

Published in final edited form as:
*J Mem Lang*. 2007 May ; 56(4): 521–536.

# The effect of additional characters on choice of referring expression: Everyone counts

**Jennifer Arnold** and
*University of North Carolina, Chapel Hill, University of Rochester*

**Zenzi M. Griffin**
*Georgia Institute of Technology, Stanford University*

## Abstract

Two story-telling experiments examine the process of choosing between pronouns and proper names in speaking. Such choices are traditionally attributed to speakers striving to make referring expressions maximally interpretable to addressees. The experiments revealed a novel effect: even when a pronoun would not be ambiguous, the presence of another character in the discourse decreased pronoun use and increased latencies to refer to the most prominent character in the discourse. In other words, speakers were more likely to call Minnie *Minnie* than *she*when Donald was also present. Even when the referent character appeared alone in the stimulus picture, the presence of another character in the preceding discourse reduced pronouns. Furthermore, pronoun use varied with features associated with the speaker's degree of focus on the preceding discourse (e.g., narrative style and disfluency). We attribute this effect to competition for attentional resources in the speaker's representation of the discourse.

### Keywords

language production; discourse; reference; pronouns; word selection; proper names

When people talk, they refer to things. They constantly make rapid decisions about whether an expression should be explicit, like *Michelle Bachelet*or *the first female president in Chile*, or whether it should be relatively underspecified, like *she*. In this paper we examine the production processes involved in the choice between less specific expressions, like pronouns, and more explicit expressions, like proper names.

Research on this issue has primarily focused on the aspects of discourse that constrain speakers' choices in referring expressions, and in particular, the linguistic discourse history. The standard approach assumes that a speaker's task is to pick a referring expression that maximally fits the current discourse situation, so as to make it easy for the listener to interpret. An explicit formulation of this idea is offered by Chafe (1994), "If language is to function effectively, a speaker is obliged to categorize a shared referent in a way that allows the listener to identify it" (p. 97). Similarly, Gundel and colleagues (1993) state, "the form of referring expressions…

Corresponding author: Dr. Jennifer Arnold, UNC Chapel Hill, Dept. of Psychology, CB#3270 Davie Hall, Chapel Hill, NC 27599-3270, Email: jarnold@email.unc.edu.

This research was partially funded by NIH grants HD-41522 to J. Arnold and MH61318-01 to Z. Griffin, as well as NSF grant BCS-0318456 to Z. Griffin.

depends on the …assumptions that a cooperative speaker can reasonably make regarding the addressee's knowledge and attention state in the particular context in which the expression is used"(p. 275). Likewise, Levelt (1989) proposes that the production of referring expressions involves calculating the accessibility of each referent in terms of the addressee's mental state. This view is embodied by Grice's maxim of quantity: "Make your contribution as informative as is required… [but not] more informative than is required" (Grice, 1975). In other words, speakers select reference forms based on their assumptions about addressees' mental states.

Support for this view of reference production comes from evidence that speakers tend to choose expressions that are unambiguous with respect to the current context. For example, experimental manipulations of the discourse context have shown that speakers use fewer third-person pronouns when there is more than one salient entity that matches the gender of the pronoun (e.g., Arnold, Eisenband, Brown-Schmidt, & Trueswell, 2000; Arnold, 1999; Francik, 1985; Karmiloff-Smith, 1985). So, a speaker is less likely to refer to Michelle Bachelet as *she*if another woman has also recently been discussed. This "Gender Effect" has been explained in terms of sensitivity to the referential ambiguity of pronouns with respect to specific situations (e.g., Givón, 1983; Karmiloff-Smith, 1985). Similarly, the referential context has been shown to influence the use of modifiers like *small*and *wooden*, which are chosen more often when needed to pick out a unique entity in the context (e.g., Brown-Schmidt & Tanenhaus, 2006; Osgood, 1971; Sedivy, 2003; Sridhar, 1988).

A second observation about reference production is that speakers tend to use less specific forms to refer to referents that have recently been mentioned in a discourse (Ariel, 1990; Arnold, 1998; Brennan, 1995; Chafe, 1976,1994; Givón, 1983; Gundel, Hedberg, & Zacharaski, 1993; Sridhar, 1988). Likewise, speakers use pronouns more often when referring to a character that was the grammatical subject (e.g., Arnold, Eisenband, et al., 2000; Stevenson, Crawley, & Kleinman, 1994), or first-mentioned entity (e.g., Gernsbacher, Hargreaves, & Beeman, 1989; Gernsbacher & Hargreaves, 1988) in the preceding clause. Grammatical subjects in English are often the first-mentioned entity in an utterance, but not always, and both positions have been shown to impact reference resolution when unconfounded (see Kaiser & Trueswell, in press). Other relevant features of the discourse are the thematic roles of recently mentioned referents, parallelism of the syntactic roles of anaphors and antecedent, and information carried by focus constructions, like clefts (e.g., Almor, 1999; Arnold, 2001; Arnold, Eisenband, et al., 2000; Ariel, 1990; Givón, 1983; Sanford & Garrod, 1981; Stevenson, et al., 1994; see Arnold, 1998, for a review). A referent that is highly accessible in an addressee's discourse representation does not require as specific a referential expression as a new referent does, so effects of discourse status can be interpreted as evidence that speakers aim to produce expressions that are optimally interpretable.

Despite the intuitive logic of selecting referring expressions to avoid ambiguity, ambiguity avoidance may not be a widespread characteristic of the production system. Consider the load that filtering every single referring expression for potential ambiguity would place on the processing mechanisms. The interpretability of each expression would need to be evaluated with respect to the discourse context, and not just the speaker's own knowledge, since the speaker of course knows the intended message. Indeed, several studies have found that speakers do not routinely design their utterances to avoid temporary syntactic ambiguities in situations where such an ambiguity might be avoided (e.g., Arnold, Wasow, Asudeh, & Alrenga, 2004; Ferreira & Dell, 2000; Kraljic & Brennan, 2005; Schaefer, Speer, Warren, & White, 2000).

With some exceptions (e.g., Brown-Schmidt & Tanenhaus, 2006; Horton & Gerrig, 2005), most research on the choice between more or less explicit forms of reference has focused on the impact of designing phrases to be pragmatically appropriate to the discourse, to the exclusion of considering the pressures inherent to the production process itself. The Gender

Effect is typically described as an example of ambiguity avoidance. Similarly, accessibility effects on the use of pronouns have been attributed to concern for the listener, where pronouns are used to signal that the referent is highly accessible or salient in the discourse (e.g., Ariel, 1990; Gundel et al., 1993). Here we consider another class of constraint on the speaker's choice of referring expression -- constraints that emerge from the pressures of utterance planning and production.

Specifically, the experiments reported here explore factors that influence pronoun use when a pronoun would be unambiguous. Two narrative production experiments demonstrate a novel effect on reference production: speakers are more likely to use a pronoun when there is a single character in the discourse situation than when another character is present that could not be the referent of a gender-marked pronoun. Preliminary evidence of this effect came from a pilot experiment. We briefly describe this pilot experiment to show that the story-telling task used in subsequent experiments replicates the well-established effects of gender and order of mention on the choice of referring expressions.

## Pilot Experiment

We presented participants with two-panel cartoons (see Figure 1) and the first sentence in a story such as Mickey went for a walk with Daisy in the hills one day. Every critical item contained two cartoon characters. Characters had either different gender (Fig. 1left) or the same gender (Fig. 1middle), and were mentioned as the grammatical subject or in an adjunct prepositional phrase in the opening sentence of the story (see Table 1). Thirty-eight participants from Stanford University repeated the first sentence of each story and then generated the next sentence in the story. Continuations were based on the second panel, in which the "Main" character (e.g., Mickey in Figure 1 left and middle) was displayed more prominently and actively, to encourage participants to begin their response with reference to that character. The majority of responses (84%) referred to the Main character alone in subject position before mentioning the other character, if the other character was mentioned at all. Only these responses were included in analyses in this experiment and the following ones. The original motivation for this study was to investigate the contrast between same-gender and different-gender situations using eye tracking. However, the eye movement data were uninformative, and so will not be discussed.

We analyzed the percentage of pronouns (out of pronouns and proper names) used to refer to the Main character. Two missing cells in the participants' analysis were replaced with the participants' means. As expected, the mean percentage of pronouns was higher in the different-gender context (48%, SE = 6%) than the same-gender context (23%, SE = 5%), which was reliable in analyses of variance ($F_1(1,35) = 22.17$, $p < .001$; $F_2(1,15) = 36.56$, $p<.001$; *minF'*$(1,49) = 13.80$, $p < .001$; 95% CI = ± 8%). Here and throughout the paper, the *minF'* is calculated using formulas (15) and (16) in Clark (1973). This finding replicated the difference in pronoun use in same- and different-gender contexts that has been reported elsewhere (e.g., Arnold, Eisenband et al., 2000; Francik, 1987; Karmiloff-Smith, 1985).

This study also replicated the well-established tendency for pronouns to be used more often to refer to first-mentioned than second-mentioned characters. The first sixteen participants in the pilot study saw stimuli in four critical conditions (Same-gender/1st-mentioned; Same-gender/2nd-mentioned; Different-gender/1st-mentioned; Different-gender/2nd-mentioned). The order-of-mention manipulation was achieved by simply swapping the order in which the two characters were mentioned in the first sentence. Analysis of this subset of the data revealed more pronouns for reference to the first-mentioned character: Different/first mentioned: 53% (SE = 9%); Different/second-mentioned: 17% (SE = 7%); Same/first-mentioned: 23% (SE = 9%); Same/second-mentioned: 0%. Three missing cells in the participants' analysis and two missing cells in the items analysis were replaced with the participant or item mean. A separate

ANOVA with these data showed a main effect of gender ($F_1(1,15) = 27.45$, p<.001; $F_2(1,15) = 9.27$, $p< .01$; *minF'*(1,28) = 5.96, $p< .05$; *CI*= ±9%), a main effect of order-of-mention ($F_1(1,15) = 16.68$, $p< .005$; $F_2(1,15) = 32.79$, p<.001, *minF'*(1,27) = 11.06, $p< .005$; *CI*= ±15%), and no interaction ($F_1(1,15) = 1.03$; $F_2(1,15) = 0.33$).

Although the story-telling method replicated well-established effects found with other methods, we thought there should have been a greater use of pronouns when the main character was the first mentioned character and grammatical subject in the preceding sentence, and the other character had a different gender. In this condition, pronouns would be unambiguous and their referents should be highly accessible. To see if pronoun use was uniformly low using the story-telling method, we analyzed three of the filler items where there was only a single character in both panels (see right side of Figure 1and Table 1 for an example). Speakers produced pronouns at a much higher rate for these items (85%, SE = 4%) than for the critical items in either the same or different-gender conditions.

A simple ambiguity-avoidance explanation would not predict any difference between the single-character and different-gender contexts, because a pronoun would be unambiguous in both cases. That is, the pronoun *he*in *He became very tired*clearly refers to Mickey after *Mickey went for a walk with Daisy in the hills one day*and *she*clearly refers to *Minnie*after *One day, Minnie imagined how great it would be to have a flower garden*. Yet a post-hoc comparison between the different-gender and single-character items revealed a robust effect of context ($F_1(1,35) = 55.86$, $p< .001$; $F_2(1,17) = 21.49$; *minF'*(1,27) = 15.52, $p< .001$; *CI*= ±7%).

Although using a pronoun would not cause ambiguity in the different gender condition, it seemed plausible that the presence of an additional character in the speaker's discourse representation might make the main character less prominent or accessible. That is, the presence of a second character that could potentially be referred to could make it more difficult to focus attention on the main character. Like others, we hypothesized that the likelihood of selecting a pronoun rather than a proper name may be a function of the level of accessibility or activation of the referent in the discourse structure. However, in contrast to other accounts, we conceptualized accessibility with respect to the speaker. That is, the role of accessibility in choice of referring expression could be similar to the role of accessibility in production choices about order of mention and syntactic structure. Factors that make one participant in an event more accessible in a message than another make it more likely to be mentioned early in a sentence (see, for example, Osgood, 1971;Wundt, 1900/1970). So, mentioning a referent in an early sentence position (e.g., grammatical subject in active or passive sentences or immediately following the verb in double object or prepositional datives) is more likely for given than new referents (Arnold, Wasow, Losongco, & Ginstrom, 2000; Bock, 1977), more imageable than less imageable referents (Bock & Warren, 1985), animate as opposed to inanimate referents (Bock, Loebell, & Morey, 1992), and referents expressed with shorter rather than longer noun phrases (e.g., Arnold, Wasow et al., 2000; Hawkins, 1994; Stallings, MacDonald, & O'Seaghdha, 1998; Wasow, 1997). Assuming that accessibility influences pronoun use and it is a limited resource (in effect a function of attentional resources) could then account for the lower rate of pronouns in the presence of a second character. Although this idea was appealing, it explained results from a post-hoc comparison of unmatched stimuli.

In the following experiments, we systematically investigated the effect of having additional characters present in the discourse context by measuring rates of pronoun use in contexts with either no second character or a second character of different gender. In all of the critical conditions, the Main character could be referred to unambiguously with a pronoun. These experiments replicated the effect of having another character in the discourse on choice of referring expression. In addition, reference choice varied with the speaker's ability to attend to the prior discourse information, as measured by a) whether they used a conjunction to link

to the previous utterance or not, b) whether they spoke fluently or disfluently, and c) whether they adopted a past-tense narrative style. The results of these experiments highlight the role of factors that are not directly related to the optimization of expressions for the listener and specifically those that cannot be explained by an ambiguity avoidance strategy.

## Experiment 1

A story-telling task was used to systematically investigate the novel effect of secondary characters on speakers' choices between pronouns and names. As in the pilot experiment, participants viewed two-panel cartoons (Figure 2) and heard the first sentence in a story, e.g.*Mickey went for a walk (with Daisy) in the hills one day*.Participants were asked to repeat the first sentence of each story and then generate the next sentence based on the second panel. A Main character appeared in both panels, involved in an activity worthy of narration in the second panel. The manipulation was whether another character was present or absent. The other character never had the same gender as the main character, so a pronoun could unambiguously refer to one of them. In addition, the manipulated second character was pictured as continuing what it did in the first panel or as relatively inactive in the second panel to discourage participants from mentioning it in their story continuations; it was also smaller than the Main character in the second panel. We examined how participants referred to the Main character (pronoun or name), and the latency of producing this referring expression as a function of the other character's presence or absence.

Based on the pilot study, we predicted that participants would produce fewer pronouns to refer to the main character when another character was present. In addition, we hypothesized that if this effect stemmed from competition for attentional resources, participants would take longer to generate a referring expression in the two-character condition than in the single character one.

### Method

**Participants—**Twenty-three students from Georgia Tech participated in exchange for money or course credit. All reported English as their first language and their sight to be normal or corrected-to-normal. Three additional participants were excluded because they were not native speakers of American English.

**Materials and Procedure—**Participants were asked to continue stories about pictures that were presented in two panels. All of the characters were Disney characters, to ensure that proper names were available to our speakers and that their gender would be easily identifiable (i.e., females had long eyelashes and usually wore dresses and bows, whereas males wore pants).

The visual stimuli consisted of a two-panel cartoon with either one (Figure 2left) or two characters (Figure 2middle). If there were two characters, they were displayed with equal salience in the first panel; in the second panel, the Main character was larger and more active than the second character. To create the single character context, the second character was eliminated from both panels.

Story sentences were always in past tense. In the experimental sentences, the second character was always mentioned in a "with" phrase, and each sentence ended with a phrase that referred to neither character (e.g., *Mickey went for a walk {with Daisy} in the hills one day*). The verbal stimuli for the single-character condition were created by splicing out the prepositional phrase referring to the second character (e.g., *with Daisy*), and replacing the end of the prior word with a version that contained the appropriate co-articulation. In the two-character condition one character was always a mouse (Mickey or Minnie) and the other a duck (Donald or Daisy),

which reduced conceptual similarity and avoided phonological similarity between the characters' names.

Thus, there were two conditions of interest: single-character and two-character, where the two characters always had different genders. There was a third condition, where the secondary character was present only in the first panel. However, a programming error occurred in this condition, so these data will not be reported. There were 15 items in the stimulus set, which were rotated through the three conditions in a Latin Square design, and combined with 17 filler items in order to create three stimulus lists. Each Disney character was the Main character in 3 or 4 of the 15 experimental items on a stimulus list. The filler items varied in the number of characters in each panel and the number of characters mentioned in the story sentence. There were also 2 practice items that always occurred at the beginning of each list. Items in each list were presented in a pseudo-random order, which was then reversed to create 3 more lists.

Participants were told that they would hear the beginning of a story and pictures illustrating it. They were instructed to repeat the story sentence and add a sentence based on the second illustration, imagining that they were making up the story for a five-year-old child. The experimenter went through an example story with panels printed on paper. To ensure that the characters names were fresh in the participants' minds, the experimenter showed participants a sheet with five characters and their printed names (*Mickey, Minnie, Donald, Daisy,*and *Pluto*), and named each one aloud. An identical sheet without printed names was then displayed and the participant was asked to name each character.

At the beginning of each trial, a preview of both panels of the cartoon appeared for two seconds. Then panel 1 appeared in the top half of a 21-inch monitor and a 22 kHz WAV file of the story sentence was played through computer speakers. Participants repeated the first sentence of the story. After the repetition, an experimenter pressed a key to add the second panel below panel 1 and begin digital recording of sound. The experimenter ended the trial by pressing a key after participants added another line to the story. The experimenter was present throughout the experiment.

Speech was digitally recorded at 12 kHz via a SoundBlaster card, using a headset microphone. Prior to the experiment, participants counted to 3 out loud to test and calibrate the digital recording of their voices. In both experiments, we also monitored participants' eye-movements with a remote ISCAN eye-tracker. However, we will not discuss the details of this set-up or the eye movement data further, because results were completely redundant with latency effects (i.e., the later the latency, the longer the preceding gaze on the referent), or else uninterpretable.

## Results

Here and throughout the paper, we report the percentage of pronouns produced, out of the total number of pronouns and names. We excluded cases where the referring expression denoted more than one character (e.g.,*they*,*both of them*,*Daisy and Mickey*), was possessive (*Daisy's ball*, *her ball*), or elliptical (*… and got very tired*). We only included items where the participant's response referred to the main character as the grammatical subject and preceded any mention of the other character. We excluded items with naming errors (e.g., *Mickey*for *Minnie*) or other errors. This left 191 (83%) experimental trials.

Since the pronoun data are proportional, we also analyzed the data using an arcsine transformation (Winer, Brown, & Michels, 1991), which always produced the same patterns of significance. As a measure of effect size, we report 95% confidence intervals for the difference between participant means (Masson & Loftus, 2003). Inferential statistics are reported in Table 2. For both experiments we performed analyses of variance with both participants ($F_1$)and items ($F_2$)as random factors, with either pronoun use or latency to mention

the main character as dependent variables. Context (one character or two) was the only independent variable in Experiment 1 and was manipulated within-participants and -items.

**Pronoun use—**Replicating our pilot experiment, we observed a robust difference between the two-character and single-character contexts. Participants produced an average of 46% more pronouns in the single-character context than the two-character context, with a confidence interval of ±12% (see Figure 3).

**Latency data—**The differences between the single-character and two-character contexts are also supported by an analysis of the time that passed before the participant named the main character, as measured from the time when the second panel appeared. Latencies were based on a combination of outputs from two forced alignment programs (Sphinx2 and Fasttalk™), an amplitude based Matlab routine for speech initial references, and measurements created with an audio editor.

The mean latency to refer to the main character was shorter in the single-character context (2387 ms) than the two-character context (2930 ms), with a 95% confidence interval of ± 348 (see Figure 3). This difference was reliable by participants, and marginal by items (see Table 2). Longer latencies in two-character than single-character contexts could result from different proportions of pronouns and names in the single and two character contexts. However, latency differences were similar for proper names (338 ms) and pronouns (360 ms). The paired t-tests on latencies for producing proper names alone, for participants and items with observations in both cells, was marginally significant ($t_1(12) = 2.03$, $p < .07$; $t_2(14) = 2.11$, $p < .06$), but the analysis for pronouns did not approach significance. This pattern of means suggests that the difference between contexts does not stem from differences in the latencies to produce names as opposed to pronouns.

## Discussion

As in the pilot experiment, we observed a greater use of pronouns in narratives that contained only a single character than in narratives containing two characters of different genders. This effect is similar to the Gender Effect that we replicated in the pilot experiment, in that the presence of another character reduced pronoun use. But whereas the Gender Effect could be the result of avoiding ambiguous referring expressions, the Two-Character Effect cannot. In the current experiment, there was only a single character that matched the pronouns' lexical features in both the single-character and two-character contexts.

How, then, might the presence of another character influence the choice of a pronoun or a name? We proposed that the presence of additional characters might influence the amount of attention that the speaker is able to give to each character within a non-linguistic discourse representation. We know that discourse entities differ in the degree to which they are considered accessible, which can be modeled in terms of the attention allocated to each character. If attention is a limited resource (e.g., Baddeley, 1986; Kahneman, 1973), then the presence of another entity should capture some amount of attention, decreasing the available resources for attending to other entities.[1] Variation in speakers' attention to the discourse model, as occurs with competition, can be represented as activation of discourse entities in a mental model. We assume, following others (e.g., Ariel, 1990; Arnold, 1998; Chafe, 1976;1994; Gundel et al., 1993; Kameyama, 1996; Levelt, 1989; Stevenson et al., 1994), that pronouns are chosen for entities that are highly activated or accessible, other things being equal. More explicit expressions, like proper names and definite noun phrases, are chosen for less active entities.[2]

[1]Note that this resource and attention based account differs from the idea that monitoring the felicity of a referring expression requires extra processing time that is not available under time pressure (Horton & Keysar, 1996). Rather this competition for resources does not involve consideration of an addressee at all.

If speakers experience competition when preparing to refer to a character in the presence of another character, one would expect references to begin later during different gender trials than during single character ones. This hypothesis was supported by analyses of reference onset times, which were measured relative to the onset of the second panel. Latencies were over 300 ms longer in the two-character condition for both pronouns and names, suggesting that the latency results are not due to the higher rate of proper name use in the two-character context.

Although we have presented our proposal in terms of accessibility in the speaker's mind, our data do not speak to questions about the degree to which accessibility is jointly constructed between speaker and addressee, or privately calculated, reflecting internal processing factors. Discourse models must take common ground into account at some level, for example linguistically or visually co-present information is often assumed to be in common ground (e.g., Clark & Marshall, 1981). However, when egocentrically available information differs from shared information, production decisions may reflect both sources of information (e.g., Horton & Keysar, 1996; Wardlow Lane, Groisman, & Ferreira, 1996).

What our data do show is one way in which the speaker's discourse model is affected by processing pressures that are internal to the production system. Under this competition view, the Two-Character Effect emerges out of the speaker's own attentional allocation, and not out of any consideration of whether the expression would be interpretable for the listener. There is no communicative value to choosing names more often when a pronoun would be unambiguous, and the referent is highly salient, having been mentioned as the subject of the previous clause. Instead, the reduction in pronoun use for situations with more than one character is likely to result from competition between entities in the speaker's mental model, which results in a lower level of activation for each entity.

A question arises about the level of representation at which the presence of a second character has its effect. Here we will consider two possible loci for the Two-Character Effect. One possibility is that competition occurs at the point of evaluating the scene in the second panel. This would suggest that speakers are sensitive to the presence of a second character when visually analyzing and evaluating the second panel, which may take more time and effort when there is more than one character. To the extent that the second panel guides the decision about how to continue the story, the participant must also decide which characters will be mentioned in the response.

A second, more interesting, possibility is that when two characters are present in the discourse, they share the attentional resources available, and each receives less activation in the speaker's internal representation. As a result, speakers are less likely to use an attenuated expression like a pronoun for referring to that character. The next experiment was conducted to distinguish between these possibilities.

## Experiment 2

In the following experiment we sought to replicate the Two-Character Effect and explored the locus of the competition effect by manipulating whether the second character was present in the scene that served as the basis for the participant's response. Specifically, we added a third condition, *the two/one context*, in which there were two characters of different gender in the first panel, just as in the two-character context. But the second panel only pictured the Main character, implying that the secondary character had left the scene. If competition occurs during

[2]Note however that neither pronouns nor names should be considered the "default" expression, in that each could be argued to be the default for a particular situation. Whereas explicit terms are preferred (and necessary) to refer to inaccessible entities, pronouns are preferred for highly accessible entities, so much so that an explicit reference to a highly accessible entity can induce processing difficulty, as occurs with the Repeated Name Penalty in language comprehension (Gordon et al., 1993).

the process of comprehending a scene, we would expect to see the Two-Character effect vary with the number of characters that are visible in the second panel. That is, we would predict the two/one context to elicit as many pronouns as the single-character context. On the other hand, if competition occurs during the process of representing the discourse situation, it should occur even when the Main character appears in the second panel alone. This account predicts that the two/one context should elicit significantly fewer pronouns than the single-character contexts, perhaps as few as the two-character context.

## Method

**Participants—**Twenty-three Georgia Tech students participated, having met the same criteria as in Experiment 1. Data from an additional eight participants were not analyzed due to technical problems, for example when difficulty calibrating the eyetracker led to cessation of the experiment.

**Materials and procedure—**The same materials were used as in Experiment 1, with the following modifications. A two/one context was created for every experimental item by combining the first panel and sentence from the two-character condition with the second panel from the single-character condition. The experimental stimuli were combined with six fillers that varied the number of characters shown in first and second panels.

Experiment 2 also employed a new design that allowed us to collect three times as much data from each participant. We presented the stimuli in three blocks, where each block contained all experimental and filler items. The experimental items were rotated through the three conditions, such that each block contained an equal number in each condition. Across participants, each item was presented an equal number of times in each condition during the first block. Thus, an analysis of the first block would be comparable to the analyses of the previous experiments, but the entire dataset yielded more observations, and the ability to compare each participant with his or her own data in the other conditions. The ANOVAs for Experiment 2 included Block as well as Context as a within-participants and -items factor.

## Results

**Pronoun use—**We used the same coding and analysis procedure as before. Means and 95% confidence intervals around the differences between means are presented in Figure 4. Again, we found a higher mean use of pronouns for the single-character context (67%) than the two-character context (29%), supporting the idea that the presence of a second character competes for attention and reduces the rate of pronoun usage for the main character. The novel condition here was the two/one context, where the second character was present only in the first panel and introductory sentence, and not the second panel. Here we observed a low level of pronoun use (33%), similar to that in the two-character context. The main effect of context was robust, even when only considering the first block (see Table 2). So, the single-character context differed from both other contexts, but the two-character and two/one conditions did not differ significantly. The main effect of Block and the interaction between Block and Context did not approach significance.

**Latency—**Collapsing across reference forms, latencies to refer to the main character differed between contexts. References began earlier in the single-character context (1499 ms ±117) than in the two-character (1678) and two/one (1661) contexts (see Figure 4). Latencies decreased with repeated presentations of the stimuli. In an ANOVA with Context and Block and the independent variables, both main effects were significant and did not interact (see Table 2). The latencies to produce names and pronouns for the first block were analyzed separately with ANOVAs in which Context was the only within-participants and -items factor. Block was not included as a factor, because it resulted in a high number of missing cells in the analysis

of pronoun and name responses separately. Even so, only 11/23 participants and 14/15 items contributed data to the analysis with names, and 9/23 participants and 9/15 items contributed to the analysis with pronouns. None of the Context differences reached significance in these analyses.

## Discussion

Again participants were more likely to use pronouns when there was a single character in the discourse, compared with discourses with two characters. Pronoun use was lower and equivalent for both the two-character context and the two/one context. In the two-character context both characters were present in both panels, and in the two/one context both were present in the visual and linguistic discourse context, but not in the panel that directly guided the participants' response. Put another way, the second panels (the proximal stimuli) for the two/one and single-character contexts were identical, but participants produced significantly more pronouns for the single-character context. One mechanism that could produce this difference is competition between entities in the discourse representation.

Latency data were also consistent with the hypothesis that characters competed with each other for resources in discourse representations. The latency to name the main character was longer in the two-character context than in the single-character context. The results for the two/one context eliminated one potential competing explanation for this difference. If the latency to begin speaking was due to the visual complexity of the second panel, we should have seen a difference between the two/one and two-character contexts, but they were equivalent and longer than in the single-character context. These results suggest that the presence of a second character influences the processes by which speakers choose referring expressions via the representation of the discourse rather than the evaluation of the second panel. Similarly, the effect is unlikely to be the result of needing to make a choice about who to refer to in their continuation. Although participants occasionally mentioned the second character in the two/one context (e.g., *Daisy was excited when Mickey left to go get refreshments)*, it was far less (19%) than in the two-character context (44%).[3]

Another explanation that can be excluded is the possibility that the effect of a second character could arise during grammatical encoding rather than in forming a message from the discourse representation. Whenever there are two entities in an event, the speaker has a choice about which entity to mention first, which constrains the choice of syntactic construction. For example, the information expressed in the response *Mickey dumped Daisy and went off with the boat*could have been produced as *Daisy got dumped by Mickey, who went off with the boat*. Research suggests that speakers begin with information that is more accessible conceptually or lexically (e.g. Arnold, Wasow, et al., 2000; Bock, 1982; 1986; Bock & Irwin, 1980; Ferreira & Dell, 2000; Ferreira, 2003). But even a less accessible character may compete for that first-mentioned position, which could add processing difficulty and decrease the activation on the speaker's representation of each character. If so, a second character should only reduce pronoun use when it is mentioned, and therefore present in the message. However, the reduction in pronouns for two-character contexts occurred even when the second character was not mentioned. In Experiment 1, pronoun use was 26% when the other character was mentioned in the story continuation, and 18% when it was not (vs. 64% in the single-character condition). In Experiment 2, participants used pronouns 31% when the other character was mentioned, and 32% when it was not (vs. 67% in the single-character condition). Instead, competition is more likely to have an effect in the discourse representation itself.

[3]A small portion of the single-character context sentences also had reference to another, absent Disney character, e.g. *Donald went swimming without Daisy.*

If reference production is indeed conditioned by the speaker's own attentional resources, we might also expect to see lower rates of pronoun use in other contexts that diminish the attention speakers can allocate to each character. To test these hypotheses, we explored whether pronoun use was correlated with three additional factors in Experiment 2: 1) whether the response continues the previous sentence or not, 2) whether the participant was disfluent at the onset of the response, and 3) when the participant chose to not to respond with the past tense (see Table 3).

We examined the effect of each of these variables in analyses of variance that collapsed across block (and context, in the case of the disfluency and continuation analyses) to reduce the number of cells with missing data. This was necessary because many participants produced data of only one type, e.g. mostly fluent data. Even so, some participants or items had to be dropped from the analyses because they did not have data in one of the response groups being studied; these numbers are noted in Table 3. The same basic patterns of continuation and disfluency were also observed in Experiment 1, but due to the lower number of productions per speaker, some of the analyses did not reach significance.

**Continuation—**Participants had considerable leeway in their decisions about what to say in their narratives. The instructions merely asked them to add another line to the story, making it coherent with the first line. As a result, speakers sometimes chose to add an utterance that was a completely new sentence, and sometimes chose to continue the original stimulus sentence. For example, after *Daisy went for a boat ride with Mickey one sunny afternoon*, one participant continued the sentence with *but she fell out of the boat and Mickey didn't realize it*, and another started a new sentence: *Then Daisy fell out*.

A break in speech, as occurs when a new sentence is started, is symptomatic of a shift in attention. Many processes tend to happen at or immediately before clause or sentence breaks, in particular message planning (Clark & Wasow, 1998; Ford, 1982; Ford & Holmes 1978). Attending to broader aspects of the situation may decrease the activation of the main character in their discourse representation, leading to fewer pronouns. Indeed, it has been reported that pronoun use is lower after a thematic (Vonk, Hustinx & Simons, 1992) or temporal shift in the discourse (McCoy & Strube, 1999).

To test whether our participants were also less likely to use pronouns after sentence breaks, we conducted ANOVAs on the percentage of pronouns used with Continuation as a within-participants and -items factor. An examination of our data reveals that participants did indeed use more pronouns when the response was a continuation of the stimulus sentence, defined as clauses beginning with *and*, *but*, *so*, and subordinate clauses beginning with *while*or *when*. Participants produced pronouns more often when they continued the prior sentence (80%) than when they did not (58%), with a 95% confidence interval of ±12% around the difference. This effect is not the result of the rates of continuations across conditions, which were similar (Single-character: 25%; Two-character: 20%; Two/One: 23%). Inferential statistics for this and the following analyses are shown in Table 3.

This result is consistent with the idea that speakers choose pronouns when the referent is activated in their own mental model of the discourse, where this activation stems from a variety of sources. It is not uniquely consistent with this view, however. Sentence breaks may also lead addressees to disengage attention from the preceding discourse, and thus could lead speakers to consider pronouns to be less interpretable, and therefore less felicitous.

**Disfluency—**Disfluency offers stronger evidence that speakers choose pronouns on the basis of their own mental models, rather than considering what would be interpretable to the listener. All speakers are disfluent some of the time; one count estimates that 6 words out of 100 are

disfluent (Fox Tree, 1995), although this number can vary widely by individual, speech situation, and depending on the definition of disfluency (see e.g., Shriberg, 1994). Disfluency may occur for many reasons, but in general it is an indication that the speaker needs to delay speaking for a moment, either because they are distracted or need an extra moment to prepare the current utterance (Goldman-Eisler, 1968; Brown-Schmidt & Tanenhaus, 2006; Clark & Fox Tree, 2002; Clark & Wasow, 1998). As such, disfluency indicates when the speaker is having some increase in processing difficulty, for whatever reason.

Assuming that attention is a limited resource, then any increase in attention to formulation should decrease the attention available for the discourse representation, thus decreasing the activation of each character. If so, we would expect speakers to use more explicit referring expressions, like names, when they are disfluent. Importantly, speakers do not produce disfluency as a signal of how accessible a referent is, but rather as a result of other pressures on the production system. Therefore, any effect of disfluency on pronoun use can be best attributed to changes in the speaker's own discourse representation and the activation of the characters within it.

The referring expression of interest usually occurred clause initially, which is also where much utterance planning tends to take place (Clark & Wasow, 1998; Clark & Fox Tree, 2002; Ford, 1982; Ford & Holmes, 1978). We categorized participants' responses as initially disfluent if a disfluent element occurred immediately before, during or immediately after the first word (e.g., *Mick- Mickey …*; *Uh Mickey …* ; *Mickey uh…* ). Disfluent elements included repeats, repairs, pauses, fillers like *uh*or *um*, and elongations. If a disfluent element occurred later, the trial was considered initially fluent. Analyses collapsed over Block and Context, using only Initial Disfluency as a within-participants and -items factor. The results revealed a higher likelihood of producing a pronoun in initially fluent responses (49%) than disfluent ones (36%), with a 95% confidence interval around the difference between the means of ±8%. This difference was not due to differences in disfluency rates across conditions, which were similar (Single-character = 19% disfluent, Two-character = 23%, Two/One = 20%).

**Tense—**The participants were instructed to continue the narrative that was begun in the stimulus sentence, which was always in the past tense. They were not given any instructions about what tense to use in their response, but most of the time the participants preserved the feel of a narrative genre by continuing in the past tense, as all participants did in Experiment 1. However, five of the twenty-three participants in Experiment 2 produced a mixture of present and past tense responses, apparently using the events in the second panel as a source for their response without linking them to the first sentence of the story. If pronoun use is driven by the speaker's representation of the preceding discourse, we would predict a lower overall use of pronouns for participants who were less tied to the preceding discourse, as indicated by their choice to respond in the present tense on at least some items. For example, after *Donald went to a birthday party with Minnie at a friend's house*, one participant said *Donald's singing*, whereas another (who consistently used past tense) said *He sang happy birthday*.

Confirmation of our prediction comes from a comparison of the five participants who sometimes used present tense with the other eighteen. Analyses collapsed over Block. Context was a within-subject and -items factor, and Tense Usage was included as a between-participants and within-items factor. There was a main effect of tense, where participants who consistently used the past tense had a greater overall use of pronouns (53%) than the five who used mixed past and present tense (5%), with a 95% confidence interval of 6% around the difference between the means. There was also a main effect of context, as before, and an interaction between context and tense. The interaction is likely the result of a floor effect, where the difference between contexts is necessarily smaller for those participants who produced responses in both present and past tense.

## General Discussion

Two experiments demonstrated a novel effect on speakers' decisions to use more-specified or less-specified forms of reference. Speakers produced pronouns more often when there was no other character present in the discourse context than when there was another character of a different gender. That is, they were over 30% more likely to refer to Mickey Mouse as *Mickey*rather than *he*when Daisy Duck was also in the discourse. This occurred even though the referent was always the most accessible entity in the discourse, as the subject of the previous clause tends to be (Arnold, 1998; Brennan et al., 1987, Gordon et al., 1993). Previous research has emphasized a desire for the referring expression to be pragmatically felicitous and interpretable to a listener (e.g., Chafe, 1994; Givón, 1980). On this view, a pronoun should not be infelicitous when it refers to a highly accessible entity and there is a second character in the discourse that could not be the referent of the pronoun. This suggests that the Two-Character Effect arises from aspects of the speakers' processing that are unrelated to the perceived needs of a listener.

We have explained this effect in terms of competition between two characters. This idea is consistent with evidence from the attention literature that unattended or irrelevant stimuli are processed (e.g., Mack & Rock, 1998) and can compete for resources (Eriksen & Eriksen, 1974; Stroop, 1935). The results of Experiment 2 further localized this effect to the presence of two characters in the discourse rather than their visual presence in the scene being described. Thus, even though one character may be the most accessible in the discourse at that point, it can still vary in its degree of accessibility.

Assuming that pronoun use reflects accessibility, our finding highlights the role of cognitive pressures on the perceived accessibility of discourse characters. Although this is not inconsistent with any current theory about reference production, most accounts of choices in referring expression concentrate primarily on the textual characteristics of the discourse (but see e.g., Brown-Schmidt & Tanenhaus, 2006; Horton & Keysar, 1996). These are assumed to be important because they guide the joint discourse model, which is assumed to be shared information, and thus available to guide the listener's interpretation (e.g., Chafe, 1994; Clark & Marshall, 1981; Givón, 1993; Grosz, Weinstein, & Joshi, 1994; Grosz & Sidner, 1986). That is, the standard account of pronoun choice emphasizes the need to design referring expressions to be understandable by the listener.

By contrast, our results are consistent with the idea that accessibility can also be influenced by other cognitive pressures. Our primary evidence about this point is the comparison between two-character and single-character contexts, which suggests that two entities compete with each other, lowering the overall activation that each one has in the speaker's mind. Consistent evidence also comes from other characteristics of the responses: sentence continuity, reference latency, fluency, and tense. Latency and fluency provide particularly strong evidence for speaker-internal processes affecting choice of referring expression. Fewer pronouns were produced following disfluency and latencies were longer when another character was in the discourse. Such patterns are not predicted by accounts that attribute reference choice solely to the speaker's desire to make the references interpretable, nor to characteristics of the linguistic discourse history. Even though disfluency can affect reference comprehension (Arnold, Tanenhaus, Altmann, & Fagnano, 2004; Arnold, Hudson-Kam, & Tanenhaus, 2006; Ferreira & Bailey, 2004; Brennan & Schober, 2001; Fox Tree, 1995), it is not produced specifically as a cue to referent accessibility.

We have argued that the Two-Character Effect represents a constraint that is speaker internal, not driven by consideration for the listener's needs. However, we must consider whether the presence of a second character could also affect comprehension, and thus be yet another factor

guiding the interpretability of the pronoun. That is, perhaps speakers realized that since a second character competes in their own representation, it is also likely to decrease activation in the mind the addressee, and therefore the addressee should need more information. This possibility is logically possible, albeit unparsimonious. However, it is important to note that this explanation is still very different from an ambiguity avoidance strategy, as has been proposed for the Gender Effect. Ambiguity avoidance requires explicitly modeling comprehension from the perspective of someone else (i.e., someone who does not know the intended interpretation). By contrast, speakers need only consult their own discourse representations to identify the accessibility of each discourse entity. While they may assume that competition in their own representation means competition for their addressees, this is a far simpler computation than judging the interpretation of a specific lexical item from the perspective of someone who does not know the intended referent.

The competition effect that we report here raises a question about the mechanism underlying the Gender Effect, where pronouns are used more often when there is only one gender-matched entity in the context (e.g., Arnold, Eisenband et al., 2000). Replicating the Gender Effect, our pilot experiment found a reliable difference between same-gender and different-gender contexts. Is it possible for the Gender Effect to emerge out of competition within the speaker's own mental representation? While not conclusive, there are several results that suggest that such a source is feasible. First, there are results suggesting that semantic similarity within a message representation causes interference in production. Semantic similarity between two objects mentioned in the same utterance increased latencies to refer to the first object (Freedman, Martin, & Biegler, 2004). For example, speakers took 41 ms longer to begin saying *horse and giraffe*than *horse and toaster*. Note that other studies suggest that simply viewing a related object does not cause interference (Bloem & La Heij, 2003; Damian & Bowers, 2003), so having the second object in a discourse representation seems to be a prerequisite for interference, if not the source of it. Second, the experiments reported here suggest that having additional entities in a discourse representation not only delays reference but also has the more specific effect of decreasing the use of pronouns. This competition may be particularly strong when entities share features that are relevant for reference, such as animacy, number, and gender in English.

It has been argued that languages constrain the features that speakers need to consider as they plan their utterances. Thus, speakers of English need to "think gender" and "think animacy" as they plan their referring expression (see Slobin, 1996). If these features receive particular activation in the representation of the discourse model, we would expect to see competition between entities that share these features, with the strength of competition reflecting the degree of overlap. Thus, it may not be necessary to posit that speakers avoid ambiguous pronouns by considering the needs of their listeners, since the same effects may arise out of competition within speakers' own discourse representations.

The data we present here do not adjudicate between the ambiguity-avoidance and competition accounts of the Gender Effect. However, in other domains it is evident that speakers do not routinely avoid ambiguities in situations where there are easily available mechanisms to do so. For example, Ferreira and Dell (2000) found that the production of optional *that*(e.g., *I know that you can type*) was not used to signal that *you*was the subject of an embedded clause, but rather was used to buy the speaker an extra moment to plan when the following words were less available. Similarly, Arnold, Wasow, and colleagues (2004) found that speakers did not use constituent ordering to avoid temporary syntactic ambiguities. While speakers may occasionally use prosody to avoid global ambiguities (Snedeker & Trueswell, 2003), some experiments have found that prosodic choices are insensitive to whether the context itself disambiguates (e.g., Kraljic & Brennan, 2005; Schaefer, Speer, Warren, & White, 2000).

On the other hand, there is good evidence that speakers do design referring expressions to pick out a unique object in the discourse, at least when there are no other sources of constraint available to make disambiguation unnecessary (e.g., Brown-Schmidt, Campana, & Tanenhaus, 2004). For example, speakers tend to use size and material adjectives in definite descriptions more often when there is a contrasting object in the context (Sedivy, 2003). The use of contrasting adjectives, like *small*, has also been linked to the time at which the speaker visually fixates the competitor (Brown-Schmidt & Tanenhaus, 2006), supporting the conclusion that speakers are actively disambiguating their referring expressions by seeking out potential competitor objects. Speakers are also more likely to use an optional *that*in sentences like *Put the penguin (that's) in the cup on the star*when there is a second penguin present (Haywood, Pickering, & Branigan, 2005).

However, cases in which speakers show such audience design may be different from pronoun production in a crucial way. Ferreira and colleagues (2005) demonstrated that speakers were much more likely to avoid ambiguity when the ambiguity could be assessed at a non-linguistic message level, without considering the linguistic expression that might be used to refer to an object. For example, reference to a flying-mammal-bat in the presence of a wooden-object-bat was not disambiguated nearly as often as reference to a flying-mammal-bat in the presence of a second flying-mammal-bat. Demonstrations that speakers intentionally disambiguate their referential expressions typically occur in situations like the former, e.g. where there are multiple objects of the same type, varying only in size, material, or physical orientation. In these cases, as with multiple flying-mammal-bats, the speaker can appreciate the high semantic overlap between the objects without explicitly considering referential expressions. By contrast, an ambiguity avoidance account of the Gender Effect would be more like what Ferreira et al. call a *linguistic ambiguity*, in that it would require the speaker to consider a particular linguistic form -- a gender-marked pronoun -- and whether it would be ambiguous in that context.

Regardless of whether the Gender Effect and the Two-Character Effect can be subsumed under the same competitive mechanism, it is clear that the presence of multiple entities in the discourse lowers the rate of pronominal expressions in production. This finding underscores the need to understand the relationship between the mechanisms of language production and the properties of the discourse that influence speakers' mental representations.

**Acknowledgements**

We are grateful to Kristin Garton, Nadine de Lassus, Elisa Lawler, Tatiana Meteleva, Demetria Mitchell, and Nikta Pirouz, for their help with data collection and processing.

## Appendix 1

## Single- and two-character stimulus sentences (with the phrase mentioning a secondary character in parentheses)

Daisy wanted to shoot some hoops (with Mickey) one day at the park.

Daisy traveled to the awards ceremony (with Mickey) on the company expense account.

Daisy watched the playoffs (with Mickey) from excellent seats.

Daisy went for a boat ride (with Mickey) one sunny afternoon.

Donald walked onto the stage (with Minnie) at the beginning of the talent show.

Donald went camping (with Minnie) on the shore of Lake Kalapa.

Donald went snorkeling (with Minnie) last weekend.

Donald went to a birthday party (with Minnie) at a friend's house.

Mickey cooked up some fun (with Daisy) on the castle grounds.

Mickey decided to go horseback riding (with Daisy) around the town of Old Cheyenne.

Mickey ventured into the forest (with Daisy) one dark scary night.

Mickey went for a walk (with Daisy) in the hills one day.

Minnie enjoyed the sunny weather (with Donald) at the local pool

Minnie spent the morning (with Donald) in the mountains.

Minnie went for a hike (with Donald) in Yosemite National Park.

## References


Almor A. Noun-phrase anaphora and focus: The informational load hypothesis. Psychological Review 1999;106:748–765. [PubMed: 10560327]

Ariel, M. Accessing noun-phrase antecedents . London: Routledge; 1990.

Arnold JE. Reference form and discourse patterns. (Doctoral dissertation, Stanford University, 1998). Dissertation Abstracts International 1998;59:2950.

Arnold, JE. Marking salience: The similarity of topic and focus . University of Pennsylvania; 1999. Unpublished manuscript

Arnold JE. The effect of thematic roles on pronoun use and frequency of reference continuation. Discourse Processes 2001;31:137–162.

Arnold JE, Eisenband JG, Brown-Schmidt S, Trueswell JC. The rapid use of gender information: Evidence of the time course of pronoun resolution from eye tracking. Cognition 2000;76:B13–B26. [PubMed: 10822045]

Arnold, JE.; Hudson-Kam, C.; Tanenhaus, MK. If you say "thee uh-" you're describing something hard: the on-line attribution of disfluency during reference comprehension . University of North Carolina ; Chapel Hill: 2006. Unpublished manuscript

Arnold JE, Tanenhaus MK, Altmann R, Fagnano M. The old and thee, uh, new. Psychological Science 2004;15:578–582. [PubMed: 15327627]

Arnold JE, Wasow T, Asudeh A, Alrenga P. Avoiding attachment ambiguities: The role of constituent ordering. Journal of Memory and Language 2004;51:55–70.

Arnold JE, Wasow T, Losongco A, Ginstrom R. Heaviness vs. newness: The effects of structural complexity and discourse status on constituent ordering. Language 2000;76:28–55.

Baddeley, AD. Working memory . Oxford: Clarendon Press; 1986.

Bloem I, La Heij W. Semantic facilitation and semantic interference in word translation: Implications for models of lexical access in language production. Journal of Memory and Language 2003;48:468–488.

Bock JK. The effect of a pragmatic presupposition on syntactic structure in question answering. Journal of Verbal Learning and Verbal Behavior 1977;16:723–734.

Bock JK. Toward a cognitive psychology of syntax: Information processing contributions to sentence formulation. Psychological Review 1982;89:1–47.

Bock JK, Irwin DF. Syntactic effects of information availability in sentence production. Journal of Verbal Learning and Verbal Behavior 1980;19:467–484.

Bock JK, Warren RK. Conceptual accessibility and syntactic structure in sentence formulation. Cognition 1985;21:47–67. [PubMed: 4075761]

Bock K, Loebell H, Morey R. From conceptual roles to structural relations: Bridging the syntactic cleft. Psychological Review 1992;99:150–171. [PubMed: 1546115]

Brennan SE. Centering attention in discourse. Language and Cognitive Processes 1995;102:137–167.

Brennan, SE.; Friedman, MW.; Pollard, CJ. A centering approach to pronouns; Proceedings from the 25th Annual meeting of the Association for Computational Linguistics; USA. 1987. p. 155-162.

Brennan SE, Schober ME. How listeners compensate for disfluencies in spontaneous speech. Journal of Memory and Language 2001;44:274–296.

Brown-Schmidt, S.; Campana, E.; Tanenhaus, MK. Real-time reference resolution by naive participants during a task-based unscripted conversation. In: Trueswell, JC.; Tanenhaus, MK., editors. Approaches to studying world-situated language use: Bridging the language-as-product and language-as-action traditions. Boston: MIT press; 2004. p. 153-172.

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

Chafe, W. Givenness, contrastiveness, definiteness, subjects, topics, and point of view. In: Li, CN., editor. Subject and topic. New York: Academic Press Inc; 1976. p. 25-56.

Chafe, W. Discourse, consciousness, and time . Chicago: Chicago University Press; 1994.

Clark HH. The language-as-fixed-effect fallacy: A critique of language statistics in psychological research. Journal of Verbal Learning and Verbal Behavior 1973;12:335–359.

Clark HH, Fox Tree JE. Using uh and um in spontaneous speaking. Cognition 2002;84:73–111. [PubMed: 12062148]

Clark, HH.; Marshall, CR. Definite reference and mutual knowledge. In: Joshi, AK.; Webber, BL.; Sag, IA., editors. Elements of discourse understanding. Cambridge: Cambridge University Press; 1981. p. 10-63.

Clark HH, Wasow T. Repeating words in spontaneous speech. Cognitive Psychology 1998;37:201–242. [PubMed: 9892548]

Damian MF, Bowers JS. Locus of semantic interference in picture-word interference tasks. Psychonomic Bulletin and Review 2003;10:111–117. [PubMed: 12747497]

Eriksen BA, Eriksen CW. Effects of noise letters upon the identification of a target letter in a nonsearch task. Perception & Psychophysics 1974;16:143–149.

Ferreira F, Bailey KGD. Disfluencies and human language comprehension. Trends in Cognitive Science 2004;8:231–237.

Ferreira VS. The persistence of optional complementizer production: Why saying ‘that’ is not saying ‘that’ at all. Journal of Memory and Language 2003;48:379–398.

Ferreira VS, Dell GS. Effect of ambiguity and lexical availability on syntactic and lexical production. Cognitive Psychology 2000;40:296–340. [PubMed: 10888342]

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

Ford, M. Sentence planning units: Implications for the speaker’s representation of meaningful relations underlying sentences. In: Bresnan, J., editor. The mental representation of grammatical relations. Cambridge, MA: MIT Press; 1982. p. 797-827.

Ford M, Holmes VM. Planning units and syntax in sentence production. Cognition 1978;6:35–53.

Fox Tree JE. The effects of false starts and repetitions on the processing of subsequent words in spontaneous speech. Journal of Memory and Language 1995;34:709–738.

Francik EP. Referential choice and focus of attention in narratives (discourse anaphora, topic continuity, language production). (Doctoral dissertation, Stanford University, 1985). Dissertation Abstracts International 1985;46-04:1363.

Freedman ML, Martin RC, Biegler K. Semantic relatedness effects in conjoined noun phrase production: Implications for the role of short-term memory. Cognitive Neuropsychology 2004;21:245–265.

Gernsbacher MA, Hargreaves DJ. Accessing sentence participants: The advantage of first mention. Journal of Memory and Language 1988;27:699–717.

Gernsbacher MA, Hargreaves DJ, Beeman M. Building and accessing clausal representations: The advantage of first mention versus the advantage of clause recency. Journal of Memory and Language 1989;28:735–755.

Givón, T. Topic continuity in discourse: An introduction. In: Givón, T., editor. Topic continuity in discourse: A quantitative cross-language study. Amsterdam: John Benjamins Publishing; 1983. p. 1-42.

Goldman-Eisler, F. Psycholinguistics: Experiments in spontaneous speech. London: Academic Press; 1968.

Gordon PC, Grosz BJ, Gilliom LA. Pronouns, names, and the centering of attention in discourse. Cognitive Science 1993;17:311–347.

Grice, HP. Logic and conversation. In: Cole, P.; Morgan, JL., editors. Syntax and semantics 3: Speech acts. New York: Academic Press; 1975. p. 41-58.

Grosz B, Sidner C. Attention, intentions, and the structure of discourse. Computational Linguistics 1986;12:175–204.

Grosz BJ, Joshi AK, Weinstein S. Centering: A framework for modeling the local discourse. Computational Linguistics 1995;21(2):203–225.

Gundel JK, Hedberg N, Zacharaski R. Cognitive status and the form of referring expressions. Language 1993;69(2):274–307.

Hawkins, JA. A performance theory of order and constituency. Cambridge: Cambridge University Press; 1994.

Horton WS, Gerrig RJ. The impact of memory demands on audience design during language production. Cognition 2005;96:127–142. [PubMed: 15925573]

Horton WS, Keysar B. When do speakers take into account common ground? Cognition 1996;59:91–117. [PubMed: 8857472]

Kahneman, D. Attention and effort. Englewood Cliffs, NJ: Prentice-Hall; 1973.

Kaiser, E.; Trueswell, JC. Investigating the interpretation of pronouns and demonstratives in Finnish: Going beyond salience. In: Gibson, E.; Pearlmutter, N., editors. The Processing and Acquisition of Reference. Cambridge, MA: MIT Press; in press

Kameyama, M. Indefeasible semantics and defeasible pragmatics. In: Kanazawa, M.; Piñón, C.; de Swart, H., editors. Quantifiers, deduction, and context. Stanford, CA: CSLI; 1996. p. 111-138.

Karmiloff-Smith A. Language and cognitive processes from a developmental perspective. Language and Cognitive Processes 1985;1(1):61–85.

Kraljic T, Brennan SE. Prosodic disambiguation of syntactic structure: For the speaker or for the addressee? Cognitive Psychology 2005;50(2):194–231. [PubMed: 15680144]

Levelt, WJM. Speaking. Cambridge, MA: MIT Press; 1989.

Mack, A.; Rock, I. Inattentional blindness . Cambridge, MA: MIT Press; 1998.

Masson MEJ, Loftus GR. Using confidence intervals for graphically based data interpretation. Canadian Journal of Experimental Psychology 2003;57(3):203–220. [PubMed: 14596478]

McCoy, KF.; Strube, M. Taking time to structure discourse: Pronoun generation beyond accessibility. In: Hahn, M.; Stoness, S., editors. Proceedings of the Twenty First Annual Conference of the Cognitive Science Society. Mahwah, NJ: Lawrence Erlbaum Associates, Inc; 1999. p. 378-383.

Osgood, CE. Where do sentences come from?. In: Steinberg, DD.; Jakobovits, LA., editors. Semantics: An interdisciplinary reader in philosophy, linguistics and psychology. Cambridge: Cambridge University Press; 1971. p. 497-529.

Sanford, AJ.; Garrod, SC. Understanding Written Language. Chichester: John Wiley & Sons; 1981.

Schafer A, Speer S, Warren P, White S. Intonational disambiguation in sentence production and comprehension. Journal of Psycholinguistic Research 2000;29:169–182. [PubMed: 10709182]

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

Shriberg, EE. Preliminaries to a theory of speech disfluencies. University of California Berkeley; Berkeley CA: 1994. Unpublished doctoral dissertation

Slobin, D. From ‘thought and language’ to ‘thinking for speaking’. In: Gumperz, JJ.; Levinson, SC., editors. Rethinking linguistic relativity. New York, NY: Cambridge University Press; 1996. p. 70-96.

Snedeker J, Trueswell JC. Using prosody to avoid ambiguity: Effects of speaker awareness and referential context. Journal of Memory & Language 2003;48(1):103–130.

Sridhar, SN. Cognition and sentence production: A cross-linguistic study. New York: Springer-Verlag; 1988.

Stallings LM, MacDonald MC, O'Seaghdha PG. Phrasal ordering constraints in sentence production: Phrase length and verb disposition in heavy-NP shift. Journal of Memory and Language 1998;39(3): 392–417.

Stevenson RJ, Crawley RA, Kleinman D. Thematic roles, focus and the representation of events. Language and Cognitive Processes 1994;9(4):473–592.

Stroop JR. Studies of interference in serial verbal reaction. Journal of Experimental Psychology 1935;18:643–662.

Vonk W, Hustinx LG, Simons WH. The use of referential expressions in structuring discourse. Special Issue: Discourse representation and text processing. Language & Cognitive Processes 1992;73(4): 301–333.

Wardlow Lane L, Groisman M, Ferreira VS. Don't talk about pink elephants! Speakers' control over leaking private information during language production. Psychological Science 2006;17:273–277. [PubMed: 16623681]

Wasow T. End-weight from the speaker's perspective. Journal of Psycholinguistic Research 1997;20:347–361.

Winer, BJ.; Brown, DR.; Michels, KM. 3. New York: McGraw-Hill; 1991. Statistical principles in experimental design .

Wundt, W. Die sprache. In: Blumenthal, AL., editor. Language and psychology: Historical aspects of psycholinguistics . New York: Wiley; 19001970. (First published 1900 ed., Vol. 1)

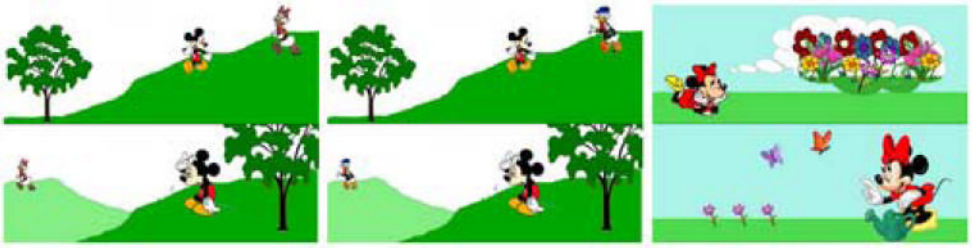

**Figure 1.**
Examples of visual stimuli for the pilot experiment. Left: Two-character, different-gender context; middle: Two-character, same-gender context; right: Single-character filler.

**Figure 2.**
Examples of visual stimuli for Experiments 1 and 2. Left: Two-character, different-gender context; middle: Single-character context, right: Two/one context for Experiment 2.

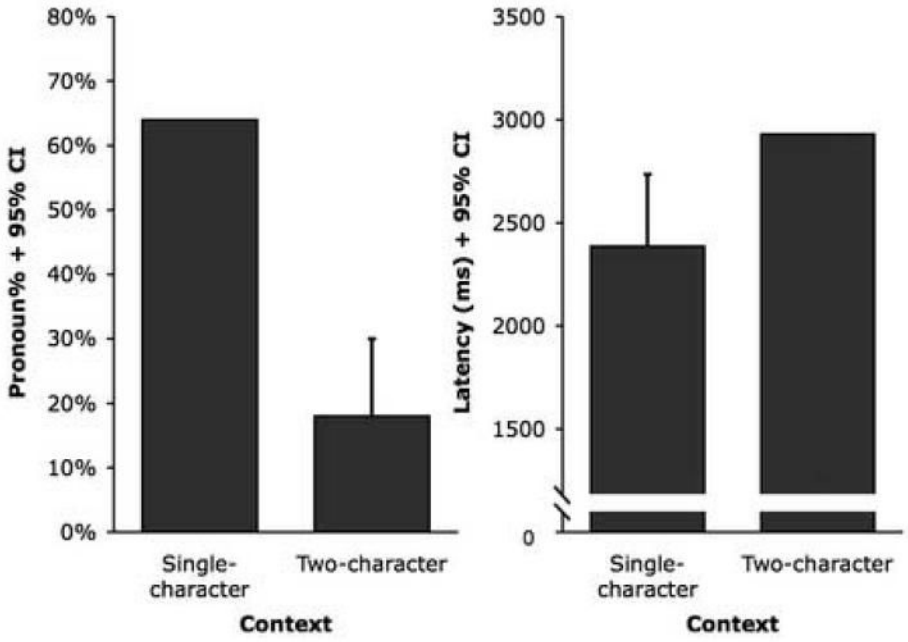


**Figure 3.**
For Experiment 1, mean percentage of pronouns and mean latencies for references collapsing over expression. Bars represent 95% confidence intervals around the differences between the means, calculated from the participants' analysis.

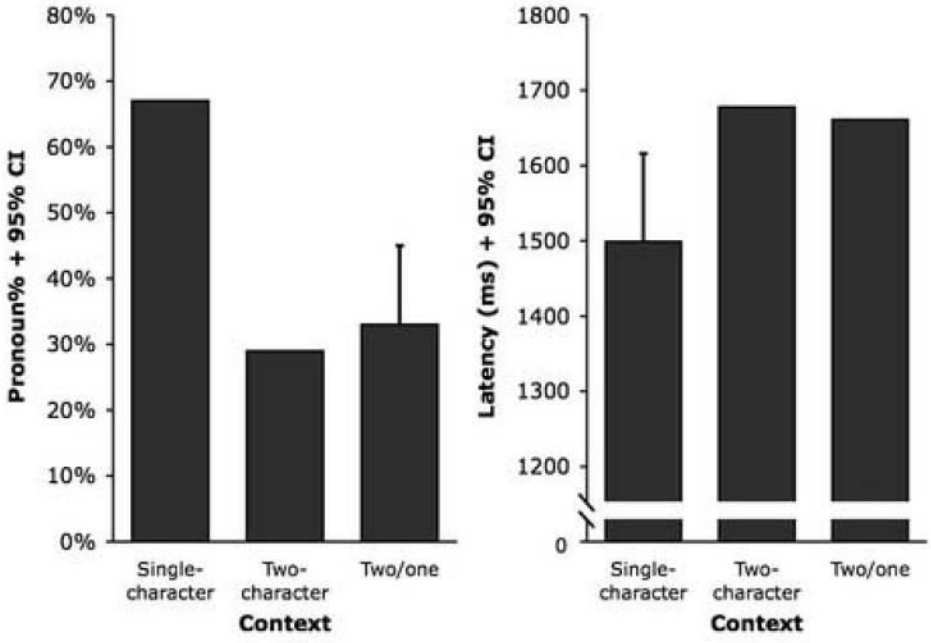


**Figure 4.**

For Experiment 2, mean percentage of pronouns and mean latencies for references collapsing over expression. Bars represent 95% confidence intervals around the differences between the means, calculated from the participants' analysis.

## Table 1

Example sentences from the pilot experiment.

| Order | Gender | Example Sentence |
|---|---|---|
| First | Same | Mickey went for a walk with Donald in the hills one day. |
| First | Different | Mickey went for a walk with Daisy in the hills one day. |
| Second | Same | Donald went for a walk with Mickey in the hills one day. |
| Second | Different | Daisy went for a walk with Mickey in the hills one day. |
| -- | Single character | One day, Minnie imagined how great it would be to have a flower garden. |

**Table 2**

Inferential statistics for Experiments 1 and 2. Effects that did not reach statistical significance are marked *ns*.

| **Dependent measure** | $df_1$ | $F_1$ | $df_2$ | $F_2$ | $df_{minF'}$ | *minF'* | ***CI* half width** |
|---|---|---|---|---|---|---|---|
| Experiment 1 Context effect | | | | | | | |
| Pronoun % | 1,22 | 30.36 | 1,14 | 54.31 | 1,36 | 19.47 | 12% |
| Latencies | 1,22 | 5.25 | 1,14 | 3.04 $^{ns}$ | 1,36 | 1.93 $^{ns}$ | 348 ms |
| Experiment 2 Context effect | | | | | | | |
| Pronoun % (All blocks) | 2,44 | 37.09 | 2,28 | 76.26 | 2,71 | 24.95 | 12% |
| Pronoun % (Block 1) | 2,44 | 23.06 | 2,28 | 25.00 | 2,70 | 11.99 | 9% |
| Latencies (All blocks) | 2,44 | 8.69 | 2,28 | 3.40 | 2,60 | 2.44 $^{ns}$ | 117 ms |

**Table 3**

Inferential statistics for additional analyses of pronoun use in Experiment 2.

| Factor | $df_1$ | $F_1$ | $df2$ | $F_2$ | $df_{minF'}$ | $minF'$ | *CI* half width |
|---|---|---|---|---|---|---|---|
| Continuations | | | | | | | |
| Continuation | 1,12[1] | 9.18 | 1,14 | 85.37 | 1,15 | 8.29 | 12% |
| Disfluency | | | | | | | |
| Disfluency | 1,21[2] | 5.41 | 1,14 | 4.68 | 1,33 | 2.49 $^{ns}$ | 8% |
| Tense used | | | | | | | |
| Tense | 1,21 | 14.86 | 1,14 | 264 | 1,23 | 14.07 | 19% |
| Context | 2,42 | 47.54 | 2,28 | 57.67 | 2,69 | 26.06 | 6% |
| Tense x Context | 2,42 | 7.03 | 2,28 | 27.98 | 2,60 | 5.62 | |

[1] Data from 10 participants omitted due to empty cells.

[2] Data from 1 participant omitted due to empty cell.