METAPHOR AND SYMBOL, *22*(2), 169–193

When *the Creampuff* Beat the Boxer: Working Memory, Cost, and Function in Reading Metaphoric Reference

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Following Almor's (1999) cost–function analysis of referential processing, we hypothesized that reading times of metaphoric anaphors are affected by readers' working memory ability and reflect a balance between discourse function and processing cost. The results from 2 self-paced reading experiments supported this hypothesis. Low-span participants always read sentences with metaphoric anaphors slower than sentences with literal anaphors. In contrast, high-span participants did not take longer to read sentences with metaphoric anaphors than those with literal anaphors when the preceding context activated enough information to facilitate reference resolution. However, when the context activated so much information that the metaphor's function was obviated, high-span readers suffered and again read sentences with metaphoric anaphors more slowly than sentences with literal anaphors. These results show that, as with other types of anaphors, processing metaphoric anaphors is affected by working memory performance, and that the balance between processing cost and discourse function varies with working memory ability.

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Most instances of language use involve multiple utterances or sentences that are related to one another and pertain to a shared topic. Repeated reference is one of the main linguistic mechanisms used for maintaining a coherent relation between successive utterances and sentences (Clark & Lucy, 1975; Gordon, Grosz, & Gilliom, 1993; Kintsch & van Dijk, 1978; van Dijk & Kintsch, 1983; Vonk, Hustinx, & Simons, 1992). Although in many cases repeated reference is realized by a pronoun or a repeated name, it can also be realized by a nonrepetitive definite anaphor, which may be used to achieve certain discourse functions such as adding or emphasizing some information (Almor, 1999; Vonk, Hustinx, & Simons, 1992). One important type of definite anaphors is metaphoric anaphors, which can emphatically express a speaker's or writer's attitude toward the referent. For example, in the following fragment (from Gibbs, 1990) the metaphoric expression "*the creampuff*" is used as an anaphor to convey Stu's friend's negative opinion of the boxer's aptitude:

Stu went to see the Saturday night fights.
There was one boxer that Stu hated.
This guy always lost.
Just as the match was supposed to start, Stu went to get some snacks.
He stood in line for 10 minutes.
When he returned, the bout had been canceled.
"What happened?" Stu asked a friend.
The friend replied, "*The creampuff* didn't even show up."

The successful comprehension of the metaphoric anaphor "*the creampuff*" depends on readers' ability to make the inference that it refers to the boxer and making this inference is likely to require some effort (Onishi & Murphy, 1993). This paper presents evidence that, similar to other kinds of anaphors, the processing of metaphoric anaphors reflects a balance between the effort associated with their initial processing (e.g., making the inference that "*the creampuff*" refers to the boxer) and the discourse function that they serve (e.g., emphasizing that Stu's friend considers the boxer too soft to fight). A crucial aspect of our argument is that the balance between processing effort (cost) and discourse function varies from one individual to another as a function of working memory ability.

The effort associated with the initial processing of a metaphor can be reduced by helpful contextual cues (for example that Stu's friend thought that the boxer was soft; Noveck, Bianco, & Castry, 2001). At the same time, providing too much contextual information (for example, a previous mention that Stu's friend thought that the boxer was as soft as a creampuff) might make a metaphoric anaphor redundant and therefore compromise its discourse function. Readers with high working memory performance are better able to use contextual cues to facilitate subsequent inferential processing (Daneman & Carpenter, 1983; Estevez & Calvo, 2000;

Linderholm, 2002). From a cost–function balance perspective, this means that contextual information that provides enough information to facilitate subsequent inferences may benefit high-span readers more than low-span readers, but contexts that provide too much unnecessary information may also impede high working memory readers more than low working memory readers. For example, high working memory readers are likely to process the metaphoric anaphor "*the creampuff*" more easily following a mention that Stu's friend thought that the boxer was "soft" than they would without this context. They may however face difficulty processing the same metaphoric anaphor following a mention that Stu's friend's thought that the boxer was a creampuff, which would render the metaphoric anaphor redundant and unnecessarily repetitious. Low-span readers, on the other hand, may neither be helped by added context nor hindered by an overly repetitious metaphorical reference; these readers may always experience more processing difficulty with metaphoric than literal anaphors. We next review some of the relevant previous research and then describe our view and its predictions in detail.

Metaphoric statements are often described as having three parts: topic, vehicle, and ground (Richards, 1936, cited in Hoffman & Honeck, 1980). The topic is the subject, the vehicle is the metaphoric description of the subject, and the ground is the characteristics shared by the topic and vehicle that provide the basis for the metaphor. For example, in the statement "*This boxer is a creampuff*," the topic is boxer, the vehicle is creampuff, and the ground would be something like "this boxer is soft and not tough enough."

Although considerable research has focused on the use of predicative metaphor statements such as "*this boxer is a creampuff*," only a small number of studies have specifically examined the use of metaphoric expressions as anaphors, as in the previous example from Gibbs (1990). Indeed, Gibbs's (1990) study was one of the few to examine metaphor processing in referential contexts. Gibbs found that even though metaphoric anaphors, like literal anaphors, do facilitate the recognition of their antecedents, sentences with metaphoric anaphors are read slower than sentences with equivalent literal anaphors ("*The creampuff didn't even show up*." vs. "*The fighter didn't even show up*.") The reading time difference between sentences with metaphoric and literal anaphors was interpreted as showing that referential contexts somehow constrain metaphor processing to follow an initial literal processing.

In a follow-up study, Onishi and Murphy (1993) replicated these results, using items constructed to make the use of metaphors more plausible than in Gibbs's items. They too found that sentences with metaphoric references took longer to read than equivalent sentences with literal references. However, they found that when they changed the target sentences in the narratives into topic–vehicle statements (e.g., "*John said that this fighter is a creampuff*"), the metaphors were read as quickly as literal statements. Onishi and Murphy concluded that metaphors are more difficult to comprehend than literal expressions in referential contexts, but

not when topic and vehicle are explicitly stated in the same sentence. They attributed this difference to the presuppositional inferences required to successfully process the two kinds of statements. Whereas reading a metaphor in a topic–vehicle statement only requires that the ground be inferred, a vehicle-only referential context also demands that the topic be inferred before the metaphor can be understood. According to this view, there is nothing special about metaphors in referential contexts; they are simply more costly to process due to the inferencing required.

Support for this view was furnished by Lemaire and Bianco (2003) who successfully reduced the reading times of metaphoric anaphors by manipulating context to facilitate the use of an anaphoric reference. For example, in one of their items, mentioning the words *cultured*, *ingenuity*, *knowledge*, *professor*, in a discourse about an explorative child reduced the difference in reading times between a metaphoric anaphor (*"the scientist"*) and a literal one (*the boy*). This finding thus supports the role of inferences in the processing cost of metaphors.

We view the matching between a referential expression and its referent as a feature matching process wherein the semantic features associated with the representation of the referential expression are matched with those of potential referents in an order that is determined by the relative salience of these referents in the discourse (Ariel, 1990; Gordon, Grosz, & Gilliom, 1993; Gordon & Hendrick, 1998; Gundel, Hedberg, & Zacharski, 1993). Because metaphoric anaphors typically share fewer semantic features with the referent than literal anaphors, we agree with Onishi and Murphy (1993) that metaphoric anaphors typically involve a more effortful matching process than literal anaphors, resulting in increased initial processing cost. However, the salience of the referent should also affect processing cost of metaphoric anaphors, because the matching between a referential expression and a referent is easier when the referent is salient than when it is not. References to salient referents may initially be less costly to process than references to nonsalient referents.

We further contrast Onishi and Murphy's (1993) emphasis on the initial effort involved in processing metaphoric anaphors with our own view, which states that, similar to other kinds of anaphors, the overall difficulty of comprehending metaphoric anaphors, which is indicated by overall reading times, reflects a balance between this initial effort and discourse function, and that this balance crucially depends on working memory and can shift as a function of working memory ability. We next discuss the balance between processing cost and discourse function in metaphoric anaphors and then address the role of working memory in this balance.

Our view is couched in the theoretical framework of the Information Load Hypothesis (Almor, 1999, 2000, 2004), which states that when the cost associated with identifying the referent or processing the information conveyed by an anaphor serves no additional discourse function, overall comprehension time increases. However, when a referential expression does serve a discourse function, its initial

processing cost can be offset by later processing advantages reflected in overall processing time. In support of this argument, Almor (1999) showed that sentence fragments with repetitive noun phrase anaphors (e.g., "The bird seemed very satisfied") are read slower when their antecedent is focused (e.g., following the sentence "It was the bird that ate the fruit") than when it is not (e.g., following the sentence "What the bird ate was the fruit"), arguably because the information in the repetitive anaphors only serves a discourse function when the antecedent is not focused and has to be reactivated. In contrast, sentence fragments with noun phrase anaphors that are more specific than their antecedent (e.g., "The robin seemed very satisfied") are read faster when their antecedent is focused (e.g., following the sentence "It was the bird that ate the fruit") than when it is not (e.g., following the sentence "What the bird ate was the fruit"), presumably because they add new information, rendering them functional regardless of focus.

We consider the function of any anaphor to be both identifying the referent and adding or emphasizing information. In the specific case of metaphoric anaphors, this information typically pertains to the attitude of the speaker or writer toward the referent. For example, referring to a boxer as a creampuff adds the speaker's opinion that the boxer is not tough enough to fight. We thus predict that the reading times of sentences with metaphoric anaphors would be affected not only by the initial processing effort associated with inferring the topic and ground but also by the balance between this effort and the discourse function of the anaphors. Thus, in our view, metaphoric anaphors may indeed be costly to process because they require the topic and ground to be inferred, but this cost will slow overall reading times less if the metaphoric anaphor adds or emphasizes information than if it does not.

As explained earlier, working memory performance plays a crucial role in determining the balance between cost and function for a given reader. Contextual information that provides enough information to facilitate subsequent inferences may benefit high working memory readers more than low working memory readers, but contexts that provide too much redundant information may also impede high working memory readers more than low working memory readers.

Although no previous studies have examined working memory differences in processing metaphoric anaphors under a cost–function balance framework, the results from several previous studies are compatible with our claims. Some support for the idea that initial processing effort could be differentiated from overall reading times comes from a study by Budiu and Anderson (2002), which found that, although reading times for metaphoric anaphors were longer than for literal anaphors, reading times for the entire sentence did not significantly differ. If the cost–function balance view is correct, this could reflect the difficulty of the inferences required for processing their stimuli, so that the benefits were not "worth" deriving and readers did not fully process the meaning of these sentences. This interpretation is supported by Budiu and Anderson's finding of a comprehension deficit in the metaphor condition.

Noveck, Bianco, and Castry (2001) also explore a cost–function hypothesis for metaphor processing, but the benefits they test for are higher rates of correct answers to comprehension questions. In their view, the discourse function of metaphors increases the reader's understanding of the discourse. Although we agree with this consequence, Almor's (1999) experiments show that this facilitated discourse integration can, in fact, reduce overall reading times. We thus include Noveck, Bianco, and Castry's work in the category of cost-only views because they do not expect benefits to manifest in the form of faster processing. Also, as pointed out by Gibbs and Tendahl (2006), the inherent difficulty in quantifying cost and function makes the results obtained by Noveck, Bianco, and Castry difficult to interpret because there are multiple ways to construe the cost and function of metaphoric statements. In this study, we bypass this problem by focusing on the difference between readers with low and high working memory for whom, as we explained earlier, the point of balance between cost and function is different, independently of how cost and function are quantified. We, however, discuss Noveck, Bianco, & Castry's results more fully in the general discussion.

There has been surprisingly little research on the role of working memory in metaphor processing, and to the best of our knowledge, no research on the role of working memory in processing metaphoric anaphors. One study that did examine the role of working memory in the processing of predicative metaphoric statements is Kazmerski, Blasko, & Dessalegn (2003) who found that high IQ and better working memory performance were associated with increased ability to process metaphoric meaning. The results of this study can be interpreted as supporting the role of working memory in determining the effort associated with processing metaphors, thus validating our interest in working memory differences, but they do not bear on whether working memory also affects the balance between cost and function.

Thus, although some research looked at the role of working memory in metaphor processing (e.g., Kazmerski, Blasko, & Dessalegn, 2003) and other research examined the balance between processing cost and discourse function of metaphoric anaphors (e.g., Noveck, Bianco, & Castry, 2001), there has been no research on the role of working memory performance in this balance. We therefore aimed to test the role of working memory in processing anaphoric anaphors within a cost–function balance framework. Onishi and Murphy's (1993) claim that metaphoric anaphor processing is slowed because of the effort associated with making inferences means that, if the context contains facilitative information, readers with good working memory performance may not be as slowed as readers with poor working memory when reading metaphoric anaphors. However, based on the cost–function balance view, we further predict that if the referent is salient in the discourse and the function served by the metaphoric anaphor is completely subserved by prior context, high working memory readers may show slower overall reading times than if the metaphor does add or reactivate information.

Examining the role of working memory can provide crucial evidence for or against the cost–function balance view. Rather than making tenuous assumptions about how to quantify cost and function, we manipulated the availability of contextual information and examined reading times of readers with high and low working memory performance. In both experiments reported here, the context provided sufficient information to facilitate the processing of a subsequent metaphoric anaphor. Both experiments also included a reinstantiation manipulation, which assessed the importance of maintaining the pertinent contextual information active in memory. However, in Experiment 1, the target referent was not the most salient referent in the discourse, thus making subsequent reference more difficult to resolve, and therefore justifying higher processing cost. This experiment specifically tested whether context that reduces the effort associated with making inferences affects processing cost differently in readers with low and high memory performance. As such, this experiment aimed to provide support for the role of processing cost and working memory in comprehending metaphoric anaphors. In Experiment 2, the target referent was the most salient referent in the discourse, thus making subsequent anaphoric reference to it easier to resolve, and therefore justifying less cost. This experiment specifically aimed to elicit a decrement in reading metaphoric anaphors in readers with high working memory when too much information was reactivated, and thus provide direct support to the cost–function balance view.

EXPERIMENT 1

Experiment 1 compared reading times in high-span and low-span readers as they read sentences with literal and metaphoric anaphors in discourse contexts that either did (the "reinstantiated" condition) or did not (the "not reinstantiated" condition) repeatedly reinstantiate the ground connecting the topic and vehicle. As in Onishi and Murphy's (1993) study, the target referent was not the most salient discourse referent in our stimulus paragraphs but instead appeared in a quote made by a character in the paragraph. We predicted a difference in reading times between high-span and low-span readers. The explicit mention of topic and vehicle and reiteration of the ground in the reinstantiated condition should reduce the effort associated with inferring the topic for high-span readers. Because the target referent was not the most salient entity in the discourse the reinstantiation of the ground information was only expected to reduce the processing cost of the subsequent metaphoric anaphor without compromising its function. We thus expected high-span readers to show a reduced difference between reading times in the metaphoric and literal conditions when the ground information was reinstantiated than when it was not. In contrast, we expected that low-span readers, who are less able to exploit previous discourse, would show slower reading times in the metaphoric condition

than in the literal condition regardless of whether the ground information was reinstantiated.

To guarantee the successful and complete instantiation of the metaphor, items in all conditions also explicitly stated the topic and vehicle early in the paragraph. For example, in Gibbs's sample item, this would amount to stating that "*the fighter was as soft as a creampuff*."

The experiment had a 2 × 2 × 2 design with factors Memory Span (High vs. Low), Context (metaphor reinstantiated vs. metaphor not reinstantiated), and Anaphor Type (literal vs. metaphor). Table 1 shows a sample item in all conditions.

We used a whole-sentence, self-paced reading task both because we wanted our results to be comparable to previous studies that used this task (Gibbs, 1990; Onishi & Murphy, 1993) and because, unlike word-by-word, self-paced reading tasks, whole-sentence reading times have been shown to provide a good measure of the integrative processes that are of interest here and that readers may defer to the end of sentences (Almor, 1999; Gordon, Grosz, & Gilliom, 1993; Nair & Almor, 2006).

METHOD

Participants

Fifty-eight University of South Carolina undergraduate students participated for course credit. All participants were native speakers of English and signed an informed consent prior to participation.

Materials and Design

Twenty story passages were used, each containing a dialogue between two characters. The sixth, or target, sentences were mostly adapted from the target sentences used by Onishi and Murphy (1993, Appendix A) in their Experiments 1 and 2; one entire item was adapted from the Onishi and Murphy sample item (p. 765), and another adapted from the Gibbs (1990, p. 59) sample item. Table 1 shows a sample item in all conditions.

All stories consisted of seven sentences followed by a comprehension question. The stories introduced a context in the first two sentences. The third sentence linked the metaphoric and literal expressions in a topic–vehicle sentence. Following Onishi and Murphy (1993), the thought expressed by the metaphor was always attributed to one of the characters in the story, either as a direct quote or a statement of belief. The fourth and fifth sentences varied by condition. In the reinstantiated condition, these sentences reinstated the metaphor without mentioning the metaphoric term, but using words that would prime the metaphoric term as well as pro-

TABLE 1
Sample Item All Conditions of Experiment 1

Sentence #	*Reinstantiated*	*Not Reinstantiated*
Literal conditions		
1	Joe and Tracey went to see the Saturday night fights.	Joe and Tracey went to see the Saturday night fights.
2	They hated one of the guys who was scheduled to be in the first match.	They hated one of the guys who was scheduled to be in the first match.
3	They liked to say that this fighter was as soft as a creampuff.	They liked to say that this fighter was as soft as a creampuff.
4	Joe went to get some snacks before the match started, but when he returned, the fat boxer wasn't in the ring.	Joe went to get some snacks before the match started, but when he returned, the lousy boxer wasn't in the ring.
5	"What happened to that wimpy ball of dough since I left?" Joe asked Tracey.	"What happened to that pathetic loser while I was in line?" Joe asked Tracey.
6	"*The fighter* didn't even show up," Tracey replied.	"*The fighter* didn't even show up," Tracey replied.
7	"We should have known," said Joe. "It would have been better to stay home and watch television instead."	"We should have known," said Joe. "It would have been better to stay home and watch television instead."
Metaphor conditions		
1	Joe and Tracey went to see the Saturday night fights.	Joe and Tracey went to see the Saturday night fights.
2	They hated one of the guys who was scheduled to be in the first match.	They hated one of the guys who was scheduled to be in the first match.
3	They liked to say that this fighter was as soft as a creampuff.	They liked to say that this fighter was as soft as a creampuff.
4	Joe went to get some snacks before the match started, but when he returned, the fat boxer wasn't in the ring.	Joe went to get some snacks before the match started, but when he returned, the lousy boxer wasn't in the ring.
5	"What happened to that wimpy ball of dough since I left?" Joe asked Tracey.	"What happened to that pathetic loser while I was in line?" Joe asked Tracey.
6	"*The creampuff* didn't even show up," Tracey replied.	"*The creampuff* didn't even show up," Tracey replied.
7	"We should have known," said Joe. "It would have been better to stay home and watch television instead."	"We should have known," said Joe. "It would have been better to stay home and watch television instead."

vide context for the connection of vehicle to topic. In the reinstantiated condition of the sample story in Table 1, Joe uses the expression "*wimpy ball of dough*" to recall the boxer's flabby physique. In the not reinstantiated condition, the fourth and fifth sentences mentioned instead properties of the referent that were related to the same general idea instantiated by the metaphor but with terms that were unrelated to the metaphor itself. In the not reinstantiated version of the sample in Table 1, Joe refers to the boxer as "pathetic loser." The sixth sentence was the target. In the metaphoric condition, the protagonist uses the metaphoric expression for reference and in the literal condition the protagonist uses the literal expression.

Each item ended with a yes/no comprehension question. For half of the items, this question directly probed the information attributed to the target referent (e.g., for an item in which a bad surgeon was metaphorically referred to as a butcher the question was "Did Sandra believe the surgeon had a good reputation?"). For the other half of the items the question required an inference about other information in the narrative (e.g., for the sample item in Table 1 the question was "Did Joe get some snacks after he found out the boxer hadn't shown up?") These questions ensured that participants were reading and comprehending the target texts and also that participants likely interpreted the metaphoric as well as literal references anaphorically. In none of the experiments reported here were there any differences in comprehension accuracy between the conditions for either low or high working memory readers, indicating that all participants likely interpreted both the metaphoric and literal references anaphorically, as we intended. The details of these analyses are not included here for space considerations but can be obtained from the authors.

Although most of our literal and metaphoric expressions were taken from Onishi and Murphy (1993), who selected these expressions to be of approximately the same length and frequency, we wanted to ensure that our modifications did not result in frequency differences between the metaphor and literal words. We therefore compared the Francis and Kucera (Francis, Kucera, & Mackie, 1982) word frequencies of our literal (mean FK frequency = 9) and metaphoric expressions (mean FK frequency = 8.5) and found no difference between the two sets of words, $t(19) = .05$, $p < 1$.

To make sure the different conditions did not vary in how much sense they made, we ran a prestudy in which undergraduate students from the University of South Carolina participant pool rated the sensibility of the stories we used in Experiment 1 in exchange for class credit. None of the raters participated in any of the other studies described in this paper. Participants were instructed to read the stories and rate them on a scale from 1 to 7 according to how sensible they found them. They were told that there were no right or wrong answers, and they should use their best judgment as to how much the stories "make sense" or are "coherent." Each participant rated each item in only one condition. Testing was conducted over the Web after participants read and agreed to an online informed consent. Each

participant rated each of the items, and the assignment of participants to item version was quasi-random such that each participant rated several items in each condition and across every set of four participants each item was rated in all versions. Participants were asked to specify the first language they spoke at home and responses from participants who indicated a language other than English were not included in the analysis. The data from the remaining 330 participants were analyzed with a 2 × 2 ANOVA with factors Reinstantiation (No vs. Yes) and Reference (Literal vs. Metaphor) once with participants as the random factor and once with items as the random factor. These analyses did not find a significant effect of Reinstantiation, $F_1, F_2 < 1$, Reference, $F_1 < 1$, $F_2(1, 19) = 1.55$, $MSe = .003$, $p < .23$, or the interaction of the two factors, $F_1 < 1$, $F_2(1, 19) = 2.27$, $MSe = .004$, $p < .16$. This indicated that the different conditions in this experiment did not vary in how much sense they made. Together with the lack of differences between the different conditions in comprehension question accuracy, the similar sensibility ratings of the items in the different conditions show that the anaphoric references were likely read and understood anaphorically in all conditions.

Twenty filler passages and four practice passages were also created, which contained metaphors but did not reinstate them. Each filler story was followed by a yes/no comprehension question to ensure that participants were reading the stories for comprehension. The correct response to half of the questions was "yes" and to half of the questions "no." The data from participants who failed to answer 80% or more of the questions correctly were excluded from further analyses.

Procedure

Reading task. Participants read the stories one sentence at a time on a computer screen. The stories and comprehension questions were presented on a Windows-based computer using the E-prime experiment administration software (Schneider, Eschman, & Zuccolotto, 2002). Participants pressed the space bar to advance from one sentence to the next, and used the "Y" and "N" keys to answer the comprehension questions. Each story began with the instruction: "PRESS THE SPACE BAR TO READ THE NEXT PARAGRAPH," and the next sentence appeared immediately after each space bar press. Reading times were recorded from one space bar press to the next. At the end of each paragraph participants saw a comprehension question with the instruction "PRESS 'Y' FOR YES AND 'N' FOR NO" presented underneath. Answer accuracy was recorded.

Participants were told that reading times were being recorded, and that they should read at a normal pace, but also understand each sentence before advancing to the next one. They were given four practice passages before beginning the test items.

Working Memory task. We used the digit-ordering task (MacDonald, Almor, Henderson, Kempler, & Andersen, 2001) to assess verbal working mem-

ory. This task is relatively simple for experimenters to administer and for participants to perform, but has been shown to correlate well with verbal working memory tasks such as reading and listening span that are more complicated to administer and perform (MacDonald, Almor, Henderson, Kempler, & Andersen, 2001). In this task, participants hear a list of digits presented to them out of order and are asked to repeat the digits in order. In each trial an E-prime script randomly selected a set of digits previously recorded by a male native speaker of English and played them to the participant. The participant then entered their response using the keyboard. For example, a participant may hear the digits: 8, 3, 5, 1, 4, 3, and would have to respond: 1, 3, 3, 4, 5, 8.

The same digit sometimes appeared more than once in a trial to discourage participants from adopting a strategy of only remembering digits that were not said. The experimenter also covered the keyboard during the trial to discourage participants from using the keyboard as a visual aid to remember the digits. Testing consisted of six blocks, each block consisting of five trials all with the same number of digits. The first block had three-digit trials, and the number of digits per trial used in each subsequent block was based on performance in the previous block. If the participant responded correctly to four or more of the trials in the previous block, the number of digits was increased by one. If the participant responded correctly to one or less of the trials on the previous block the number of digits was decreased by one. If the participant responded correctly to two or three trials in the previous block, the number of digits remained the same. At the end of this task, each participant was assigned a digit ordering span (DOS) by identifying the highest level at which the participant was able to respond correctly to two or more trials. If the participant responded correctly to four or more of the trials at that level, their DOS was the number of digits used at that level plus .5. If they responded correctly to only two or three trials at that level, they were assigned a DOS equal to that level.

RESULTS AND DISCUSSION

The data from four participants were removed because their accuracy in answering the comprehension questions fell below the 80% criterion. The remaining 54 participants were divided to a Low-Span group (DOS ≤ 7.5), $N = 27$, and a High-Span group (DOS ≥ 8), $N = 27$. In addition, response times shorter than 500 msec or longer than 7,500 msec were removed, affecting 2.2% of the data. Figure 1 shows mean reading times for the critical sentence in the different conditions, separately for the Low-Span and High-Span groups. To assess the possibility that processing the critical sentence continued during the reading of the following sentence, the reading times of Sentence 7 were also examined, but because they showed no significant difference between the conditions in either this experiment or in Experiment 2, they are not shown or discussed further.

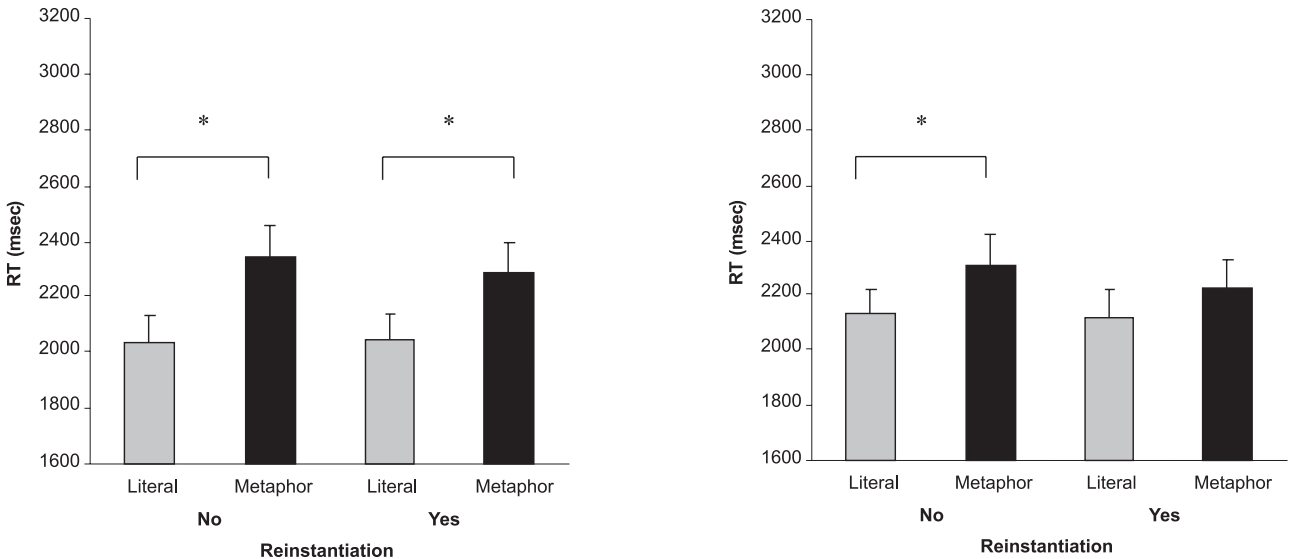

FIGURE 1 Experiment 1 critical sentence (Sentence 6) self-paced reading times: (a) Low-span participants; (b) High-span participants. Error bars show standard errors.

Reading times of the critical sentence were initially analyzed by an omnibus 2 × 2 × 2 ANOVA with factors Span (Low vs. High), Reinstantiation (No vs. Yes), and Reference (Literal vs. Metaphor), once with participants as a random factor (a mixed design with Span as a between-participants factor, and Reinstantiation and Reference as within-participant factors), and once with items as a random factor (a repeated measures design). This analysis found a main effect of Reference with sentences with literal anaphors read overall 209 msec faster than sentences with metaphoric anaphors, $F_1(1, 52) = 23.49$, $MSe = 99950$, $p < .001$, $F_2(1, 19) = 6.23$, $MSe = 164651$, $p < .02$. This analysis did not find any other significant main or interaction effects, all Fs < 1 except for the interaction of Span and Reference, $F_1(1, 52) = 2.28$, $p < .14$, $F_2 < 1$.

In addition to the omnibus analysis, a set of planned comparisons was conducted to specifically examine the reading time differences of sentences with literal and metaphoric anaphors in the different conditions by readers with different spans. The statistically significant differences found in these comparisons are marked on Figure 1.

The low-span readers were significantly slower to read sentences with metaphoric anaphors than sentences with literal anaphors in both the reinstantiated condition (albeit not in the items analysis), $F_1(1, 26) = 6.86$, $p < .02$, $F_2(1, 19) = 1.63$, $p < .22$, and the not reinstantiated condition, $F_1(1, 26) = 8.94$, $p < .007$, $F_2(1, 19) = 5.04$, $p < .04$.

The high-span readers showed no significant difference in reading times of sentences with literal and metaphor anaphors in the reinstantiated condition, $F_1(1, 26) = 1.70$, $p < .21$, $F_2(1, 19) = 1.70$, $p < .20$, but they were slower to read sentences with metaphoric anaphors than sentences with literal anaphors in the not reinstantiated condition (albeit not in the items analysis), $F_1(1, 26) = 6.32$, $p < .02$, $F_2(1, 19) = 2.11$, $p < .16$.

Thus, the reinstantiation of the metaphor eliminated the difference between the literal and metaphoric conditions for the high-span readers but not for the low-span readers. The fact that the items analyses did not reveal a significant difference in the not reinstantiated condition for the high-span readers and in the reinstantiated condition for the low-span readers may indicate that the items in this study varied in how effectively they activated the ground information. For the high-span readers, this mattered most when there was no reinstantiation because only in this condition were these readers challenged to maintain the ground information in working memory to the point where the differences between the items became important. For the low-span readers, this mattered most when there was reinstantiation because only in this condition were they able to exploit the ground information for processing the anaphoric reference (but only for some items).

Overall, the results of this experiment support the role of working memory in determining the cost of processing anaphoric metaphors. As predicted, readers

with high working-memory performance but not readers with low working-memory performance were able to take advantage of the reinstantiation of the contextual information and thus process metaphoric statements as quickly as literal ones. This shows that for the high working-memory readers, reinstantiating the ground information had a cost-reducing effect.

EXPERIMENT 2

In Experiment 1, there was no indication that high-span readers considered the context to provide so much information that it obviated the function of the metaphor. This likely reflects the fact that, in Experiment 1, the referent of the anaphor was not the most salient referent in the discourse. In studies of referential processing, slowed reading associated with redundant information is typically observed only when the antecedent is highly salient in the discourse context (Almor, 1999; Gordon, Grosz, & Gilliom, 1993). Experiment 1, however, followed Onishi and Murphy's (1993) item design, in which the target referent was always introduced and maintained as part of what one protagonist was saying to a second protagonist. This reduced the discourse salience of the referent, thus making slowed reading associated with violations of cost–function balance unlikely to occur (Almor, 1999).

When the referent is not salient, the use of an anaphor with a high cost may be better justified than when the referent is salient because the additional cost may help in identifying and reactivating the referent. In support of this notion, Almor (1999) showed that repeated definite description anaphors are read faster when their antecedent is unfocused by the previous discourse than when their antecedent is focused. For example, Almor (1999) showed that the sentence "The bird seemed very satisfied" was read *slower* following the sentence "It was the bird that ate the fruit," which focuses "the bird," than following the sentence "What the bird ate was the fruit," which focuses "the fruit" instead.

Experiment 2, therefore, investigated the processing of metaphoric anaphors to salient discourse referents. To this end, Experiment 2 used modified versions of the items from Experiment 1 in which the referent was not introduced as part of a dialogue between two protagonists but was repeatedly referred to by a pronoun appearing in the subject position of the two sentences preceding the target sentence. The elimination of the dialogue context of Experiment 1 was intended to reduce the number of referents in the discourse and extract the target referent from within the embedded conversation context. The repeated pronominal reference to the target referent in the two sentences preceding the target sentence further increased the salience of the target referent, clearly establishing it as the most salient referent in the discourse (Gordon, Grosz, & Gilliom, 1993). As in Experiment 1, all conditions explicitly mentioned the vehicle and the topic, and context was manipulated by either reinstantiating the ground or not. Table 2 shows a sample item in all con-

ditions. As in the previous experiment, we predicted that the mention of topic and vehicle and reiteration of the ground in the reinstantiated condition should reduce the effort associated with inferring the topic for high-span readers. However, in this experiment, due to the increased salience of the target referent, we predicted that for the high-span readers, the repetitive discourse context might eliminate altogether the discourse function of the metaphor, causing the high-span readers to take longer to read the target sentence in the metaphor condition. Again, as in the previous experiment, we predicted that low-span readers would not show a context benefit and may therefore again show slower reading times for metaphoric than for literal statements in all context conditions.

TABLE 2
Sample Item All Conditions of Experiment 2

Sentence #	*Reinstantiated*	*Not Reinstantiated*
Literal conditions		
1	Joe went to the Saturday night fights.	Joe went to the Saturday night fights.
2	One of the boxers scheduled for the first match had never won a fight.	One of the boxers scheduled for the first match had never won a fight.
3	He was as soft as a creampuff.	He was as soft as a creampuff.
4	He was way too fat and was spongy through the middle.	He was way too clumsy and slow in the ring.
5	He looked like a wimpy ball of dough and seemed destined to lose.	He looked very pathetic and seemed destined to lose.
6	*The boxer* never made it to the second round.	*The boxer* never made it to the second round.
7	Joe was disappointed and went home early.	Joe was disappointed and went home early.
Metaphor conditions		
1	Joe went to the Saturday night fights.	Joe went to the Saturday night fights.
2	One of the boxers scheduled for the first match had never won a fight.	One of the boxers scheduled for the first match had never won a fight.
3	He was as soft as a creampuff.	He was as soft as a creampuff.
4	He was way too fat and was spongy through the middle.	He was way too clumsy and slow in the ring.
5	He looked like a wimpy ball of dough and seemed destined to lose.	He looked very pathetic and seemed destined to lose.
6	*The creampuff* never made it to the second round.	*The creampuff* never made it to the second round.
7	Joe was disappointed and went home early.	Joe was disappointed and went home early.

METHOD

Participants

Fifty-six different native English speaking undergraduates from the University of South Carolina participant pool participated for class credit.

Materials

This experiment used modified versions of the items from Experiment 1. Most importantly, to increase the discourse salience of the topic, it was mentioned in the subject position of the two sentences preceding the critical sentence using a pronoun, and the stories included only one protagonist in addition to the topic. To make sure the metaphoric reference in the target sentence was in a prominent position that could be easily identified as referring to the most salient discourse referent, it appeared in initial subject position and was not a part of a quoted expression or thought produced by the other protagonist. To further ensure that the target referent was the most salient in the discourse context, it was mentioned in the subject position of the two sentences preceding the target sentence and was referred to by a pronoun (Gordon, Grosz, & Gilliom, 1993). Table 2 shows a sample item in all four conditions. Because the changes just described resulted in substantial changes to the items, we ran another sensibility-rating prestudy using the same method as the prestudy for Experiment 1 with 281 new undergraduate participants from the University of South Carolina participant pool who did not take part in any of the other studies reported in this paper. Again, no differences in sensibility rating were found between the different conditions, all Fs < 1.

Procedure

The same procedure was used as the previous experiment.

RESULTS AND DISCUSSION

The data from one participant were removed due to answer accuracy below the 80% criterion. The remaining 55 participants were divided into a Low-Span group (DOS ≤ 7.5), $N = 39$, and a High-Span group (DOS ≥ 8), $N = 16$. In addition, response times shorter than 500 msec or longer than 7,500 msec were removed, affecting 1.4% of the data. Figure 2 shows mean reading times for the critical sentence (Sentence 6) in the different conditions, separately for the Low-Span and High-Span groups.

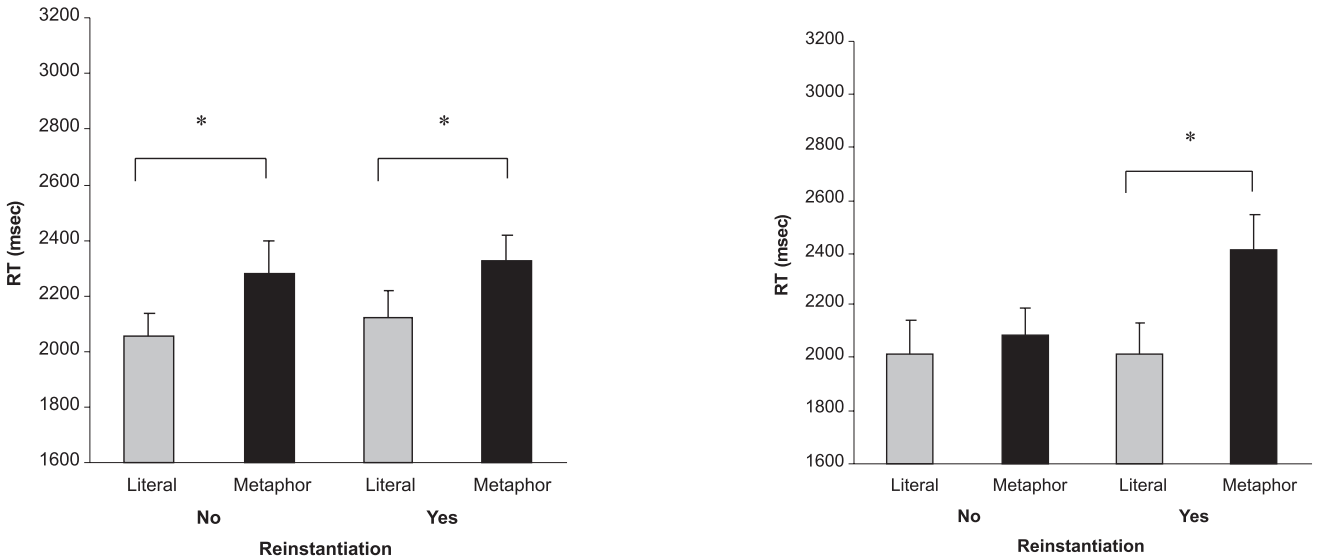

FIGURE 2 Experiment 2 critical sentence (Sentence 6) self-paced reading times: (a) Low-Span participants; (b) High-Span participants. Error bars show standard errors.

As in the previous experiment, reading times of the critical sentence were analyzed by an omnibus 2 × 2 × 2 ANOVA with factors Span (Low vs. High), Reinstantiation (No vs. Yes), and Reference (Literal vs. Metaphor). This analysis found a main effect of Reference with sentences with literal anaphors read overall 226 msec faster than sentences with metaphoric anaphors, $F_1(1, 53) = 17.60$, $MSe = 131{,}563$, $p < .001$, $F_2(1, 19) = 6.52$, $MSe = 236{,}985$, $p < .02$. The effect of Reinstantiation, with sentences in the reinstantiated condition read 109 msec faster than sentences in the no reinstantiation condition, was marginally significant by participants, $F_1(1, 53) = 3.60$, $MSe = 149{,}056$, $p < .07$, but not by items, $F_2(1, 19) = 1.32$, $MSe = 124{,}844$, $p < .27$. No other main or interaction effects were significant, Fs < 1.

As in the previous experiment, a set of planned comparisons was conducted to specifically examine the differences in reading times between sentences with literal and metaphoric anaphors in the different conditions by readers with different spans. The differences that were found to be statistically significant in these comparisons are marked on Figure 2.

The low-span readers were significantly slower to read sentences with metaphoric anaphors than sentences with literal anaphors in both the reinstantiated condition, $F_1(1, 38) = 5.72$, $p < .03$, $F_2(1, 19) = 6.93$, $p < .02$, and the not reinstantiated condition, $F_1(1, 38) = 6.13$, $p < .02$, $F_2(1, 19) = 3.48$, $p < .08$. Thus, in this experiment, too, the low-span readers read the metaphor versions slower than the literal ones regardless of whether the ground information was reinstantiated or not.

The high-span readers showed a significant difference in reading times of sentences with literal and metaphor anaphors in the reinstantiated condition, $F_1(1, 15) = 9.30$, $p < .009$, $F_2(1, 19) = 4.49$, $p < .05$, with sentences with metaphoric anaphors read 395 msec slower than sentences with literal anaphors. In contrast, the 73 msec difference in high-span readers' reading times of sentences with metaphoric and literal anaphors in the not reinstantiated condition was not significant, $F_1, F_2 < 1$. Thus, in this experiment, the high-span readers showed a marked difference between the literal and metaphor versions in the reinstantiated condition but no significant difference in the not reinstantiated condition. For these participants, the reinstantiation of the ground information resulted in slower reading of the metaphoric statements than of the literal statements, compatible with the notion that, in this condition, the information conveyed in the metaphoric expression was redundant and therefore lacking in discourse function.

The difference between the results of this experiment and Experiment 1 likely reflects the fact that in Experiment 1, the referent of the anaphoric expression was not salient enough to perturb the balance between the cost and the function of the metaphoric expression. Overall, the results of this experiment strongly support the role of working memory in the processing of metaphoric anaphors in line with the cost–function balance view but not with the cost-only view.

GENERAL DISCUSSION

Taken together, the results of both experiments show that, as with other kinds of referential processing, working memory performance plays an important role in how readers process metaphoric reference. Overall, these results show that readers with high working memory performance read sentences with metaphoric anaphors most like sentences with literal anaphors when the preceding context provides and activates just enough information to facilitate the initial processing of the metaphor, but not so much as to void the metaphor of any discourse function. In contrast, readers with low working memory performance show little sensitivity to the information provided in the context and to whether it is reactivated prior to reading sentences with metaphoric anaphors. For these readers, no amount of information provided and reactivated in the preceding context eliminates the reading time difference between sentences with metaphoric and literal anaphors. This likely reflects the reduced ability of readers with low working memory performance to use information from the discourse context in the processing of new information.

To the best of our knowledge, our results are novel in showing differences between readers with low and high working memory performance in processing metaphoric anaphors. These results are therefore important in that they highlight the central role that individual differences play in the processing of metaphoric anaphors. Because the digit ordering verbal working memory measure that we used here is not likely to tap aspects of processing that are unique to metaphoric anaphors, the present results show that general working memory performance is important for processing metaphoric anaphors. Our results are compatible with Kazmerski, Blasko, and Dessalegn's (2003) in showing a link between high working memory performance and better ability to process metaphoric meaning. In addition to these general working memory differences, recent research has shown differences in processing figurative language based on age (Noveck, Bianco, & Castry, 2001), gender (Link & Kreuz, 2005), personal and group characteristics (Colston & Katz, 2003), and recent experience (Boroditsky & Ramscar, 2002; Gibbs & Tendahl, 2006). The present research clearly shows that future research on metaphoric anaphors should control and assess working memory performance and possibly other aspects of individual variability before deriving any general conclusions about how readers process metaphoric anaphors.

Our results are consistent with Noveck, Bianco, and Castry's (2001) developmental study, which found that, although children and adults take longer to read metaphoric than literal sentences, the gap in reading times between metaphoric and literal referential sentences decreases with age. Noveck et al. attributed their results to different levels of experience in using metaphoric expressions, and argued that less experience with metaphors makes them more costly to process. The present results suggest that experience may not have been the only factor underlying the age differences in the Noveck et al. study; children's limited computational

resources may have also played a role. In their study, adults further showed a small comprehension benefit for metaphor items over literal items, reflected in higher accuracy in answering comprehension questions. Noveck et al. interpreted these results as demonstrating the potential benefits of metaphors that are shown when the processing cost is not too high, an interpretation that is consistent with our own cost–function balance view.

Our results are also consistent with Kazmerski et al. (2003) findings about the role of IQ and working memory in processing predicative metaphoric statements (e.g., "lawyers are sharks"). In one experiment, Kazmerski et al. found that readers with high IQ had more difficulty than readers with low or medium IQ in suppressing nonliteral meaning, suggesting that nonfigurative meaning can be computed automatically by readers with high mental resources. In a second experiment, high IQ and better working memory performance were associated with better ability to derive detailed information from metaphoric statements. Although these studies did not examine the processing of metaphoric anaphors or manipulate the availability of contextual cues, they nevertheless found, similar to our first experiment, that better mental resources allow readers to process metaphors more easily.

Our results are compatible with those of Noveck et al. (2001) and of Kazmerski et al. (2003), but extend them in two important ways. First, our finding of a bigger gap in metaphoric and literal reading times for high-span participants when the context had already activated the information conveyed by the metaphor shows more directly that it is the balance between cost and function (and not just the initial cost of processing) that affects the overall processing of sentences with metaphoric anaphors. Second, the fact that we observed the effects of cost, function, and the balance between them on reading times, as opposed to question accuracy or latency, shows that the balance between cost and function affects the processing of sentences with metaphoric anaphors and not only the resulting memory representation.

Importantly, these results indicate that the processing of metaphoric anaphors can be explained within a general framework of anaphor processing (Almor, 1999, 2000, 2004). As with other types of anaphors, the processing of metaphoric anaphors can be sensitive to the salience of the referent. When the referent is highly salient, and an anaphor does not serve any discourse function besides identifying the referent, a costly anaphor generally results in slower overall reading than a less costly anaphor (Almor, 1999). However, unlike other kinds of anaphors that cause imbalance between processing cost and discourse function, such as repeated anaphors with salient antecedents, metaphoric anaphors reach this point of imbalance only for readers who have sufficient working memory performance.

Although the present research focused on the processing of metaphoric anaphors, it is important to consider how it fits within the more general research on metaphor processing. This literature has generally argued for one of two opposing

views, which we call here the "three-stage view" and the "one-stage view." According to the three-stage view (Clark & Lucy, 1975; Grice, 1975; Searle, 1979), an utterance is first interpreted literally, and the product of literal interpretation is "verified" and integrated into the discourse representation. Only if this integration fails does the utterance undergo a third stage of processing in which it is interpreted figuratively. In contrast, according to the one-stage view (e.g., Glucksberg & Keysar, 1990), literal and figurative processing occur simultaneously.

Empirical studies based on processing times have yielded mixed results. In support of the one-stage view, some studies that compared predicative metaphoric statements in the form "TOPIC is a VEHICLE" (e.g. "*This boxer is a creampuff*") to literal statements with equivalent meaning (e.g., This boxer is not tough) found comparable reading times for the two kinds of sentences, indicating that metaphoric and literal statements are processed similarly (e.g., Gildea & Glucksberg, 1983). In support of the three-stage view, studies of metaphoric anaphor processing found that metaphoric anaphors take longer to read than comparable literal anaphors, suggesting that sentences containing metaphoric anaphors involve more processing stages than literal anaphors (Gibbs, 1990; Lemaire & Bianco, 2003; Onishi & Murphy, 1993). However, the results we reported here clearly show that under some contextual conditions readers with high working memory performance show no difference between reading sentences with metaphoric and literal anaphors. The results of Kazmerski et al. (2003) similarly show that readers with high IQ or high working memory find metaphor processing relatively easy.

Although Kazmerski et al. interpreted their results as supporting a single stage processing view, we do not believe that our results provide clear-cut support for or against the single-stage view. Finding some contexts in which metaphoric processing is not slower than literal processing, as we did here, provides little information about the number of processing stages involved, because different processing stages may be faster or slower depending on many factors. For example, in a context that (a) facilitates the identification of the referent (as in the experiments reported here), but (b) does not introduce and reactivate too much information so as to obviate the metaphoric anaphor's function, identifying the referent and integrating the metaphoric anaphor into the discourse representation are likely to be easier for readers than in contexts in which either referent identification is difficult or the metaphor's function is obviated. If the three-stage model is correct, a literal anaphor does not require additional processing stages, but if it is costly to process and serves no discourse function it may still take longer to process than a metaphoric anaphor in a well-balanced context. Thus, without an additional and implausible assumption that processing stages have a fixed duration, the present results are compatible with both the three-stage and one-stage views.

We therefore prefer to think about reading time differences between sentences with metaphoric and literal references in terms of different processing costs and

discourse functions rather than the reflection of distinct processing stages with fixed durations. A metaphoric anaphor will be at its easiest to process only when the preceding context strikes the right balance between cost and function, given the reader's specific abilities. On one hand, if reference resolution is not sufficiently facilitated by preceding context either because of lack of information or because the reader does not have enough resources to take advantage of the context, then high cost will cause processing to be less than optimal. On the other hand, if preceding context facilitates reference resolution but gives too much information, the metaphoric anaphor may be redundant, also compromising ultimate optimality.

ACKNOWLEDGMENTS

This work was partially supported by a grant from the University of South Carolina Research and Productive Scholarship Fund.

A preliminary analysis of the results of the first experiment was presented in the 2004 annual meeting of the Psychonomics Society in Minneapolis, MN. The authors wish to acknowledge Melissa Stockstill Jantz, Sam Hardy, Allison Anna Gulick, Dewaker Deepika, Jenika N. Mehta, Jeremy Daniel Melville, Joanna Maria Piasecki, Jon Randall Lowell, Lesya Ariko Lasota, Melissa Ann Robinson, Monica Michaela Johnson, Raquel Hilda Vaca, Raymond August Saut, Robert James Frankenberger, Sara Ann Peters, and Cintia Widmann for helping prepare stimuli, run participants, and transcribe and code the data.

REFERENCES

Almor, A. (1999). Noun-phrase anaphora and focus: The informational load hypothesis. *Psychological Review*, *106*(4), 748–765.

Almor, A. (2000). Constraints and mechanisms in theories anaphor processing. In M. W. Crocker, M. Pickering, & C. Clifton, Jr. (Eds.), *Architectures and mechanisms for language processing* (pp. 341–354). New York: Cambridge University Press.

Almor, A. (2004). A computational investigation of reference in production and comprehension. In J. C. Trueswell & M. K. Tanenhaus (Eds.), *Approaches to studying world-situated language use : Bridging the language-as-product and language-as-action traditions* (pp. 285–301). Cambridge, MA.: MIT Press.

Ariel, M. (1990). *Accessing noun-phrase antecedents*. London; New York: Routledge.

Boroditsky, L., & Ramscar, M. (2002). The roles of body and mind in abstract thought. *Psychological Science*, *13*, 185–189.

Budiu, R., & Anderson, J. R. (2002). Comprehending Anaphoric Metaphors. *Memory and Cognition*, *30*, 158–165.

Clark, H. H., & Lucy, P. (1975). Understanding what is meant from what is said: A study in conversationally conveyed requests. *Journal of Verbal Learning & Verbal Behavior, 14*(1), 56–72.

Colston, H. L., & Katz, A. N. (2003). *Figurative language comprehension: Social and cultural influences*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Daneman, M., & Carpenter, P. A. (1983). Individual differences in integrating information between and within sentences. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *9*(4), 561–584.

Estevez, A., & Calvo, M. G. (2000). Working memory capacity and time course of predictive inferences. *Memory*, *8*(1), 51–61.

Francis, W. N., Kucera, H., & Mackie, A. W. (1982). *Frequency analysis of English usage: Lexicon and grammar.* Boston: Houghton Mifflin.

Gibbs, R. W. (1990). Comprehending figurative referential descriptions. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *16*(1), 56–66.

Gibbs, R. W., & Tendahl, M. (2006). Cognitive effort and effects in metaphor comprehension: Relevance theory and psycholinguistics. *Mind & Language*, *21*(3), 379–403.

Gildea, P., & Glucksberg, S. (1983). On understanding metaphor: The role of context. *Journal of Verbal Learning & Verbal Behavior*, *22*(5), 577–590.

Glucksberg, S., & Keysar, B. (1990). Understanding metaphorical comparisons: Beyond similarity. *Psychological Review*, *97*(1), 3–18.

Gordon, P. C., Grosz, B. J., & Gilliom, L. A. (1993). Pronouns, names, and the centering of attention in discourse. *Cognitive Science*, *17*(3), 311–348.

Gordon, P. C., & Hendrick, R. (1998). The representation and processing of coreference in discourse. *Cognitive Science*, *22*(4), 389–424.

Grice, H. P. (1975). Logic and Conversation. In P. C. J. Morgan (Ed.), *Syntax and semantics III: Speech acts* (pp. 41–58). New York: Academic Press.

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

Hoffman, R. R., & Honeck, R. P. (1980). A peacock looks at its legs: Cognitive science and figurative language. In R. P. Honeck & R. R. Hoffman (Eds.), *Cognition and figurative language* (pp. 3–24). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Kazmerski, V. A., Blasko, D. G., & Dessalegn, B. G. (2003). ERP and behavioral evidence of individual differences in metaphor comprehension. *Memory & Cognition*, *31*(5), 673–689.

Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological Review*, *85*, 363–394.

Lemaire, B., & Bianco, M. (2003). *Contextual effects on metaphor comprehension: Experiment and simulation*. Paper presented at the Proceedings of the 5th International Conference on Cognitive Modeling (ICCM 2003).

Linderholm, T. (2002). Predictive Inference Generation as a Function of Working Memory Capacity and Causal Text Constraints. *Discourse Processes*, *34*(3), 259–280.

Link, K., & Kreuz, R. (2005). Do men and women differ in their use of nonliteral language when they talk about emotions? In H. Colston & A. Katz (Eds.), *Figurative language comprehension: Social and cultural influences* (pp. 153–181). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

MacDonald, M. C., Almor, A., Henderson, V. W., Kempler, D., & Andersen, E. S. (2001). Assessing working memory and language comprehension in Alzheimer's disease. *Brain & Language*, *78*(1), 17–42.

Nair, V., & Almor, A. (2006). *Referential processing in word by word reading*. Poster presented at the 2006 annual CUNY conference on sentence processing, New York.

Noveck, I. A., Bianco, M., & Castry, A. (2001). The costs and benefits of metaphor. *Metaphor and Symbol*, *16*(1–2), 109–121.

Onishi, K. H., & Murphy, G. L. (1993). Metaphoric reference: When metaphors are not understood as easily as literal expressions. *Memory & Cognition*, *21*(6), 763–772.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). E-Prime reference guide.
Searle, J. (1979). Metaphor. In A. Ortony (Ed.), *Metaphor and Thought* (pp. 92–123). New York: Cambridge Press.
van Dijk, T. A., & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic.
Vonk, W., Hustinx, L. G., & Simons, W. H. (1992). The use of referential expressions in structuring discourse. *Language & Cognitive Processes*, *7*(3), 301–333.