually* ***both*** *made of walnut*" disambiguates toward the paired grouping (i.e., chair + bookshelf). Note that *both* could be viewed as more ambiguous than *all*, because it disambiguates reference simply to a pair of entities (and there are three possible pairs in the context), whereas *all* unambiguously signals that reference must be to the maximal grouping. However, given our context we assume that chair + bookshelf is the only paired grouping available for reference, or at least that other paired groupings (such as table + bookshelf) are strongly dispreferred.

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If readers exhibit a preference for *they* to refer to a pair of entities and *these* to refer to a maximal grouping, then—other things being equal—processing difficulty should be greater when the maximal grouping is referred to with *they* than when it is referred to with *these*, with the reverse pattern for the paired grouping. Overall, this pattern should result in an interaction between the two experimental factors of referring expression type (*they* vs. *these*) and antecedent groupings (a pair of entities vs. the maximal grouping). This interaction should initially be found at the point where the reader first encounters the disambiguating information (i.e., *all*/*both*).

Methods

Participants. Forty paid native English speakers aged 21 to 24 from the University of Edinburgh participated in the experiment. All were unaware of the purpose of the study.

Apparatus. We used an Eyelink 1000 eye-tracker (SR Research Ltd., Ottawa, Ontario, Canada) in tower-mounted mode, with a chin rest to stabilize each participant's head.

Materials. Forty items were created based on example (4) above.[1] Each two-sentence item appeared in the four conditions obtained by crossing disambiguation (all vs. both) with referring expression (they vs. these). Adverbials were used immediately before the disambiguating quantifiers (i.e., actually, seemingly, and genuinely). The length of the adverbs ranged from 7 to 11 characters. We were careful to select homogenous entities (i.e., furniture: a table, a chair, and a bookshelf; or tea-set pieces: a teapot, a saucer, and a plate) (see Koh & Clifton, 2002) and assign the same properties (i.e., the table, chair, and bookshelf were all made from walnut). The entities mentioned in the first sentence were always nonhuman to allow acceptability when used with *these*. To signal a symmetrical relation between the entities, we always used prepositions (e.g., next to, besides) that confer equivalence (i.e. "A is next to B" implies "B is next to A"). The paired group of entities was always described using two definite descriptions coordinated with *and* (e.g., the spoon and the fork).

The 40 stimuli were distributed into four lists, following a Latin square procedure. In all four lists each item appeared in only one condition and each condition appeared an equal number of times. Ten participants were assigned to each list. There were 68 fillers and three practice items, all of which were similar in length to the experimental sentences. The following is a filler example:

> Recently, it had become trendy to have full moon festivals on the beach, with live music. The audience quite willingly familiarized themselves with the new type of music.

The texts were presented on one or two written lines. Each line had between 75 and 100 characters. *They* and *these* always appeared near the middle of the line.

Procedures. We presented 111 texts in Times New Roman 18-point font, in fixed random order, and with no two experimental items adjacent to each other. The experiment began with three fillers to familiarize participants with the experimental procedure. Although viewing was binocular, only the right eye was tracked. Items appeared on a 19-inch monitor approximately 70 cm from the participant's eyes. For the experimenter to check the calibration of the participant's eyes, before each item the participant fixated on a black square. After reading each item the participant pressed a button to end the sentence. For 50% of items, a comprehension question then appeared, which the participant answered by pressing a button on the left or right of the button box. The comprehension questions never probed the referents of *they*/*these*.

Data analysis. Texts were divided into seven regions. These regions are defined in Table 1. Below, we report data for the *anaphor, disambiguation*, and *spillover* regions. Fixations of less than 80 ms or

[1]Please visit http://stimuli-plurality for the full set of stimuli used in Experiment 1.

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Table 1. Analysis Regions (R) in Experiment 1 (Critical Regions Are R2-R3-R4).

Region	Sample Stimulus
1: Context antecedent	The table was next to the chair and bookshelf
2: Anaphor	They/these were/
3: Disambiguation	actually both/all
4: Spillover	made of walnut
5: Conjunction	and looked
6: Final	very expensive.

more than 1,200 ms were excluded from analysis. All participants scored at least 90% correct in their answers to the comprehension questions.

We chose regression path time on the critical disambiguating region (i.e., *actually, both/all*) as our primary measure of initial processing. Regression path time is calculated as the sum of all fixations from first entry into the region from the left, until the first fixation to a later region, and thus reflects fixation behavior that immediately follows the reader's inspection of a given region. We selected this measure due to its sensitivity to manipulations of anaphoric reference in our previous work (Çokal et al., 2014, 2016). For completeness, we also report first-pass reading times (i.e., the sum of fixations from when a region is first entered from the left to when the region is first exited, either to left or right) and second-pass reading times (i.e., sum of all fixation durations after the first exit of the region either to right or left). In addition to the critical disambiguating region, these three measures are also reported for the anaphor region and the spill-over region. In our regression path and first-pass analyses we removed zeros, and such trials were treated as missing data. Because of the removal of zeros, the missing data were 19.8% in the anaphora region, 0.03% in the disambiguation region, and 0.01% in the spillover region. In second pass, on the other hand, zero values were retained, as these zero values are meaningful (i.e., the lack of a second-pass fixation is presumably indicative of a relatively easy trial).

The means for each region were analyzed using repeated-measures ANOVA, treating referring expression (*they-these*) and antecedent grouping (*paired grouping* vs. *maximal grouping*) as within-participant and within-item factors. Analysis was performed on each participant's means, collapsing over item ($F1$) and on each item's means collapsing over participants ($F2$).

As stated above, given our design, the crucial prediction is for an interaction in the disambiguating region, which would demonstrate that the two referring expressions differ in their antecedent preferences. If obtained, this interaction will be followed up by planned contrasts testing the effect of referring expression within each level of disambiguation (i.e. *these* vs. *they* for *both* and *these vs. they* for *all*).[2] F-ratios for the two eye-movement measures and three regions are given in Table 2.

Results and discussion

Data are reported for the three eye-movement measures in the anaphora, disambiguation, and spillover regions (see Table 3). In regression path time, the predicted interaction of the two variables (antecedent-grouping vs. referential-expressions) was significant in the disambiguating region, by both subjects and by items. References to the pair of entities with *they* (e.g., the chair and the bookshelf) led to shorter regression path times than did references with *these* (pairwise comparison: $t1(39) = -2.429$, $p = .020$; $t2(39) = -2.639$, $p = .012$). References to the maximal grouping (e.g., the table, the chair, and the bookshelf) with *these* did not significantly differ from references to the maximal grouping with *they* (pairwise comparison: $t1(39) = .580$, $p > .05$, $t2(39) = .520$, $p > .05$). In the same region there was a main effect of antecedent grouping. References to a pair of entities led to longer regression path times than maximal-grouping entity. However, this may simply reflect the length difference between *both* and *all*. No other effects reached conventional levels of significance in regression path time.

[2]Note that the converse comparison (directly comparing *both* vs. *all* within each level of referring expression) would be hard to interpret, because this would involve directly comparing different words in the disambiguating region.

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Table 2. *F*-Statistics for Main Effects and Interactions for Eye-Movement Measures in the Three Analysis Regions.

	Anaphora		Disambiguation		Spillover	
	$F1_{(1,39)}$	$F2_{(1,39)}$	$F1_{(1,39)}$	$F2_{(1,39)}$	$F1_{(1,39)}$	$F2_{(1,39)}$
Regression path						
Anaphora	1.456	<1	2.203	2.113	1.48	1.814
Antecedent-grouping	4.060[a]	2.866	12.343[b]	9.596[b]	<1	<1
Anaphora × antecedent-grouping	<1	<1	5.931[b]	4.577[b]	<1	<1
First pass						
Anaphora	6.286[b]	10.644[b]	1.169	<1	<1	<1
Antecedent-grouping	1.857	1.522	33.447[b]	26.644[b]	<1	<1
Anaphora × antecedent-grouping	<1	<1	<1	<1	1.849	2.010
Second pass						
Anaphora	7.334[b]	8.953[b]	2.420	2.943	<1	<1
Antecedent-grouping	<1	<1	2.246	2.142	<1	<1
Anaphora × antecedent-grouping	1.465	1.521	1.238	1.911	<1	<1

[a]$p < .1$
[b]$p < .05$

Table 3. Means (and Standard Errors) for Regression Path Times, First-Pass Reading Times, and Second Pass Reading Times.

	Anaphora	Disambiguation	Spillover
Regression path			
Paired grouping reference with *they*	312 (28)	506 (30)	615 (27)
Paired grouping reference with *these*	331 (23)	585 (44)	624 (25)
Maximal grouping reference with *they*	347 (28)	475 (36)	654 (27)
Maximal grouping reference with *these*	365 (26)	460 (29)	644 (33)
First Pass			
Paired grouping reference with *they*	289 (22)	411 (23)	470 (21)
Paired grouping reference with *these*	324 (22)	394 (22)	497 (21)
Maximal grouping reference with *they*	308 (20)	328 (15)	491 (20)
Maximal grouping reference with *these*	334 (22)	321 (12)	481 (25)
Second Pass			
Paired grouping reference with *they*	100 (16)	185 (23)	165 (23)
Paired grouping reference with *these*	151 (26)	225 (33)	165 (27)
Maximal grouping reference with *they*	115 (19)	179 (26)	163 (23)
Maximal grouping reference with *these*	138 (18)	183 (23)	154 (19)

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First-pass and second-pass reading times both showed a significant main effect of referring expression in the anaphor region, with longer reading times for *these* than for *they*. However, this may simply reflect the length difference between these two words. First-pass reading times additionally showed a significant main effect of antecedent grouping in the disambiguating region, with longer reading times for the paired grouping than for the maximal grouping. Again, this effect most likely reflects length differences (*actually both* vs. *actually all*).

In summary, the interaction between referring expression type and antecedent grouping was observed in regression path time: When the critical region disambiguated toward the paired grouping, there was significantly more processing difficulty in the *they* condition than in the *these* condition, whereas the pattern was nonsignificant for the maximal grouping. This indicates the preference for a paired antecedent grouping is stronger for *they* than it is for *these*.

Experiment 2

Experiment 1 showed that readers' antecedent grouping preferences differed between *they* and *these*. Experiment 2 extended these analyses to test whether writers would use the same preferences in an off-line sentence completion task. In this experiment participants were given the context sentences from Experiment 1 but with target sentences left blank after *they* or *these* (see sample stimulus

below). Participants were asked to complete each sentence in a manner consistent with the previous text. The sample stimulus was as follows:

The table was next to the chair and the bookshelf. They/these . . . .

Based on the results of Experiment 1, we expected that the relative frequencies of antecedent choice would differ as a function of whether the referential expression was *they* or *these* and that participants would write more completions referring to the paired grouping with *they* than with *these*.

Methods

Participants. The participants were 16 paid British native speakers of English from the University of Edinburgh. Participants were not informed of the purpose of the study.

Materials and procedures. There were 40 experimental and 60 filler stimuli.[3] The experimental stimuli used the context sentences from Experiment 1. There were two types of referential expressions (*they* and *these*), and this factor was manipulated within items and subjects. Two versions of each sentence and two files were constructed. In each file, each sentence appeared in only one condition, but each condition appeared an equal number of times. Sentences were presented in a booklet in fixed random order. Each participant was asked to complete the stimuli sentences coherently. She or he was told to complete the sentences, drawing on the information contained in the previous sentence. After participants had completed all sentences, they were asked to underline what *they* and *these* referred to in their completions.

Results and discussion

While coding sentence completions, we counted participants' underlined antecedent groupings of *they* or *these* (i.e., entity pairs or maximal groupings). We also coded prenominal uses of *these* (i.e., *these* + noun phrase) or unclear references as "other." In 7% of cases the antecedents of *they* and *these* were unclear or *these* was used as a prenominal (e.g., "these things"). Subsequently, we excluded all trials coded as "other" from further statistical analysis. Continuation codings, as well as samples for *they* and *these*, are presented in Appendix A. Two research assistants independently transcribed the data and coded the continuations according to predetermined categories. Any continuations that annotators did not understand were excluded from data analysis. Figure 1 shows the relative proportions of references to paired and maximal groupings for each referential expression.

Because this experiment's data were categorical, the statistical analyses in this section involved logistic mixed effects regression,[4] taking the condition (*they* vs. *these*) as the fixed effect and including crossed random intercepts and slopes for subjects and items. Experiment participants had a strong preference for *they* when referring to a pair of entities and *these* to a maximum group (*they*: pair 65% vs. maximal 31%, others 4%; *these*: pair 4% vs. maximal 93%, others 3%; see Fig. 1). The analysis yielded a highly significant effect of referential expression ($Z = -6.926$, $p < .05$), confirming that *they* led to reliably more references to the paired grouping than did *these*. Thus, the completion preferences were consistent with Experiment 1. Specifically, *these* was preferred when referring to a maximum grouping, whereas *they* was preferred when referring to a paired grouping.

[3]Please visit http:// stimuli-plurality for the full set of stimuli used in Experiment 2.
[4]The analyses were computed using the lme4 package in R: (see http://lme4.r-forge.r-project.org). The official number of lme4 was 999375-35. R 3.0 for Windows was used.

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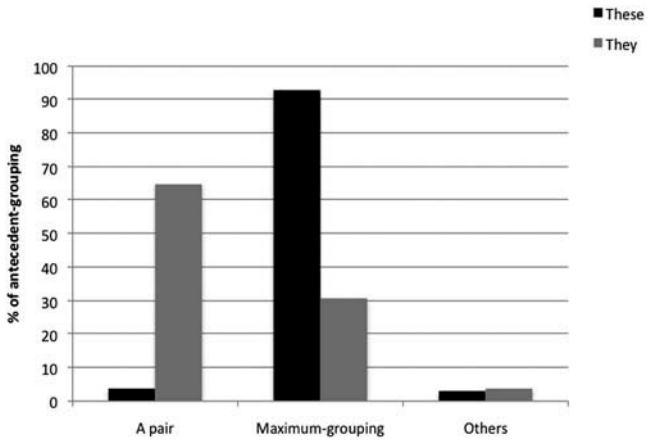

Figure 1. Proportion of entity pairs or maximum-group responses for each referential expression.

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General discussion

The results from both eye-tracking and sentence-completion experiments show that the preferred antecedent grouping is affected by the choice of referential expression. Although *they* was preferred when referring to the paired grouping in both eye-tracking and sentence-completion experiments, *these* was strongly preferred when referring to the maximal grouping in the sentence-completion experiment. Therefore, our findings show limitations in the application of the closure strategy (Koh & Clifton, 2002). If the closure strategy applied generally, then contexts such as ours, involving ontologically similar entities linked by symmetrical predicates, should have led to a maximal grouping preference across the board. However, our results suggest that the antecedent-grouping preference depends on the referential expression type. This may reflect different encoded procedural instructions communicated by the use of these two referential expressions (Ariel, 2001; Brown-Schmidt et al., 2005; Çokal et al., in press; Cornish 2008). As mentioned in the Introduction, Çokal et al. (in press) argued that the difference in preference between singular *this* and *it* may be related to the difference between the more complex propositional antecedent preferred by *this* and the simpler concrete entity preferred by *it*. Similarly, in the studies reported by Brown-Schmidt et al. (2005), the demonstrative *that* was preferred when it referred to a composite entity (e.g., a cup on a saucer), whereas the pronoun *it* was preferred when it referred to a simple topical entity (e.g., a cup). In the terms of the current experiment, the preference profile for *these* and *they* may also be due to the difference between the more complex maximal grouping and the relatively simpler paired grouping. However, we emphasize that the effect of referring expression should be seen as relative rather than indicating an absolute preference for *they* to refer to a paired grouping and *these* to refer to a maximal grouping. Bearing in mind that Koh and Clifton (2002) found a preference for *they* to refer to the maximal grouping in their experiments using stimuli such as (1), this indicates that there must be other factors that affect the preference beyond the ones that we have considered here, and future research should examine such factors.

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Appendix A

Categories for Coding the Antecedents of They *and* These

1. If *they* or *these* referred to the maximal grouping, then its antecedent was coded as the maximal grouping.
   - The jersey was next to the cushion cover and the blanket. They needed to be folded to put away.
   - The altarpiece was close to the chalice and the candlestick. These were used in the ritual Sunday morning.
2. If *they* or *these* referred to the paired grouping, then its antecedent was coded as the entity pairs.
   - The table was next to the chair and the bookshelf. They were made of dark wood.
   - The jersey was next to the cushion cover and the blanket. These were on the sofa while the jersey fell off.
3. Other categories
   - If the antecedents of *they* or *these* were not clear, or if *these* was used as a prenominal (i.e., *these* items), then all these cases were coded as other categories.