Talking about SOME and ALL: What determines the usage of quantity-denoting expressions?

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Abstract

Reference production is often studied through single dimensions of contrast (e.g., "*tall glass*" when there are one or two glasses of varying height). Yet real-world communication is rarely so simple, raising questions about the factors guiding more complex referents. The current study examines decisions to mention set relations (e.g., using quantity-denoting expressions like "*some of the houses*" to refer to 2-out-of-5 houses) versus object categories only (e.g., using bare plurals like "*houses*"). Two experiments used vignettes to vary discourse focus on objects (prominent vs. non-prominent) and scenes to vary the set type described (subset vs. total set). Speakers were more likely to communicate set relations of prominent objects, particularly when they elicited high name agreement in the case of total sets. Speakers' use of quantity-denoting expressions also increased listeners' sensitivity to set relations in an object-matching task. This suggests that unlike simpler forms of modification that often decrease with greater focus, quantity-denoting expressions provide additional information about the set relations of prominent referents.

Keywords

language production; *referring expressions*; *discourse focus*; *quantifiers*

Introduction

One powerful feature of human language is the ability to communicate about quantity. For example, seeing two houses on a street may lead a speaker to mention the object category (e.g. "*There were pretty houses on that street*"), or pick out a set reference with a definite description (e.g., "*I saw the houses that you had talked about*"), or describe its relationship to a larger set (e.g. "*Some of the houses were for sale*"). The varying specificity of these expressions suggests that descriptions about quantity reflect choices that speakers make about how to communicate complex referents. Yet, despite a wealth of empirical research on how speakers communicate reference (Arnold, 2008; Arnold & Griffin, 2007; Brown-Schmidt & Tanenhaus, 2006, 2008; Ferreira, Slevc, & Rogers, 2005; Fukumura, van Gompel, & Pickering, 2010; Nadig & Sedivy, 2002; Sedivy, 2003) and how listeners comprehend expressions about quantity (Breheny, Ferguson, & Katsos, 2013ab; Degen &

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Tanenhaus, 2015; Grodner, Klein, Carbary, & Tanenhaus, 2010; Huang & Gordon, 2011; Huang & Snedeker, 2009, 2011; Lidz & Musolino, 2002; Moxey & Sanford, 1993), there is no existing work on the circumstances that lead speakers to comment on referent quantity or its relationship to a relevant set.

This current study examines these questions. We focus on the communicative factors that motivate speakers to produce expressions about the relationship between quantities within a set. We will broadly refer to descriptions of these set relations as "*quantity-denoting expressions.*"[1] Understanding when and why speakers produce quantity-denoting expressions is important for several reasons. First, despite their ubiquity in everyday conversation, these expressions describe abstract set relations that do not refer to particular individuals or their properties (Frege, 1893). This abstractness offers a unique window onto how the mind formulates concepts that go beyond perceptual inputs (Jackendoff, 1991; Schwarzschild, 2006). Importantly, while this question is typically tackled from the perspective of comprehension (e.g., how do listeners interpret the meanings of quantity-denoting expressions?), insight into production sheds light on more basic questions of how complex objects are construed as coherent sets and what linguistic factors contribute to the transmission of these representations during communication.

Second, recognizing the communicative factors that lead speakers to produce quantity-denoting expressions informs the types of experience-driven predictions that are made during comprehension. Across diverse traditions, psycholinguistic theories have proposed a tight coupling between production and comprehension systems, e.g. Production-Distribution-Comprehension framework (MacDonald, 2013), P-chain framework (Dell & Chang, 2013), Forward models (Pickering & Garrod, 2013), and Noisy-channel models (Gibson, Bergen, & Piantadosi, 2013). Critically, while traditional methods such as grammaticality judgments and corpus analyses address the syntactic and semantic contexts associated with quantity-denoting expressions, they offer limited insights into why these descriptions are produced in the first place. Moreover, understanding the causes of comprehension patterns relies on assumptions about when and how speakers describe sets of quantities. For example, it has been argued that since small sets in the subitizing range have a default construal vis-a-vis numbers like "*two,*" listeners are slower to match these sets to dispreferred descriptions like "*some*" (Grodner et al., 2010; Degen & Tanenhaus, 2015). Yet, there has been little empirical work testing the robustness of these assumptions across contexts.

Finally, understanding how quantity-denoting expressions are produced tests the limits of current theories of reference production, which often rely on contexts with a single dimension of contrast (e.g., saying "*tall glass*" in the context of one versus two glass(es) of varying height). It is well documented that speakers tend to use complex referring expressions in contexts featuring multiple similar entities (Arnold, 2008, 2010; Brown-Schmidt & Tanenhaus, 2006, 2008; Ferreira et al., 2005). They will adopt postnominal

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[1]Similar notions of set relations have been discussed in other frameworks. Under Conceptual Semantics (Jackendoff, 1991), they are referred to as the function ELT (element of) whereby the first argument extracts individuals from the larger reference set (e.g., "*some of the houses*"). In the literature on definite descriptions (Link, 1983; Prince, 1992; Munn, Miller, & Schmitt, 2006), plural NPs refer to the maximal set of individuals within a given set (e.g., "*I saw the houses*").

modifiers to specify location (e.g., "*Pick up the square on the left*") when object position varies in a scene (Brown-Schmidt & Tanenhaus, 2008), produce adjectival modifiers to refer to size (e.g., "*big triangle*") when competing objects contrast along this dimension (Sedivy, 2003; Ferreira et al., 2005; Nadig & Sedivy, 2002; Brown-Schmidt & Tanenhaus, 2006), and specify full names (e.g., "*Daisy*") when describing previously mentioned referents if other characters are in the scene (Arnold & Griffin, 2007). Together, this suggests that speakers produce more explicit descriptions when it is necessary to disambiguate a referent, and this need is higher for entities that are not already in discourse focus.

However, there are reasons to believe that quantity-denoting expressions may not serve the same disambiguation function as other forms of modification. Unlike other referential objects, sets typically involve collections of individuals rather than a specific one. Consequently, when speakers produce expressions to refer to sets, they may be less concerned about identifying a particular referent and instead wish to draw attention to relationships between individuals within the set. This raises questions about message design. What aspects of a situation are important for speakers to communicate? In the current study, we test the hypothesis that set relations are more noticeable when the sets themselves are salient. This may occur through multiple routes, but we begin by testing two contextual properties that may affect the likelihood of mentioning sets.

First, the production of quantity-denoting expressions may be driven by properties of the communicative context. Discourse focus refers to the degree to which referents are prominent in a context, often through recent or repeated mention (Arnold, 2010; Ariel, 1990). When applied to sets, increased focus on referents may encourage speakers to build discourse representations that specify set relations. For example, hearing someone talk about the houses on your street may lead you to recognize this group as a set. Thus, later on you might describe a subset of them as "*some of the houses.*" Second, production of quantity-denoting expressions may be driven by properties of the set relations, such as the consistency of referring expressions used to describe them.[2] It is well documented that speakers will spontaneously retrieve descriptions for objects that elicit high name agreement (e.g., an apple often labeled as "*apple*") but not ones that elicit a wide range of expressions (e.g., a couch can be labeled as "*couch*," "*sofa*," "*loveseat*") (Dikker & Pylkkänen, 2011, 2013). They are also more likely to mention basic-level color terms (e.g., lexicalized descriptions like "*pink circle*") compared to ones that need to be constructed (e.g., non-lexicalized descriptions like "*light blue circle*") (Viethen, Goudbeek, & Krahmer, 2012). Taken together, this raises questions of whether descriptions of set relations vary in consistency and how this variability predicts the likelihood of producing quantity-denoting expressions at all. For example, if a set of 5-out-of-5 houses is frequently described as "*all of the houses,*" this may prompt speakers to recognize this dimension in novel situations. Alternatively, the consistency of descriptions for set relations may reveal a natural tendency

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[2]In language-production research, variation in name agreement is often synonymous with effects of "*codability.*" One classic finding is that objects with lower codability (e.g., "*sofa*," "*couch*") exhibit delayed latency to speak due to increased competition during lexical selection (Lachman, 1973; Griffin, 2001). While these mechanisms may also explain possible consistency effects for set relations, it is likely that for sets, variable descriptions reflect higher-level conceptual processes (e.g., the decision to mention a set as "*the houses,*" a set relation like "*some of the houses,*" or an exact numerosity like "*two of the houses*").

to perceive particular configurations as sets. Either way, we may see increased use of quantity-denoting expressions for set types that elicit more consistent descriptions.

In the current study, we test these predictions using a referential-communication task. Pairs of speakers and listeners were presented with a series of vignettes and displays about characters (e.g., Presidents Obama, Bush, and Carter) or objects (e.g. houses, washing machines, and cars). Following each vignette, speakers saw scenes where target objects were distributed among characters and were asked to describe this event to listeners. Within trials, we manipulated the quantity of objects received by a character. Total sets distributed one set of objects to a single character (e.g., Obama has the total set of houses), while subsets shared the objects between two characters (e.g., Obama and Bush each have a subset of houses). Across trials, we also varied whether the objects were in discourse focus. In Experiment 1, half the trials increased focus by directly mentioning the objects in the preceding vignettes (e.g., a story about houses, cars, and washing machines), while the other half decreased focus by mentioning the characters instead (e.g., a story about Obama, Carter, and Bush). In Experiment 2, vignettes for all trials mentioned object sets, but discourse focus varied whether attention was on one object set only (e.g., houses) versus three object sets (e.g., houses, cars, and washing machines).

We adopted this paradigm to explore the conditions that encourage production of quantity-denoting expressions. Our first hypothesis concerns the role of discourse focus. Does attention to objects affect whether speakers explicitly acknowledge set relations (e.g., describing a subset as "*Obama got some of the houses*") or adopt less informative descriptions instead (e.g., "*Obama got houses*")? We predict that greater discourse focus will promote set representations, which in turn will increase communication of this information. This would demonstrate one way in which discourse focus leads to referential explicitness (e.g., speakers more likely to say "*some of the houses*" when the focus is on a set of houses) rather than reduction (e.g., less likely to say "*tall glass*" when the focus is on a single glass). Our second hypothesis concerns effects of description consistency. We predict that speakers will mention set relations in contexts that elicit consistent conceptualizations of the set. Total sets may elicit a narrow range of conceptualizations, leading to a limited set of expressions, such as "*the house*" or "*all the houses.*" By contrast, subsets may be more variable in how they are construed. Consequently, speakers may focus on the object type without considering quantity at all (e.g., "*some houses*"), state the exact number without specifying its relationship to the total set (e.g., "*two houses*"), indicate an approximate quantity in a vague manner (e.g., "*a few*", "*a bunch*", "*several*"), or explicitly define the set relation (e.g., "*some of the houses*," "*a few of the houses*"). Thus, we predict that how consistently speakers conceptualize sets, as measured by the range of expressions used, will relate to the likelihood of marking set membership explicitly.

Experiment 1

Methods

Participants—Twenty-four pairs (48 total participants) of native English-speaking undergraduates at the University of North Carolina at Chapel Hill took part in this study for course credit.

Procedure, Design, and Materials—Speaker and listener roles were randomly assigned at the beginning of the study. Half the participants served as speakers and half served as listeners. Both participants sat in front of their respective computer screens. Speakers were positioned behind listeners, so they saw the contents of both screens while the same was not true for listeners. Each trial unfolded over two stages. First, during the Vignette Stage, listeners read aloud written vignettes about three object sets or three characters (e.g., "*Different prizes were given away to contestants on a game show…*"). Fig. 1 illustrates that scripts for these vignettes appeared at the bottom of the screen and were paired with corresponding visual displays.

Next, during the Object Movement Stage, different displays appeared on the speakers' and listeners' screens. Listeners' displays featured three object sets at the bottom of the display and three characters at the top of the display. These displays established the relevant set of objects in the discourse by defining the entire set (e.g., saying "*all of the cars*" naturally refers to all the cars that the game show had, rather than all the cars in the universe or all the cars that Carter received). In contrast, speakers' displays featured the three object sets distributed among the three characters. At the bottom of these displays, two questions prompted speakers to provide relevant descriptions of their display. Since listeners could not see the speakers' display, their task was to use speakers' descriptions so that they can make their own displays look like that of the speakers. To maximize the informativity of these utterances, neither speakers nor listeners were allowed to follow-up after the speakers' initial descriptions.

Four critical trial types represented the cells of a 2 × 2 design. The first factor – discourse focus – contrasted materials that focused on the object types (object-focused trial) with those that focused on the receiving characters (character-focused trial). In the object-focused trials, vignettes introduced each of the three object sets, and question prompts asked about two target objects using a plural definite description (e.g., "*What happened to the houses? What happened to the washing machines?*"). In the character-focused trials, vignettes introduced each of the three characters, and question prompts asked about two target characters, without referring to specific object sets (e.g., "*What did Carter win? What did Bush win?*"). The second factor – set type – contrasted whether question prompts referred to total sets that were distributed to a single character (e.g., "*What did Bush win?*" refers to the character who has the total set of washing machines in the speakers' display in Fig. 1b) or subsets that were shared among two characters (e.g., "*What did Carter win?*" refers to the character who has a subset of houses).

To verify that vignettes for the object-focused trials increased the prominence of the target object in question, 48 additional participants were recruited through Amazon Mechanical Turk (www.mturk.com) and presented with one version of each of the 16 items (i.e., a written script for either an object- or character-focused vignette). After each vignette, participants were asked to rate "*How likely is that speakers will say more about the ___?*" where the name of the target object was supplied on each trial (e.g., "*houses*"). Ratings ranged on a scale of 1 (not at all likely) to 7 (very likely) and confirmed that target objects were far more likely to be mentioned when preceded by object-focused vignettes (M = 4.35, SE = 0.20) compared to character-focused vignettes (M = 3.13, SE = 0.14) (t = 12.09, $p <$.

001). These results suggest that our manipulation of discourse focus successfully increased the prominence of the target object.

Two versions of each base item were used to create two lists such that each list contained eight items in each condition and that each base item appeared just once in every list. Across the critical trials, each of the 16 vignettes (item) asked two questions, one about a subset scenario and one about a total set scenario. Thus, each speaker produced a total of 32 utterances that were included in the final analysis. Within each list, critical trials were also randomized with 16 additional filler trials that were designed to divert attention away from the manipulated variables. These trials introduced stories about one to three characters, each paired with a single object in the prompt scenes (e.g., Snow White got an apple, Kermit got a painting).

Coding procedure—Trained research assistants transcribed speakers' utterances in the critical trials. Approximately 1.5% of these trials were excluded from further analyses because of inaudible speech or equipment malfunction. Trials were checked by a second research assistant who confirmed transcriptions for 98.6% of the trials. Inconsistencies were resolved through discussion between the two transcribers.

Initial inspection of speaker utterances revealed that information about set relations was often communicated in one of two ways. First, speakers sometimes identified a set **directly** by stating whether the individuals involved comprise the entire set (e.g., "*all the houses*") or just a part of it (e.g., "*some of the houses*"). Across subsets and total sets, mention of this kind recruited a range of quantity-denoting descriptions (Jackendoff, 1991; Schwarzchild, 2006), including universal or existential quantifiers (e.g., "*some of the houses*"), adjectives (e.g., "*few of the houses*"), count phrases (e.g., "*ten of the houses*"), or anaphoric expressions (e.g., "*the rest of the houses*"). However, speakers also often identified total sets **indirectly** through plural definite NPs like "*the houses*" (Link, 1983; Prince, 1992; Munn et al., 2006). While plural definite NPs do not describe relationships between individuals within the set explicitly, they highlight a group of individuals and treat them as familiar in the discourse. This, in turn, implies reference to the total set, unless a subset had already been made salient in the context. Importantly, both direct and indirect references to sets contrast with expressions which make **no commitment** to a particular set (e.g., plural indefinite NPs like "*some houses*").

Based on these observations, we developed a coding scheme that categorized speakers' utterances into three levels of increasing specificity (examples provided in Table 1).[3]

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[3]Category 1 descriptions that included quantifiers but not definite NPs (e.g., "Obama got some houses") accounted for 9% of utterances in Experiment 1 and 20% in Experiment 2. Follow-up analyses confirmed that interactions between discourse focus and set type were found regardless how these utterances were classified, suggesting that this alone did not drive critical patterns. Moreover, while there may be contexts where these descriptions convey set membership to the same degree as Category 3 utterances (e.g., "Obama got some of the houses"), we believe that a conservative classification is licensed here for two reasons. First, these Category 1 descriptions occur in both Experiments, suggesting that production was not tied to idiosyncratic features of the materials (e.g., direct priming from question prompts). Second, Experiment 2 revealed that listeners match set relations more often after Category 3 utterances like "some of the houses" (94%) compared to Category 1 utterances like "some houses" (61%). This demonstrates that even naïve participants judged the latter description to be less informative than the former.

1. <u>Category 1 - No set information:</u> Speakers referred to the correct object category with a bare plural or an indefinite description (e.g., "*Obama got houses*").

2. <u>Category 2 - Definite NP implies total set:</u> Speakers referred to the correct object category and implied its set status with a definite description (e.g., "*Obama got the houses*").

3. <u>Category 3 - Explicit mention of set relations:</u> Speakers referred to the correct object category, marked its set status with a definite description, and explicitly mentioned its set relations through a quantity-denoting expression (e.g., "*Obama got some of the houses*").

Original coding by a first coder was checked by a second coder who confirmed categorization with a mean Cohen's kappa of .92. Disagreements between the two coders were resolved by a third independent coder. Both transcriptions and categorizations were conducted by research assistants who were blind to the conditions that utterances came from.

Results

To provide an overview of how speakers performed in this task, we first assessed global properties of their utterances across conditions (Fig. 2). For subsets and total sets, the primary description was a bare, plural definite NP in the object-focused trials (e.g., "*the houses*") and a bare, plural indefinite NP in the character-focused trials (e.g., "*houses*"). Importantly, we also found that subsets and total sets differed in the range of expressions they elicited. Compared to total sets, subsets highlighted multiple dimensions via a wide range of descriptions (N = 23 types in object-focused trials, N = 26 types in character-focused trials). These included more specific expressions such as count phrases (e.g., "*eight of the paintings*"), universal/existential quantifiers (e.g., "*some of the golf balls*"), and anaphoric expressions (e.g., "*the rest of the pictures*"). By contrast, total sets elicited a narrower range of expressions (N = 6 types in object-focused trials, N = 11 types in character-focused trials) and were often described with the quantifier "*all.*"

To test our primary hypotheses, we then analyzed coded descriptions to address two questions: (1) Does discourse focus influence speakers' production of quantity-denoting expressions to specify set relations? (2) Does description consistency increase the specificity of referring expressions? Unless otherwise noted, coded descriptions were analyzed using logistic mixed-effects models, implemented through the lme4 software package in R (Bates, Maechler, Bolker, & Walker, 2013). Subjects and items were modeled simultaneously as random-effects variables, including slopes and intercepts. Discourse focus (object- vs. character-focused trials) and set type (total set vs. subset trials) were modeled as fixed-effects variables. Significant interactions were followed up through planned comparisons, in which separate analyses were performed on each level of discourse focus and tested for effects of set type.[4]

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[4] We also compared the discourse structure of utterances by assessing the likelihood of object-first mention across conditions (e.g., "*The houses* went to Obama"). This construction was quite common in the object-focused trials (65%), where speakers' prompts asked about the outcomes of objects (e.g., "*What happened to the houses?*"). In contrast, it was infrequent in character-focused trials

Question 1: Does discourse focus influence the use of quantity-denoting expressions?—To test the prediction that speakers would be more likely to acknowledge set relations when the set was in focus, we first examined the likelihood of producing quantity-denoting expressions (Category 3 utterances, e.g., "*all of the houses*" or "*some of the houses*"). Fig. 3 illustrates that explicit mention of set relations was surprisingly infrequent, accounting for only 24% of utterances across conditions. Importantly, consistent with our hypothesis, speakers were more likely to produce explicit descriptions of set relations in the object-focused trials (M = 28%, SE = 5%) compared to the character-focused trials (M = 22%, SE = 5%) (z = 3.98, *p* < .001). These results suggest that increased focus on object sets draws attention to relationships between individuals and promotes explicit communication of this dimension. There was no additional effect of or interaction with set type (*p*s > .15).

Given the infrequency of Category 3 utterances overall, we examined whether speakers recruited other ways of indicating set relations. Sets were often indirectly referred to through plural/singular definite NPs (Category 2 utterances, e.g., "*the houses*" or "*the honey*"). These descriptions accounted for an additional 33% of utterances and were prevalent in the object-focused trials. Speakers also often produced indefinite and bare plural/singular NPs (Category 1 utterances, e.g., "*some houses,*" "*houses,*" or "*honey*"), which accounted for 43% of utterances across conditions. Relative to the other categories, these descriptions were ambiguous since they only marked the category membership. Thus, when speakers failed to identify target objects as members of a set, listeners would not know whether quantity was relevant to the task.

To examine whether direct *or* indirect reference to sets was affected by discourse focus or set type, we combined the proportion of all definite NPs across conditions (Category 2 and 3 utterances). Similar to the above analysis, this approach revealed more definite NPs in object-focused trials (M = 86%, SE = 4%) compared to character-focused trials (M = 28%, SE = 6%), leading to a main effect of discourse focus (z = 7.85, *p* < .001). Definite NPs also occurred more frequently in reference to total sets (M = 63%, SE = 8%) compared to subsets (M = 51%, SE = 7%), leading to a main effect of set type (z = 2.42, *p* < .05). Importantly, these patterns were qualified by an interaction between discourse focus and set type (z = 3.85, p < .001). While speakers in the character-focused trials were equally likely to produce definite NPs across both set types (total sets: M = 31%, SE = 7%; subsets: M = 24%, SE = 5%) (z = 0.38, *p* > .70), definite NPs in the object-focused trials were more frequent in reference to total sets (M = 94%, SE = 2%) compared to subsets (M = 78%, SE = 4%) (z = 4.24, *p* < .001). This demonstrates that communicating set relations, directly or indirectly, is more common when the referent is in focus, particularly in the case of total sets.

Question 2: Does description consistency influence the use of quantity-denoting expressions?—To test the prediction that speakers' production of quantity-denoting expressions would be influenced by description consistency, we first examined whether conditions varied along this dimension. To assess the number of unique descriptions

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(1%), where prompts asked about the characters (e.g., "*What did Carter win?*"). There was no difference across subsets and total sets (*p*s > .80). Together, this pattern confirms that manipulating the prior discourse varied speakers' focus on objects.

produced, we used a chi-square test of goodness-of-fit to compare the observed distribution of expressions within levels of discourse focus and set type to what would have been expected based on chance (i.e., equal numbers across levels). The number of unique descriptions was calculated across subjects and items, for each condition. This analysis confirmed that a greater range of expressions was found with subsets compared to total sets ($X^2(1, N = 66) = 15.51$, $p < .001$), but there was no effect of discourse focus ($X^2(1, N = 66) = 0.97$, $p > .30$).

Next, to assess whether effects of set type varied by discourse focus, we used a chi-square test of independence to compare differences between subsets and total sets across levels of discourse focus. This analysis revealed no interaction ($X^2(1, N = 66) = 0.69$, $p > .50$). In sum, we found that set-type differences generate variable description consistency, but discourse focus does not. This pattern suggests a potential explanation for speakers' tendency to produce more quantity-denoting expressions for total sets than subsets. Since total sets elicit high name agreement, this increases the ease of formulating specific descriptions.

Discussion

Experiment 1 revealed that speakers were more likely to use quantity-denoting expressions to directly communicate relationships between individuals within a set when it was in discourse focus (e.g., houses that make up the reference set in "*some of the houses*"), compared to when it was not. This is consistent with our hypothesis that quantity-denoting expressions are different from other forms of modification, which are often adopted when referents are not in discourse focus, e.g., modified NPs (e.g., "*the red house*") and proper names (e.g., "*Donald*"). In addition, we observed robust effects of set type on the variety and specificity of descriptions produced. Speakers were more likely to mark sets indirectly through definite NPs when referring to total sets compared to subsets. They also produced a smaller range of unique expressions for total sets, suggesting that this set type elicits higher name agreement relative to subsets.

One curious pattern that emerged in Experiment 1 was speakers' tendency to produce more definite NPs (e.g., "*the houses*") and fewer indefinite/bare NPs (e.g., "*some houses,*" "*houses*"). Definite NPs were used on 88% of object-focused trials, but only 29% of character-focused trials. On the one hand, this effect could be another instantiation of how discourse focus on referents increases mention of set relations. For example, when houses are in focus, saying "*the houses*" naturally refers to the total set of houses in the display. Thus, even though set relations were not explicitly mentioned, speakers can use a plural definite NP to imply it. However, this interpretation does not fit well with descriptions of subsets, where plural definite NPs like "*the houses*" were used on 56% of object-focused trials. Out of context, these descriptions could be easily misinterpreted as referring to the total set. Their frequent occurrence in Experiment 1 suggests that use of definite NPs may in part reflect linguistic priming of the mentioned target objects in the question prompts (e.g., "*What happened to the houses?*").

Nevertheless, the most notable finding in Experiment 1 was the overall low production of quantity-denoting expressions. These descriptions accounted for only a quarter of all

utterances, suggesting that *even* in the presence of visual displays contrasting total sets and subsets, speakers often don't bother to mention set relations at all. This may reflect the conceptual abstractness of these relations in the first place. Importantly, it raises the question of when quantity-denoting expressions are ever used. To pursue this point, Experiment 2 examined speakers' descriptions following vignettes that introduced a single, focused object set (e.g., houses) versus three distinct object sets (e.g., houses, washing machines, and cars). We reasoned that if discourse focus on objects draws attention to sets, then speakers should be even more likely to describe set relations when there is only a single object in focus.

Experiment 2 also implemented two additional methodological changes. First, we removed the prompt question entirely, to avoid any potential linguistic priming of definite NPs. Instead, speakers were cued to describe target characters and objects via a red box (Fig. 4). Second, we tested the communicative success of speakers' choices by examining how they affected listeners' comprehension accuracy.[5] By recording the listeners' display changes, we can obtain converging evidence of how discourse focus shapes speakers' descriptions. If increased focus on target objects alters the specificity of speakers' contributions, then this information should also be reflected in the precision of listeners' interpretation.

Experiment 2

Methods

Participants—Twenty-four pairs (48 total participants) English-speaking undergraduates at the University of North Carolina at Chapel Hill took part in this study for course credit.

Procedure, Design, and Materials—The procedure was based on those of Experiment 1, with two minor modifications. During the Object Movement Stage, we cued target objects on speakers' displays using red boxes, to avoid direct priming of definite NPs from prompt questions. Also, to examine whether listeners' interpretations of events were influenced by the specificity of speakers' utterances, we recorded the changes listeners made to their displays following speakers' descriptions.

Critical trial types again represented the cells of a 2×2 design. However, the first factor – discourse focus – now contrasted vignettes and displays focusing on one object type (1-object trial) with those focusing on three object types (3-object trial). In the 1-object trials, vignettes described facts about one object type (e.g., houses). In the 3-object trials, the same vignettes from the Experiment 1 object-focused trials were used to introduce three object types (e.g., houses, cars, washing machines). The second factor – set type – again contrasted target objects distributed to a single character (total set trial) or shared between two characters (subset trial). Unlike Experiment 1, configurations for target objects were identical across 1- and 3-object displays since the extra objects in the 3-object trials were always given to a third, unprompted character (e.g., President Bush in Fig. 4b). Four versions of each base item were used to create four lists such that each list contained four items in each condition and that each base item appeared just once in every list. Across all

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[5]Unfortunately, listeners' actions were not systematically recorded in Experiment 1. Thus, we are unable to compare performance across experiments.

lists, 16 critical trials were again randomized with 16 additional filler trials designed to divert attention away from the manipulated variables.

Similar to Experiment 1, we verified that vignettes for the 1-object trials increased the prominence of the target object by recruiting 48 participants through Amazon Mechanical Turk. Participants were asked to rate the likelihood of a speaker mentioning the target object (e.g., "*houses*") after reading one version of an item (i.e., 1- or 3-object vignettes). As expected, target objects were more likely to be mentioned when they were preceded by 1-object vignettes (M = 6.02, SE = 0.09) compared to 3-object vignettes (M = 3.18, SE = 1.16) (t = 31.43, p < .001). Importantly, direct comparisons of the focus manipulation across Experiments 1 and 2 revealed a significant interaction (t = 11.75, p < .001). While target objects were always more likely to be mentioned following prominent trials compared to non-prominent trials, this effect was greater when discourse focus was manipulated through object quantity (i.e., 1- vs. 3-object vignettes) versus object mention (i.e., object- vs. character-focused vignettes).

Coding procedure—Speakers' utterances were transcribed and coded in the manner described in Experiment 1 (Table 2). Approximately 0.9% of these trials were excluded from further analyses because of inaudible speech or equipment malfunction. A second research assistant confirmed transcriptions for 98.2% of the trials and categorization of utterances with a mean Cohen's kappa of .90.

Changes in listeners' display were coded along two dimensions. "*Category only*" referred to responses that matched characters with correct object categories but not with the set type on speakers' display (e.g., when speakers' displays show a total set of houses given to Obama, but listeners give him only a subset of them). "*Set relations*" referred to responses that matched both characters with the correct object category and the set type (e.g., when listeners give all of the houses to Obama). While matches for total set responses required that listeners moved the entirety of the set to the correct character, subset responses were considered a match when the overall configuration was met and did not require exact number matches to speakers' display (e.g., target objects split among two matching characters).

Results

Similar to Experiment 1, we started with an overview of how speakers performed in this task. Fig. 5 illustrates that subsets again highlighted multiple dimensions using a wider range of descriptions (N = 34 types in 1-object trials, N = 23 in 3-object trials). Within this condition, closer inspection revealed a mix of indefinite NPs and more specific expressions (e.g., numerals, "*half of the,*" "*some of the,*" "*the rest of the*"). In contrast, total sets elicited a narrower range of expressions (N = 14 types in 1-object trials, N = 8 in 3-object trials) and were often described with a single quantifier, "*all.*" Next, we analyzed coded descriptions to address two questions: (1) Does discourse focus influence the production of quantity-denoting expressions to specify set relations? (2) Does description consistency increase the specificity of set referring expressions? Additionally, we analyzed changes to listeners' displays to answer a third question: (3) Are listeners sensitive to the specificity of speakers'

utterances? Unless otherwise noted, Experiment 2 was analyzed in a manner similar to Experiment 1. However, effects of discourse focus now corresponded to the distinction between 1-object- vs. 3-object trials.

Question 1: Does discourse focus influence the use of quantity-denoting expressions?—To test the prediction that speakers would be more likely to acknowledge set relations when the set was in focus, we again examined how often they produced quantity-denoting expressions to directly highlight relationships within a set (Category 3 utterances). Fig. 6 illustrates that across conditions, these explicit descriptions accounted for 43% of speakers' overall utterances. This is an almost 80% increase over Experiment 1 and suggests that adding 1-object trials in Experiment 2 successfully focused speakers' attention to set relations. Importantly, the frequency of these descriptions again varied across conditions. Speakers were more likely to produce quantity-denoting expressions when referents were prominent in the 1-object trials compared to the 3-object trials, but this effect was greater when referring to total sets (1-object: M = 73%, SE = 7%; 3-object: M = 43%, SE = 7%; z = 4.30, $p < .001$) compared to subsets (1-object: M = 32%; SE = 6%; 3-object: M = 23%, SE = 5%; z = 2.30, $p < .05$). This led to main effects of discourse focus (z = 4.71, $p < .001$) and set type (z = 6.56, $p < .001$) as well as an additional interaction between the two (z = 2.39, $p < .05$).

Similar to Experiment 1, we also found that speakers sometimes referred to sets using bare definite NPs (Category 2 utterances). These descriptions accounted for 7% of overall utterances, but were particularly prevalent when describing total sets that were not in focus in the 3-object trials. This is consistent with the notion that definite NPs can be used to indirectly refer to an entire set of individuals (Link, 1983; Prince, 1992; Munn et al., 2006). To examine whether reference to sets, either directly *or* indirectly, was affected by discourse focus or set type, we analyzed the combined production of definite NPs (Category 2 and 3 utterances). We found that these expressions were again more frequent in the 1-object trials (M = 54%, SE = 8%) compared to the 3-object trials (M = 46%, SE = 7%) (z = 2.17, $p < .05$) and for total sets (M = 70%, SE = 7%) compared to subsets (M = 30%, SE = 6%) (z = 7.40, $p < .001$). Similar to earlier patterns, there was also a marginal interaction between discourse focus and set type (z = 1.64, $p = .10$), whereby greater focus increased production of definite NPs for total sets (1-object: M = 75%, SE = 7%; 3-object: M = 65%, SE = 7%; z = 2.24, $p < .05$) but not for subsets (1-object: M = 33%, SE = 6%; 3-object: M = 28%, SE = 6%; z = 0.61, $p > .50$). This demonstrates that even if we consider definite NPs as an indirect mechanism for marking total sets, we still find that discourse focus on objects supports communication about sets.

Question 2: Does description consistency influence the use of quantity-denoting expressions?—To test the prediction that production of quantity-denoting expressions would be influenced by description consistency, we examined whether conditions varied along this dimension. Chi-square tests confirmed that subsets had lower description consistency compared to total sets ($X^2(1, N = 79) = 15.51$, $p < .001$). However, unlike Experiment 1, greater focus in the 1-object trials also generated more diverse descriptions compared to the 3-object trials. This led to a marginal effect of discourse focus

(X^2(1, N = 79) = 3.66, p = .06), with no interaction between focus and set type (X^2(1, N = 79) = 0.11, p > .80). Taken together, this demonstrates that set type and discourse focus both yield effects of description consistency, though they are stronger in the former compared to the latter. Much like Experiment 1, variation in description consistency again explains the greater tendency to produce quantity-denoting expressions for total sets.

Question 3: Are listeners sensitive to the specificity of speakers' utterances?

—To test whether listeners were sensitive to speakers' utterances, we examined the changes they made to their displays in response. Unsurprisingly, listeners always matched characters with correct object categories (e.g., when speakers' displays show a total set of houses with Obama, listeners moving any houses to Obama on their displays). However, their likelihood of matching set relations increased with the specificity of speakers' descriptions. For example, when speakers explicitly communicated set relations with a definite NP and quantifier (e.g., "*all of the houses*"), listeners were more likely to move the total set of houses, rather than a subset of them. We used a logistic mixed-effects model to predict the precision of listeners' responses (category match only vs. set-relation match) based on the specificity of speakers' utterances (Category 1 vs. 2 vs. 3, with Category 2 as the reference category). Subjects and items were modeled simultaneously as random-effects variables, including slopes and intercepts. Listeners made more set-relation matches after Category 2 utterances (M = 77%, SE = 5%) compared to Category 1 utterances (M = 56%, SE = 2%) (z = 2.52, p < .05). They also made more set-relation matches after Category 3 utterances (M = 94%, SE = 5%) than Category 2 utterances (z = 2.91, p < .01), showing an even bigger increase in accuracy than for the comparison between Categories 1 and 2.

Discussion

In Experiment 2, we again found robust effects of both discourse focus and consistency on descriptions of object sets. Speakers were more likely to recruit quantity-denoting expressions to explicitly mark the set type when preceding stories described a single prominent set of objects compared to three different sets of objects. Moreover, like Experiment 1, we found that total sets elicited a narrower range of referring expressions compared to subsets. Importantly, effects of discourse focus also interacted with the set type, leading to an overwhelming preference for quantity-denoting expressions to describe total sets that were in focus (73% in 1-object/total set trials vs. less than 45% in all other trials). These results suggest that discourse focus encourages the mention of set relations via quantity-denoting expressions, especially when the set relations themselves are easy to encode. We will return to this notion in the General Discussion and examine its implications for models of production and comprehension.

In Experiment 2, listeners' responses to speakers' utterances revealed a direct relationship between their ability to match the precise set relation of the target object and the specificity of speakers' descriptions. When speakers produced quantity-denoting descriptions that referred directly to set relations (e.g., saying "*all of the houses*" to describe a total set of houses), listeners frequently replicated these set relations in their own displays (e.g., moving all of the houses to Obama). However, when speakers omitted this information in their descriptions (e.g., producing "*houses*" or "*the houses*"), listeners often failed to reproduce

set relations and generated incorrect matches 23% of the time (e.g., moving only some of the houses). This suggests that speakers' decisions about referring expressions have profound impacts on listeners' comprehension.

General Discussion

The current experiments explored why speakers produce quantity-denoting expressions to directly highlight relationships between individuals within sets in some contexts (e.g. "*some of the houses*") but vaguer descriptions of the category in other contexts (e.g. "*houses*" or "*some houses*"). Using a referential-communication task, we found that discourse focus on objects in general (Experiment 1) or a specific object category (Experiment 2) increases use of expressions that mark set relations directly and fewer ambiguous descriptions. More explicit expressions are also more common in references to total sets compared to subsets, an asymmetry that may be related to the description consistency of the former compared to the latter. Finally, speakers' utterances directly influence listeners' awareness of the relevance of set relations. When speakers marked set relations using quantity-denoting expressions, listeners attended to this dimension as well.

Our results suggest that relationships between discourse focus and producing quantity-denoting expressions differ from other types of referring expressions. Speakers often adopt more complex, modified descriptions when referring to entities that are not in discourse focus and more information is needed to disambiguate referents (Ariel, 1990, 2001; Arnold & Griffin, 2007, Brown-Schmidt & Tanenhaus, 2006, 2008; Ferreira et al., 2005; Gundel, Hedberg, & Zacharski, 1993; Nadig & Sedivy, 2002; Sedivy, 2003). However, our results demonstrate that set relations are different. Speakers need to first construe a collection of individuals as a set before deciding to describe the relationship between them. Thus, increasing discourse focus on sets leads speakers to produce *more* quantity-denoting expressions and *fewer* bare NPs. This suggests that providing additional information about sets is driven less by a need to identify a particular referent but is instead motivated by a desire to draw attention to specific relationships within a set. Nevertheless, even among focused sets, these relations are sufficiently abstract that speakers often fail to mention them altogether (see Experiment 1).

We also observed that some set types evoked a narrower range of expressions than others. Across experiments, reference to total sets was associated with greater description consistency and specificity. This pattern is akin to effects of description consistency on the production of object (Dikker & Pylkkänen, 2011, 2013) and color descriptions (Viethen et al., 2012). It also suggests parallels between *how* speakers refer to set and *whether* they mention this dimension at all. Yet, the current findings remain open to multiple explanations of this relationship. One possibility is that consistency effects reflect properties of particular set types. Speakers may be more likely to design their message around total sets because this relation is a salient dimension for conceptualization. Another possibility is that consistency effects reflect the ease of retrieving linguistic forms from memory. Speakers may produce more explicit quantity-denoting expressions for total sets because there is less competition from other ambiguous forms. Future work is needed to tease apart these mechanisms at various levels of production.

Beyond quantity-denoting expressions, these data address important questions about how discourse representations and communicative goals relate to choices of referential forms. While prior work has mostly examined effects of discourse focus when describing particular individuals (e.g., "*the tall glass*," "*Donald*," etc., see Arnold, 2010, for a review), the current study explores these effects when describing relationships between sets of individuals. Comparisons across experiments illustrate that discourse focus can vary attention to objects, which in turn impacts whether sets relations will be mentioned. Recall that both experiments had a 3-object condition, but in Experiment 1 this condition contrasted with a 3-character condition, while in Experiment 2 it contrasted with a 1-object condition. In Experiment 1, stories about objects versus characters motivated the question of who got what, which led to low use of quantity-denoting expressions overall. While they were most prevalent in the total set/object-focused (i.e., 3-object) condition, they still only accounted for 31% of utterances. However, in Experiment 2, stories about one versus three objects motivated a more specific question of how many were given. Interestingly, this subtle change increased mention of set relations for total set in the less prominent, 3-object trials (43% of utterances). Since materials for 3-object trials were identical across experiments (see Figures 1 and 4), this difference suggests that broader contextual goals (e.g., co-occurrence with trials about characters in Experiment 1 or 1-object set in Experiment 2) can influence the degree to which quantity is considered relevant for communication.

Finally, production processes also shed light on the comprehension of quantity-denoting expressions. In the case of scalar inferences, it is well documented that when a speaker says "*I own some of the socks*," listeners' ability to infer "*She doesn't own all of them*" is sometimes instantaneous (Grodner et al., 2010; Degen & Tanenhaus, 2015; Breheny et al., 2013ab) while at other times delayed (Huang & Snedeker, 2009, 2011; Panizza et al., 2009). Pertinent to this pattern, our findings reveal that speakers are surprisingly inconsistent when referring to subsets. Importantly, when descriptions are highly variable during communication (e.g., describing 2-out-of-4 socks as "*some/a few/half of the socks*"), listeners may not initially attend to subset relations and would only arrive at this interpretation following semantic analysis (e.g., interpreting "*some of the socks*" as possibly all of them) and pragmatic inferencing (e.g., if she meant "*all of them*," she would have said "*all*"). In contrast, in contexts where speakers' descriptions for subsets are highly consistent (e.g., reliably referring to 2-out-of-4 socks as "*some of the socks*"), listeners can predict likely descriptions for this dimension during communicative interactions (see also Dell & Chang, 2013; Pickering & Garrod, 2013). This, in turn, supports rapid reference restriction to subsets once they hear "*some.*" Taken together, our data are consistent with the proposal that listeners access pragmatic inferences through multiple routes that are informed by speakers' contributions during communication (Huang & Snedeker, 2010, in prep).

In conclusion, the current study demonstrates that producing quantity-denoting expressions depends on both properties of discourse focus and set type. Using a referential-communication task, we find that speakers are more likely to distinguish set relations (subset or total set) when corresponding objects are focused in the discourse. Moreover, while they produce a variety of descriptions when referring to subsets, they are more likely to directly mention set relations for total sets. This suggests that variation in description consistency may impact speakers' attention to set relations. Finally, listeners are sensitive to the

informativity of speakers' contributions and distinguish among set relations when speakers explicitly mark this dimension in their utterances. Together, these results demonstrate that details of discourse representations and communicative goals have direct consequences on speakers' choices of referential forms.

Acknowledgements:

References

Ariel M (1990). Accessing noun-phrase antecedents. London: Routledge.

Ariel M (2001). Accessibility theory: An overview In Sanders T, Schilperoord J, & Spooren W (Eds.), Text representation: Linguistic and psycholinguistic aspects (pp. 29–87). Amsterdam/Philadelphia: John Benjamins.

Arnold JE, & Griffin ZM (2007). The effect of additional characters on choice of referring expression: Everyone counts. Journal of Memory and Language, 56, 521–536. [PubMed: 18449327]

Arnold JE (2008). Reference production: Production-internal and addressee-oriented processes. Language and Cognitive Processes, 23, 495–527.

Arnold JE (2010). How speakers refer: the role of accessibility. Language and Linguistic Compass, 4, 187–203.

Bates D, Maechler M, Bolker B, & Walker S (2013). lme4: Linear mixed-effects models using Eigen and S4. R package version, 1.

Breheny R, Ferguson HJ, & Katsos N (2013a). Investigating the time-course of accessing conversational implicatures during incremental sentence interpretation. Language and Cognitive Processes, 28, 443–467.

Breheny R, Ferguson HJ, & Katsos N (2013b). Taking the epistemic step: Toward a model of on-line access to conversational implicatures. Cognition, 126, 423–440. [PubMed: 23291422]

Brown-Schmidt S & Tanenhaus MK (2006). Watching the eyes when talking about size: An investigation of message formulation and utterance planning. Journal of Memory and Language, 54, 592–609.

Brown-Schmidt S, & Tanenhaus M (2008). Real-time investigation of referential domains in unscripted conversation: A targeted language game approach. Cognitive Science, 32, 643–84. [PubMed: 19890480]

Degen J, & Tanenhaus MK (2015). Processing scalar implicature: A constraint-based approach. Cognitive Science, 39, 667–710. [PubMed: 25265993]

Dell GS, & Chang F (2014). The P-chain: relating sentence production and its disorders to comprehension and acquisition. Philosophical Transactions of the Royal Society B: Biological Sciences, 369, 20120394.

Dikker S, & Pylkkanen L (2011). Before the N400: Effects of lexical–semantic violations in visual cortex. Brain and Language, 118, 23–28. [PubMed: 21458057]

Dikker S, & Pylkkänen L (2013). Predicting language: MEG evidence for lexical preactivation. Brain and Language, 127, 55–64. [PubMed: 23040469]

Ferreira VS, Slevc LR, & Rogers ES (2005). How do speakers avoid ambiguous linguistic expressions? Cognition, 96, 263–284 [PubMed: 15996561]

Frege G (1893). The foundations of arithmetic. Evanston, IL: Northwestern University Press.

Fukumura K, van Gompel RP, & Pickering MJ (2010). The use of visual context during the production of referring expressions. The Quarterly Journal of Experimental Psychology, 63, 1700–1715. [PubMed: 20127548]

Gibson E, Bergen L, & Piantadosi ST (2013). Rational integration of noisy evidence and prior semantic expectations in sentence interpretation. Proceedings of the National Academy of Sciences, 110, 8051–8056

Griffin ZM (2001). Gaze durations during speech reflect word selection and phonological encoding. Cognition, 82, B1–B14. [PubMed: 11672707]

Grodner D, Klein N, Carbary K, & Tanenhaus M (2010). "Some" and possibly all, scalar inferences are not delayed: Evidence for immediate pragmatic enrichment. Cognition, 116, 42–55. [PubMed: 20394919]

Gundel JK, Hedberg N, & Zacharski R (1993). Cognitive status and the form of referring expressions in discourse. Language, 69, 274–307.

Huang Y & Gordon P (2011). Distinguishing the time-course of lexical and discourse processes through context, co-reference, and quantified expressions. Journal of Experimental Psychology: Learning, Memory, and Cognition, 37, 966–978.

Huang Y & Snedeker J (2009). On-line interpretation of scalar quantifiers: Insight into the semantics-pragmatics interface. Cognitive Psychology, 58, 376–415. [PubMed: 18976987]

Huang Y & Snedeker J (3, 2010). Some inferences still take time: Prosody, predictability, and the speed of scalar implicatures. Poster presented at the 23rd annual CUNY conference on Human Sentence Processing New York, NY.

Huang Y & Snedeker J (2011). 'Logic & Conversation' revisited: Evidence for a division between semantic and pragmatic content in real time language comprehension. Language and Cognitive Processes, 26, 1161–1172.

Huang Y & Snedeker J (in prep). Some inferences still take time: Prosody, predictability, and the speed of scalar implicatures. Manuscript available.

Jackendoff R (1991). Parts and boundaries. Cognition, 41, 9–45. [PubMed: 1790657]

Lachman R (1973). Uncertainty effects on time to access the internal lexicon. Journal of Experimental Psychology, 99, 199–208.

Lidz J, & Musolino J (2002). Children's command of quantification. Cognition, 84, 113–154. [PubMed: 12175570]

Link G (1983). The logical analysis of plural and mass terms: A lattice-theoretical approach In Bäuerle R, Schwarze C, & von Stechow A (Eds.), Meaning, Use, and Interpretation of Language (pp. 302–323). Berlin: De Gruyter.

MacDonald MC (2013). How language production shapes language form and comprehension. Frontiers in Psychology, 4, 226. [PubMed: 23637689]

Moxey L, & Sanford A (1993). Communicating quantities. Hove, UK: Erlbaum.

Munn A, Miller K, & Schmitt C (2006). Maximality and plurality in children's interpretation of definites. In Bamman D, Magnitskaia T, & Zaller C (Eds.), BUCLD 30: Proceedings of the 30th annual Boston University Conference on Language Development (pp. 377–387). Somerville, MA: Cascadilla Press.

Nadig A & Sedivy J (2002). Evidence of perspective-taking constraints in children's on-line reference resolution. Psychological Science, 13, 329–336. [PubMed: 12137135]

Panizza D, Chierchia G, Huang Y, & Snedeker J (4, 2009). Relevance of polarity for the on line interpretation of numerals and determiners. Paper presented at the 19th annual Semantics and Linguistic Theory (SALT) conference Columbus, OH.

Pickering MJ, & Garrod S (2013). An integrated theory of language production and comprehension. Behavioral and Brain Sciences, 36, 329–347 [PubMed: 23789620]

Prince EF (1992). The ZPG letter: Subjects, definiteness, and information status In Mann WC & Thompson SA (Eds.), Discourse description: Diverse linguistic analyses of a fund-raising text (pp. 295–326). Amsterdam/Philadelphia: John Benjamins.

Schwarzschild R (2006). The role of dimensions in the syntax of noun phrases. Syntax, 9, 67–110.

Sedivy JC (2003). Pragmatic versus form-based accounts of referential contrast: Evidence for effect of informativity expectations. Journal of Psycholinguistic Research, 32, 3–23. [PubMed: 12647560]

Viethen HAE, Goudbeek MB, & Krahmer EJ (2012). The impact of colour difference and colour codability on reference production. In Miyake N, Peebles D, & Cooper R (Eds.), Proceedings of

the 34th Annual Meeting of the Cognitive Science Society (pp. 1084–1098). Austin, TX: Cognitive Science Society.
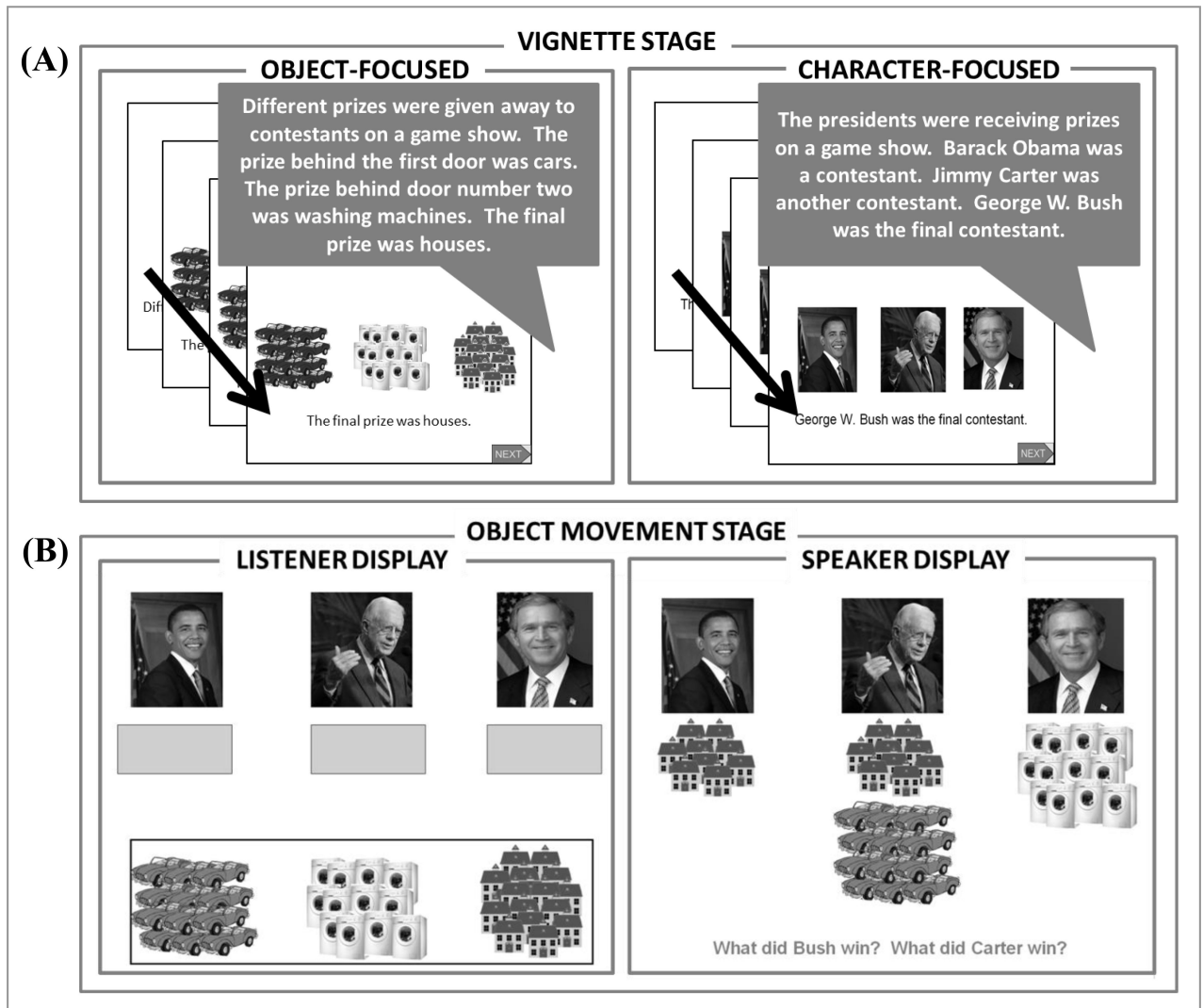
Figure 1.
In Experiment 1, examples of (A) vignettes/displays shared by participants during the Vignette Stage and (B) displays unique to listeners/speakers during the Object Movement Stage. Note that the words for the vignette were displayed at the bottom of each screen, and listeners read them aloud, which is represented by the speech box in the figure.
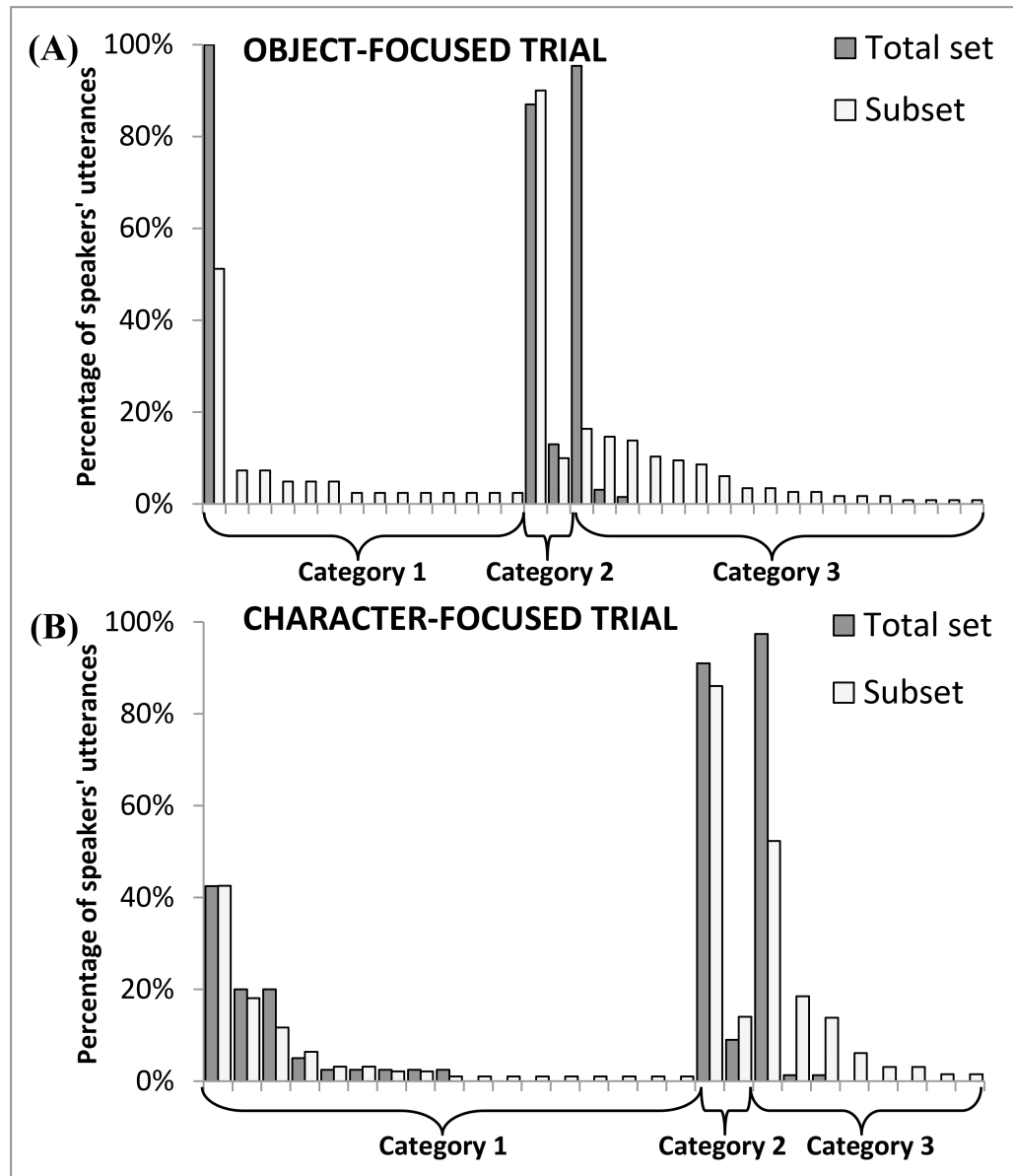
Figure 2.

In Experiment 1, speakers' utterances coded by three categories of specificity in (A) Object-focused and (B) Character-focused trials. Each bar represents a unique description for the target set. Category 1 provides no set information (e.g., indefinites), Category 2 implies the total set (e.g., definite), and Category 3 explicitly mentions set status (e.g., quantity-denoting expressions).
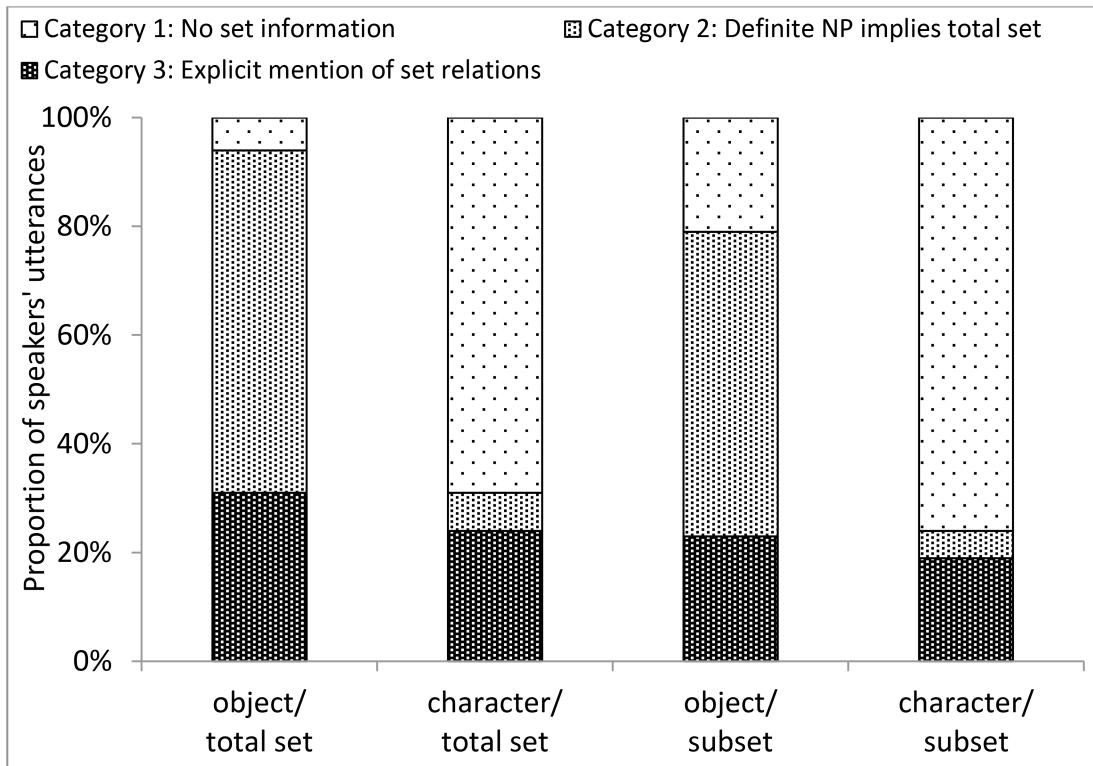
Figure 3.
In Experiment 1, speakers' utterances in each condition, coded by three categories of description specificity.
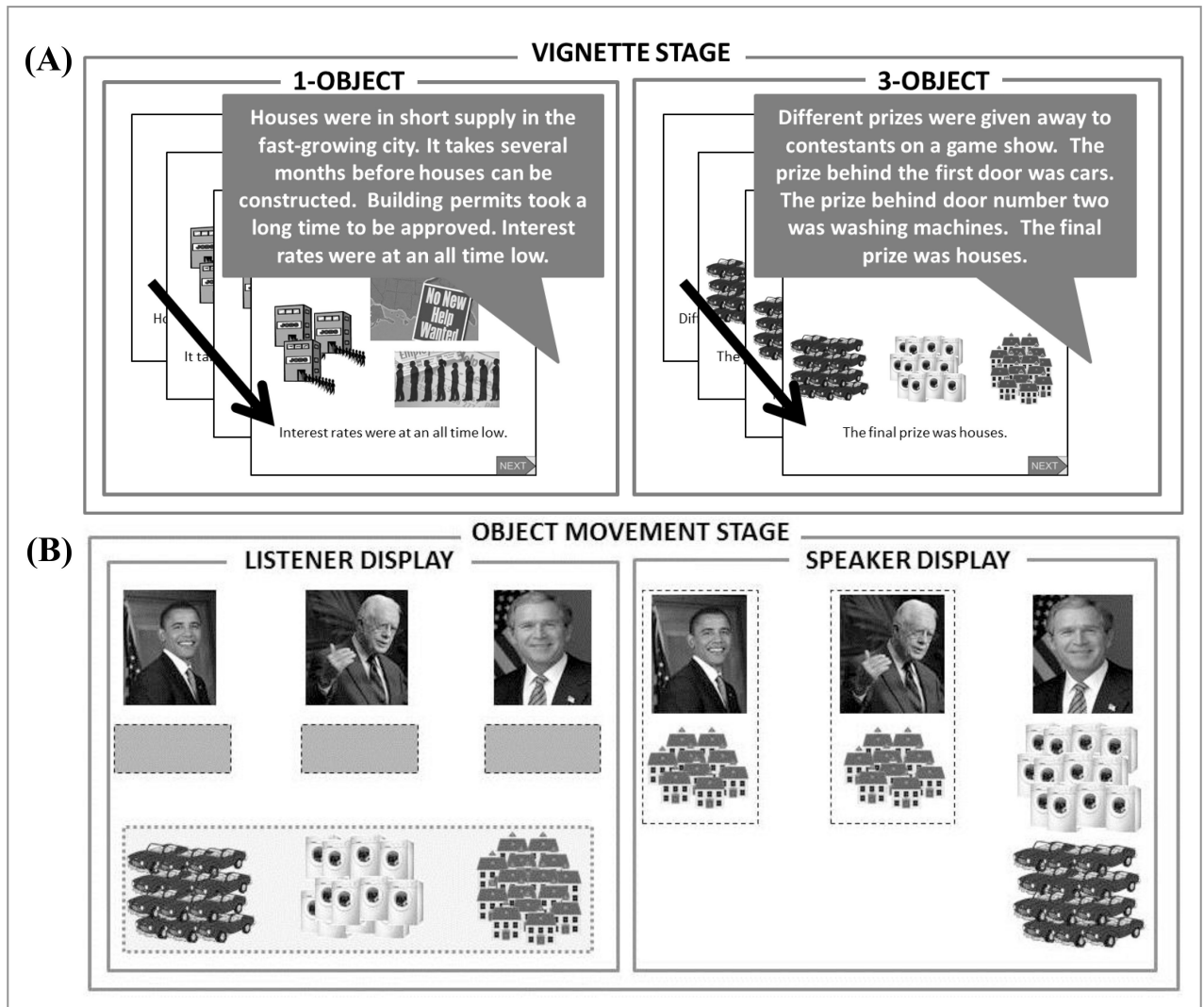
Figure 4.
In Experiment 2, examples of (A) vignettes/displays shared by participants during the Vignette Stage and (B) displays unique to listeners/speakers during the Object Movement Stage.
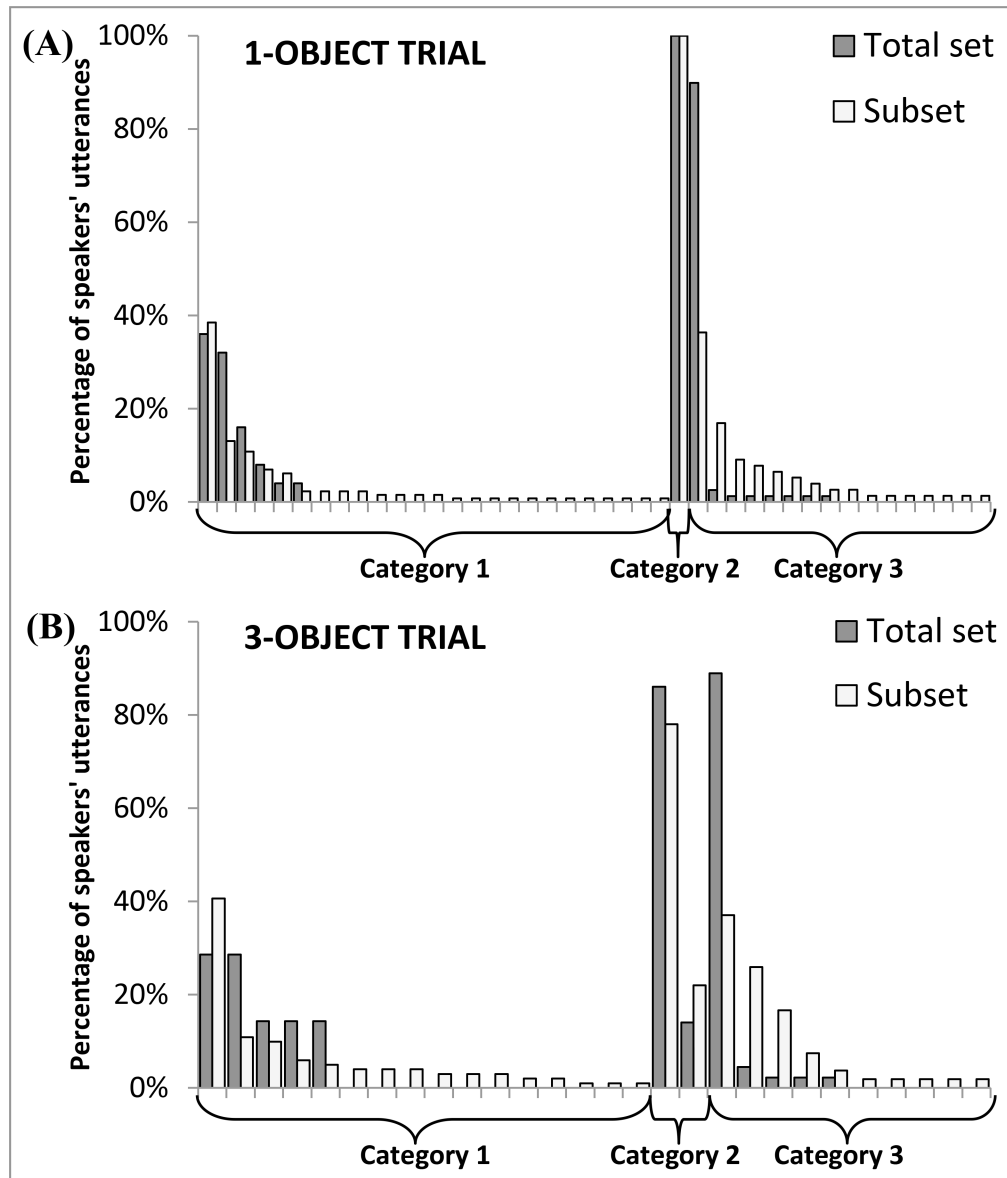
Figure 5.

In Experiment 2, speakers' utterances coded by three categories of specificity in (A) 1-object and (B) 3-object trials. Each bar represents a unique description for the target set. Category 1 provides no set information (e.g., indefinites), Category 2 implies the total set (e.g., definite), and Category 3 explicitly mentions set status (e.g., quantity-denoting expressions).
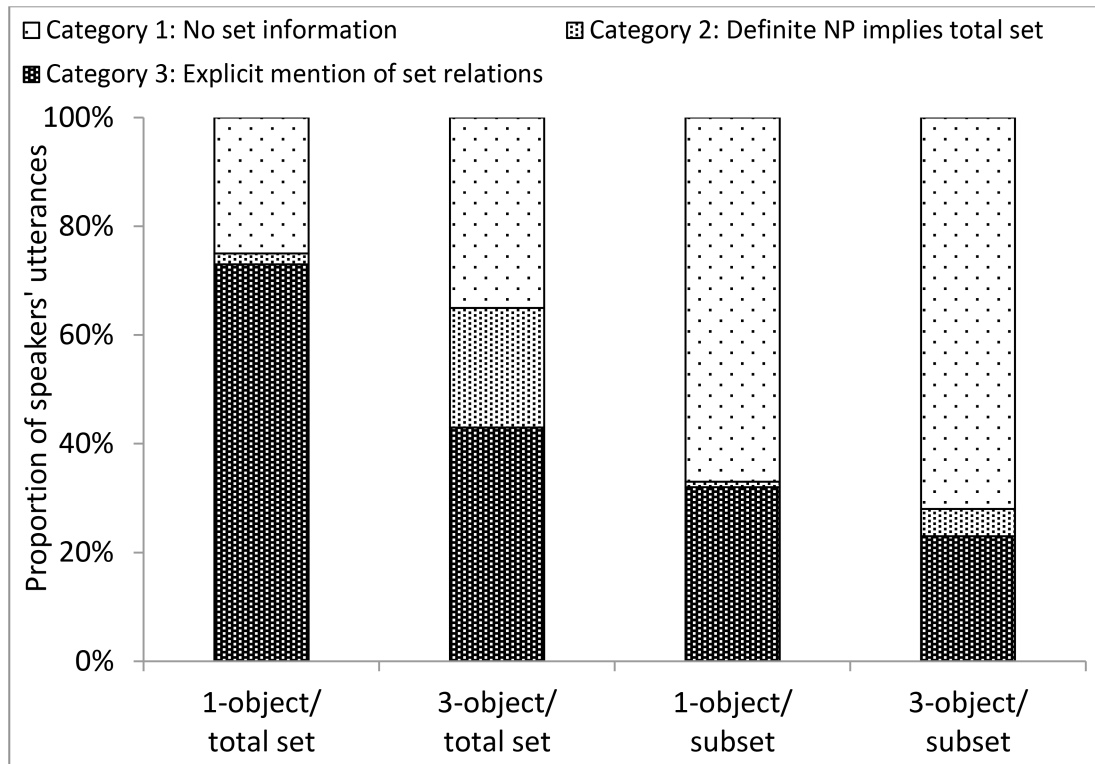
Figure 6.
In Experiment 2, the proportion of speakers' utterances in each condition, coded by categories of description specificity.

Table 1.

In Experiment 1, examples of utterances coded by three categories of set-reference specificity.

CODING OF DESCRIPTION	EXAMPLE OF SPEAKER UTTERANCES	
	OBJECT-FOCUSED TRIALS	CHARACTER-FOCUSED TRIALS
CATEGORY 1: NO SET INFORMATION		
Bare plural	*"Obama and the other guy both got houses"*	*"Harry bought brooms"*
Bare singular	*"Darth Vader bought gum"*	*"Pooh brought honey"*
Indefinite determiner	*"She also got some pantsuits"*	*"Angelina bought some easels"*
Quantifier/Measurement	*"A smallish clump of golf balls went to Jordan"*	*"Big Bird ate lots of apples"*
Adjective	*"Paula got more microphones"*	*"He got a few microphones"*
Count	*"The Joker got nine hotdogs"*	*"Eeyore bought about five ribbons"*
CATEGORY 2: DEFINITE NP IMPLIES TOTAL SET		
Definite plural	*"Hillary won the pantsuits"*	*"Tom bought the paintings"*
Definite singular	*"The gum went to Vader and Skywalker"*	*"Pooh got the honey"*
CATEGORY 3: EXPLICIT MENTION OF SET STATUS		
Universal/Existential quantifier	*"Some of the golf balls went to Michael Jordan"*	*"Rachel bought all of the pans"*
Partitive adjective	*"Most of the rackets went to Michael Phelps"*	*"Eeyore having most of the bows"*
Partitive count	*"Eight of the paintings went to Angelina Jolie"*	*"Martha bought 3/5 of the presents"*
Pronoun	*"Tom Brady took the rest of the golf balls"*	*"Tom bought the rest of the pictures"*
Predicate	*"The apples were split between Big Bird and Elmo"*	*"Joker bought the remainder of the presents"*

Table 2.

In Experiment 2, examples of utterances coded by three categories of set-reference specificity.

CODING OF DESCRIPTION	EXAMPLE OF SPEAKER UTTERANCES	
	1-OBJECT TRIALS	3-OBJECT TRIALS
CATEGORY 1: NO SET INFORMATION		
Bare plural	*"The politician on the right got cupcakes"*	*"Michael Jordan bought footballs"*
Bare singular	*"Charlie Brown gets candy"*	*"Winnie the Pooh gets honey"*
Indefinite determiner	*"Tom Cruise has some pomegranates"*	*"Pam got some hotdogs"*
Quantifier/Measurement	*"Hillary Clinton has a lot of water"*	*"The boy with the blanket gets a bunch of rocks"*
Adjective	*"The red-headed boy got less chairs"*	*"He bought less rings than the guy in brown"*
Count	*"Charlie Brown got 4 pieces of candy"*	*"Rabbit got 4 jars of honey"*
CATEGORY 2: DEFINITE NP IMPLIES TOTAL SET		
Definite plural	*"Simon Cowell and the buildings"*	*"The woman had the iPhones"*
Definite singular	*"The democrats got the water"*	*"Winnie got the honey"*
CATEGORY 3: EXPLICIT MENTION OF SET STATUS		
Universal/Existential quantifier	*"The humans got all the candy"*	*"Britney Spears got all the Chihuahuas"*
Partitive adjective	*"Michael Jordan got most of the roses"*	*"They both have the same amount"*
Partitive count	*"Twelve of them go to Paula"*	*"Dwight actually brought 6 of them"*
Pronoun	*"Bert has the other half"*	*"The apple man has the other half of the iPhones"*
Predicate	-	*"The two on the right split the Duff beer"*