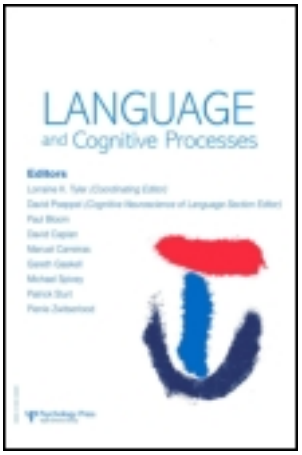

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Focus and noun phrase anaphors in spoken language comprehension

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Focus and noun phrase anaphors in spoken language comprehension

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Two experiments employed a lexical decision task and a delayed cued recall task to investigate whether and how syntactic focusing affects the online processing and long-term encoding of repeated and non-repeated definite NP anaphors in spoken language comprehension. For discourses with repeated anaphors (Experiment 1), focus facilitated lexical decisions but resulted in poorer recall performance. Discourses with non-repeated anaphors (Experiment 2) showed focus facilitation in lexical decision but no effects in recall. These results show that, similar to reading, spoken language comprehension is impeded by repeated reference to a focused discourse referent. The finding that repetition initially facilitates processing but then interferes with the resulting memory representation is consistent with theories that view referential processing as consisting of multiple stages that can be differentially impacted by repetition.

Most utterances spoken or written in a discourse context not only convey new information, but also include previously mentioned 'given' information that serves to coherently link the new information to the representation of the

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ongoing discourse (Prince, 1981; Vallduví, 1992). The manner by which speakers and writers express given information is affected by the degree to which this information is accessible in the context of the discourse. For example, when referring to the most highly activated referent in the discourse (the discourse focus), speakers and writers will generally use a reduced nominal form such as a pronoun or a zero anaphora (Ariel, 1990; Gundel, Hedberg, & Zacharski, 1993). Correspondingly, when readers and listeners encounter a pronoun, they generally assume that it refers to the most accessible (i.e., most highly activated) referent in the discourse context and are slowed down if it turns out to refer to a different entity (Gordon, Grosz, & Gilliom, 1993). Previous research in reading has shown that the effect of referent accessibility extends beyond the form of referring expressions (e.g., pronouns vs. noun-phrases) such that the processing of different definite noun-phrase (NP) anaphors is also affected by the accessibility of the referent (Almor, 1999, 2000, 2004; Cowles & Garnham, 2005; van Gompel, Liversedge, & Pearson, 2004). Like pronouns, definite NP anaphors that are more general than their antecedent are read faster when the antecedent is highly accessible than when it is not. For example, the anaphor '*The bird*' is read faster in the discourse '*It was the robin that ate the fruit. The bird seemed quite satisfied.*' where its antecedent '*the robin*' is focused by the it-cleft, than in the discourse '*What the robin ate was the fruit. The bird seemed very satisfied.*' where '*the fruit*' and not '*the robin*' is focused by the wh-cleft (Almor, 1999). In contrast, repeated definite NP anaphors are read slower when the referent is highly accessible than when it is not. For example, the repetitive anaphor '*The robin*' is read slower in '*It was the robin that ate the fruit. The robin seemed quite satisfied.*' than in '*What the robin ate was the fruit. The robin seemed very satisfied.*' (Almor, 1999).

This 'repeated name penalty' has been central to theories of referential processing. According to one view (Gordon et al., 1993), the repeated name penalty occurs when readers are misled by the absence of a pronoun reference to the discourse focus. In this view, pronouns are used to refer to the discourse focus because they provide readers and listeners with a 'coherence cue'. A failure to use a pronoun to refer to the discourse focus deprives readers and listeners of this important coherence cue and thus results in increased comprehension effort. A later revision of this view (Gordon & Hendrick, 1998) also attributed the repeated name penalty to the construction of a mental representation for a new referent that takes place when a full name is processed, but when the full name is repetitive has to be reconciled with the existing representation. Although both the early and revised versions of this view can explain why repeated anaphors are processed slower than pronouns when reference is made to the discourse focus, they cannot explain the differences between the processing of repeated vs. non-repeated NP anaphors (Almor, 1999).

An alternative view is the Informational Load Hypothesis (ILH; Almor, 1999, 2000, 2004), which, in line with Relevance Theory (Sperber & Wilson, 1995), expresses the principle that comprehenders expect speakers and writers to choose anaphors whose processing cost is balanced by discourse function and are slowed when this expectation is violated. The discourse function of anaphoric expressions is identifying a referent and/or adding new information to the discourse. According to this theory, the repeated name penalty is the result of processing an anaphor that has a high processing cost, when this high cost appears to serve no discourse function (i.e., the anaphor adds no new information, and the referent is easy to identify because it is the discourse focus and is thus the 'default' antecedent).

According to the ILH, the processing cost of anaphors reflects the constraints of the architecture of working memory. Specifically, the ILH attributes processing cost to interference related to the need to maintain separate representations of the referential expression and of the prior representation of the referent in the discourse until these representations are integrated. According to the ILH, this cost is affected by the semantic overlap between the representations of the anaphor and of the referent in the previous discourse. This reflects the difficulty in maintaining distinct representations that are very similar, especially when these representations are strongly activated as is the case when the antecedent is focused. A computational model that implements some of the claims of the ILH is described in Almor (2004). This model assigned greater cost for maintaining separate representations if the relevant items are highly activated in memory, compared with when activation is low. The model implements this property by defining cost as a function of both the overlap between the semantic feature representations of the referent and the referential expressions and their overall level of activation.

The importance of the relation between referent salience and semantic overlap in determining the cost of referential expressions has been supported by several studies which found slower processing associated with anaphors that are semantically close to their focused antecedent (e.g., a category anaphor '*bird*' with a typical antecedent '*robin*') than anaphors that are semantically distant from their focused antecedent (e.g., a category anaphor '*bird*' with an atypical antecedent '*ostrich*'; Almor, 1999; Cowles & Garnham, 2005; van Gompel et al., 2004). Almor (2004) further elucidated these inverse typicality and conceptual distance effects by describing a method for calculating the cost associated with semantic overlap on the basis of feature-based distributed semantic representations of the antecedent and the anaphor.

An important outcome of this framework is that, everything else being equal, the cost of processing a reference to the discourse focus would be higher as the semantic overlap between the representation of the referential

expression and the representation of a salient referent in memory increases. For example, an NP anaphor (e.g., '*the bird*') would have higher cost when used as a repeated anaphor (i.e., for the focused antecedent '*bird*'), than when used as a category anaphor (e.g., for the focused antecedent '*robin*'). Therefore, in this cost–function balance framework, referential expressions that carry a low amount of information, such as pronouns and (to a lesser extent) category anaphors, would be easier to process when the referent is salient than when it is not. Such general expressions do not pose a substantial processing burden that has to be balanced by serving some special function such as reactivating the referent or adding new information. In contrast, references to less salient referents would incur lower cost due to lesser memory interference (Almor, 2004). Moreover, when referring to a less salient referent, the information carried by the anaphor may serve a discourse function in identifying the referent and reactivating its representation. Thus, when referring to less salient referents, more informative referential expressions are preferred both because they do not incur as much cost as when used to refer to the discourse focus and because they have greater functionality.

The separate consideration of processing cost, function, and the balance between cost and function results in a model that distinguishes between several stages of processing. Initially, a referential expression undergoes lexical processing which activates a semantic representation of the referential expression. Once sufficient semantic information is activated, referent identification can proceed by matching the activated semantic representation with the representation of the referent in the previous discourse. The final stage of processing of an anaphoric expression is the integration of the representation of the referent and any new information into the existing representation of the discourse. Until integration is complete there is a cost associated with the maintenance of the semantic representation of the referent. According to the ILH, the integration stage is affected by both this cost, and by the balance between this cost and the function of the anaphor. Specifically, it is during this stage that, in line with much work in pragmatics (e.g., Grice, 1975) and especially Relevance theory (Sperber & Wilson, 1995), comprehension is slowed by processing a costly expression that serves no discourse function. In addition to slowed processing, it is also possible that unnecessary cost also interferes with encoding in long-term memory and therefore leads to poorer representation of the discourse in long-term memory.

Although the ILH does not assume that these stages occur in a strict serial order, it does assume that lexical processes would occur relatively early, and discourse integration would occur relatively late in processing. This means that repeated reference could have a different effect on processing at different stages. In particular, repetition can facilitate the initial processing of a

referential expression both through lexical priming, which may speed the initial lexical processing of the referential expression, and through facilitating referent identification. However, if the referent is salient, repetition may lead to semantic interference between the representation of the repeated anaphor and the existing representation of the referent. This may impede integration, especially if comprehenders cannot establish the functional justification intended by the speaker or writer for using an expression with a high cost (Sperber & Wilson, 1995).

This view therefore predicts that measures that tap different processing stages may yield seemingly contrasting results about the effect of repeated reference. In particular, repeated reference to a salient referent is predicted to have a facilitative effect on measures that primarily assess lexical activation, such as lexical decision (e.g., Nicol, Fodor, & Swinney, 1994; Swinney, 1979; Swinney, Onifer, Prather, & Hirshkowitz, 1979), and measures that assess the activation of the referent in memory, such as probe recognition (Gernsbacher, 1989, 1990; Gordon, Hendrick, & Foster, 2000). In contrast, repeated reference to a salient referent is predicted to interfere with measures that reflect discourse integration, such as whole sentence self-paced reading, and will show a repeated name penalty (Almor, 1999; Gordon, 1993).

To summarise, the theoretical framework of the ILH distinguishes between different stages and measures of processing. Measures of early processing are predicted to show facilitation associated with semantic overlap, and measures of overall comprehension are predicted to show interference reflecting the cost associated with semantic overlap, especially when this cost serves no additional discourse function.

Although the origins of the repeated name penalty are still a matter of debate (e.g., Cowles & Garnham, 2005), all current theories attribute it to general language processes that are not restricted to a specific modality such as reading. Unfortunately, almost all of the relevant empirical evidence is based on reading-based paradigms. Therefore, it is not clear to what extent the results of these studies apply to spoken language comprehension, and in particular whether an effect similar to the repeated name penalty could be observed in spoken language comprehension.

The referential processes described by the ILH should affect spoken language comprehension just as they do reading. In fact, processing a rapidly changing speech signal in which information is only present for a short duration and is not available for later reprocessing is likely to depend on memory more than written text, which could even be processed non-sequentially and regressively. This might accentuate any effects that are related to memory constraints in spoken language comprehension in comparison to reading because the cost related to maintaining multiple representations may be higher in spoken language comprehension. Thus, if the ILH is correct in attributing the repeated name penalty to memory

constraints then it reasonable to expect repeated name penalty in spoken language comprehension.

Although the theoretical claims of the ILH clearly apply to spoken language comprehension, the measurement of the relevant effects in spoken language comprehension is not straightforward. In reading, the repeated name penalty has been observed in fragment or whole sentence reading times but not in single word reading (Nair & Almor, 2006). Nair and Almor explained this on the basis of the ILH's attribution of the repeated name penalty to the integration stage, which occurs rather late in processing. In the present study we therefore used a combination of two tasks. A lexical decision task aimed to test the lexical activation of the anaphoric expression as it was processed, and a memory task tested the final product of processing in memory. We next discuss each of these tasks.

The present research employed a cross modal lexical decision task to assess the influence of discourse focus on the immediate processing of repeated and non-repeated anaphors. A lexical decision task in which the anaphor serves as the target minimally requires some lexical processing of the anaphor and may therefore provide a good indication of how this processing is affected by discourse focus and the repetition of the antecedent (Nicol et al., 1994; Swinney, 1979; Swinney et al., 1979). Furthermore, although this task was originally proposed to tap just lexical processing, some researchers believe that this task instead reflects the general difficulty of retrieving the target from memory on the basis of a dynamically constructed representation of the discourse context and the target word (McKoon & Ratcliff, 1994; McKoon, Ratcliff, & Ward, 1994; Potts, Keenan, & Golding, 1988; Ratcliff & McKoon, 1995; Seidenberg, Waters, Sanders, & Langer, 1984). In the present context, this property can make the task useful in that it may assess not only the lexical processing of the anaphoric expression but also the effort involved in identifying the referent. Indeed, if McKoon and Ratcliff are correct in that the lexical decision task depends on an integrated representation of the target word and the preceding discourse in working memory, which is then matched with lexical knowledge in long-term memory, then this task may be able to tap the integrative processing that the ILH views as the origin of the repeated name penalty.

To assess the outcome of the integrative processing of the anaphor, the present research measured memory performance for discourses with repeated and non-repeated references to focused and unfocused antecedents. Memory representation is the final product of the integrative processing of the discourse and may therefore show the effects of several factors that affect discourse such as focus and repeated reference. In reading, discourse focus has been shown to have an enhancing effect on the resulting memory representation of the discourse. Birch and colleagues (Birch, Albrecht, & Myers, 2000; Birch & Garnsey, 1995), who found that people are faster to

name and recognise referents that have been focused syntactically than referents that have not been focused, suggested that discourse focus plays a prominent role in the longer-term encoding of the discourse in memory. Although it is not clear how these findings may change as a result of subsequent reference, it is reasonable to expect similar effects in spoken language comprehension. The present research therefore used a recall task to gauge the memory of discourses in which focused and non-focused references were referred to with repeated and non-repeated anaphors.

Furthermore, using spoken materials can also address some concerns about how readers interpreted written materials in several previous studies (e.g., Almor, 1999; Birch et al., 2000; Birch & Garnsey, 1995; Cowles & Garnham, 2005). For example, in previous studies that used clefts to manipulate focus, readers could have in some cases chosen a 'non default' interpretation of these items with a different focusing effect than the one intended. For example, readers could read the sentence 'It was the bird that ate the fruit' as if the stress is on FRUIT and the sentence 'what the bird ate was the fruit' as if the stress is on BIRD. Although by definition such non default interpretations are not very likely even in reading, the use of spoken stimuli in which the intonation matches the intended interpretation would make the alternative interpretation highly unlikely.

At this point it should be noted that, although it is plausible that focus and referent form would affect spoken language comprehension similar to how they affect reading, there are several reasons that may in fact make spoken language comprehension different. Generally, although written materials are often easier to incorporate in experimental studies and have been consequently used very frequently in psycholinguistic experiments attempting to assess referential processing in general, it is important to remember that reading is a derived form of language comprehension that has to be formally taught and that is not universally available to the entire human population. More specifically, it may be that the strictly sequential processing of speech is biased toward allocating most computational resources for on-line word recognition and syntactic parsing, leaving only limited resources for integrative discourse processing (McKoon & Ratcliff, 1992). This may lead to a universal repetition advantage in spoken language comprehension because, through priming, repetition is likely to facilitate lexical processing regardless of discourse factors such as the accessibility of the referent. By the same token, if resources are limited, referent salience may always aid referential processing in spoken language comprehension regardless of the form of referential expressions. Thus, it may be that due to the constraints of processing spoken language, some of the effects that are seen in reading during online processing would be delayed in spoken language processing and perhaps be only reflected in the resulting memory representation of the discourse. This possibility reinforces our

decision to use a memory task to assess the outcome of discourse integration.

Overall, the present work aimed to establish whether syntactic focus manipulations similar to the ones used by Almor (1999) would yield similar effects in spoken language comprehension in that processing repetitive NP anaphors would bear some penalty when the referent is focused in comparison to when it is not, but processing non-repetitive NP anaphors would show no such penalty. Specifically, the present work aimed to uncover the effect of it-clefts and wh-clefts on the immediate lexical processing of subsequent anaphoric expressions and on the long-term encoding of the referents in memory. Similar effects in written and spoken language comprehension would suggest that the underlying mechanisms are not specific to one modality and operate in the context of processing both written text and speech. Experiment 1 tested focus effects on the processing and memory of repeated NP anaphors and Experiment 2 tested focus effects on the processing and memory of non-repeated NP anaphors.

EXPERIMENT 1

The first experiment was designed to assess the effect of discourse focus on the processing of repeated NP anaphors in spoken language comprehension by measuring lexical decision latencies and delayed recall for these anaphors.

Two possible outcomes in the lexical decision task are of particular interest. Shorter lexical decision latencies for nouns in NPs with a focused antecedent than for nouns in NPs with an unfocused antecedent would show that focus facilitates responses in a lexical decision task, despite the use of repeated NP anaphors. This would not mean that there is no repeated name penalty in spoken language comprehension. Rather, in line with the ILH's distinction between early and late processing stages, such a finding may indicate that the lexical decision task only measures the lexical processing and referent identification aspects of anaphor processing and that these are facilitated by discourse focus. In contrast, longer lexical decision latencies for NP anaphors with a focused antecedent than for NP anaphors with an unfocused antecedent could be interpreted as a manifestation of the repeated name penalty in spoken language comprehension and indicate that this penalty occurs early and can be revealed in a lexical decision task. Such a finding could in fact be explained by McKoon and Ratcliff's claim that the lexical decision task reflects the complete integration of the target with the discourse context rather than just the lexical processing of the target (McKoon & Ratcliff, 1994; McKoon et al., 1994; Ratcliff & McKoon, 1995).

Focus was manipulated by using the two kinds of clefts described above: it-clefts and wh-clefts (see Table 1). A repeated NP anaphor co-referred with

a focused antecedent (the clefted NP) in half of the critical trials (*i* and *iv* in Table 1), and with an unfocused antecedent (the other NP in the cleft) in the other half (*ii* and *iii* in Table 1). The noun of this repeated NP anaphor was the target for the lexical decision. This design provided a measure of focus that was based on the difference between the lexical decision latencies for the same nouns when the NPs they were a part of had focused antecedents and when they had unfocused antecedents. Importantly, because it-clefts and wh-clefts focus a different NP while maintaining a similar word order across sentences (Almor, 1999; Birch, Albrecht, & Myers, 2000; Birch & Garnsey, 1995), anaphors were separated from their antecedents by a similar number of words in the focused and in the unfocused conditions. This ensured that the measure of focus was not confounded with recency of mention. The fact that the lexical decision targets were repeated the same number of times in the focused and the unfocused conditions also ensured that the measure of focus was not confounded with the number of previous mentions.

Because we were also interested in the effect of focus and repeated reference on the longer-term memory representation of the discourse that resulted from the integration stage, we included a cued recall memory task at the end of the experiment. In this task, participants were reminded of the critical items using one of the nouns in the clefted sentences, and were asked to recall the other noun. For example, for the sample item in Table 1, participants were asked to answer the question '*Who ate the fruit?*'. Responses were scored for being correct or incorrect. As with the lexical decision task, two possible outcomes are of special interest. If a repeated name penalty affects the resulting memory representation of the discourse we should observe poorer recall performance for items in which the repetitive anaphor had a focused antecedent than for items in which the repetitive

TABLE 1
An example of an item in all four conditions in Experiment 1. For expository purpose, the focused noun is underlined and the target of the lexical decision (always the subject of the second sentence) is shown in bold face

	Antecedent position	
Construction	*First*	*Second*
	(i)	(ii)
IT	It was the bird that ate the fruit. The **bird** seemed very satisfied.	It was the bird that ate the fruit. The **fruit** was already half rotten.
	(iii)	(iv)
WH	What the bird ate was the fruit. The **bird** seemed very satisfied.	What the bird ate was the fruit. The **fruit** was already half rotten.

anaphor had an unfocused antecedent. This should affect the recall of both nouns from items that had a repeated reference to a focused antecedent because the repeated noun is always a part of the recall task, either as the recall target or as the recall cue. For example, a repeated name penalty would be reflected by finding that answering either question, '*Who ate the fruit?*' or '*What did the bird eat?*', is less accurate if the original item had a repeated reference to a focused referent as in: '*It was the bird that ate the fruit. The bird seemed quite satisfied.*' than if the original item did not have a repeated reference to the focused referent as in: '*What the bird ate was the fruit. The bird seemed quite satisfied.*' Alternatively it may be that the discourse processes underlying the repeated name penalty in reading do not occur in spoken language, or do not affect the resulting memory representation. In this case, we might expect that focus will either not affect recall, or, following Birch and Garnsey (1995), improve recall.

Method

Participants. Fifty-two undergraduate students recruited from the University of South Carolina Psychology Department participant pool participated for class credit. All participants were native speakers of American English and were naive about the goals of the experiment.

Materials. The 20 critical items were based on the text stimuli used in Almor (1999); Experiment 3) (see Table 1). Each item started with a clefted sentence that introduced two nouns balanced for word frequency (Francis, Kucera, & Mackie, 1982), and roughly for word length and number of syllables. All the items were recorded by a male native speaker of American English. The speaker was informed about the goal of the experiment and was instructed to read the clefted sentences with an intonation matching their focusing function. For example, the speaker was instructed to read the it-cleft '*It was the bird that ate the fruit*' (*i* and *ii* in Table 1) as if correcting someone thinking that the fruit was eaten by someone or something other than the bird. Similarly, the speaker was instructed to read the wh-cleft '*What the bird ate was the fruit*' (*iii* and *iv* in Table 1) as if correcting someone thinking that the bird ate something different than the fruit. To maintain a uniform intonation pattern for each kind of cleft, all the it-clefts were recorded consecutively in one list and all the wh-clefts were recorded consecutively in a separate list. Sixty-three two-sentence distractor items were also recorded in the same session. In 19 distractor items, the noun in the subject of the second sentence was an English word, and in the other 44 distractor items it was not a word although phonologically possible (e.g., *boyg*). The location in the word in which non-words stopped matching any real English word was varied between the first, middle, and final phoneme (e.g., *Gedancers*, *arFitect*,

and *presideK* correspondingly). Out of the 44 items with the non-word in the subject position of the second sentence, 10 started with an it-cleft, 10 with a wh-cleft, and the other 24 with a non-clefted sentence. That ensured that clefts were not always followed by a real word. The clefted distractor sentences were recorded together with the experimental clefts. All items were recorded onto a DAT recorder and were later sampled at 20 kHz using the BLISS software (Mertus, 2002).

Design and procedure. The experiment was conducted using an auditory lexical decision paradigm wherein the lexical decision target was part of the utterance, marked by a preceding tone. The E-prime experimental software (Schneider, Eschman, & Zuccolotto, 2002) was used for stimuli presentation and experimental control. In each trial, participants heard a leading sentence followed by a 600 ms inter-sentential silence, a 100 ms 1000 Hz tone indicating that the following noun was the target, and then the second sentence starting with a definite NP subject (the noun being the lexical decision target). Participants were instructed to wait for the tone and then decide as quickly and as accurately as they could whether the next noun after the tone was a word or not. They were also instructed to listen to the paragraphs and understand them because they would be tested later on their contents. Participants pressed the 1 key on the keyboard to respond positively when they thought they heard a word, and the 2 key to respond negatively. Stimulus items were played continuously and were not interrupted for the lexical decision; participants had to make their decisions while listening to the rest of the sentence. Participants were not given any feedback about their lexical decision performance during the experiment but data from participants whose lexical decision accuracy fell below 80% were not included in the analyses. Trials were separated by a 2-seconds delay. The time lapse from the onset of the second sentence (i.e., the beginning of the definite article) and the participant's pressing a key, as well as the response the participant made, were recorded by the computer.

The experiment thus included two factors, construction type (it-cleft vs. wh-cleft) – which determined the focused noun phrase, and antecedent position (first vs. second) – which determined with which of the noun phrases in the leading sentence the subject of the second sentence co-referred. Overall, this part of the experiment had four conditions (2 syntactic constructions $\times$ 2 antecedent positions). Table 1 lists an example of an item in all four conditions.

Each item appeared in each of the four conditions but each participant heard only one version of each item. Overall, each participant heard 20 critical items, 5 from each condition. The assignment of items to conditions was pseudo-randomised so that among each group of four consecutive participants, each item appeared in all four conditions. The order of

presentation of the 83 items was individually randomised for each participant.

Each session started with a practice block that included 20 sentences presented with the same procedure as the experimental block. During the practice trials participants received feedback for each lexical decision (correct, wrong, or time-out). No participant was eliminated from the study on the basis of his or her performance on the practice trials but participants who did not respond to at least half of the lexical decisions in the practice trials correctly and within the allotted time for each item had to repeat the practice block again. At the end of the practice block, participants were asked to fill out a questionnaire which required them to recall nouns from 4 out of the 20 items that they had heard in the practice block.

At the end of the experiment participants were given a memory recall task. They were asked to fill out a questionnaire with 20 questions requiring them to recall one entity mentioned in each of the 20 clefts in the experimental items. For example, for the item in Table 1, participants were asked to answer the question: '*Who ate the fruit?*'. Half of the questions mentioned the first noun and required participants to recall the other noun and the other half mentioned the second noun and required the recall of the first. All questions included the verb that was used in the clefted sentence. Because preliminary analyses indicated that recall performance did not vary as a function of whether participants recalled the first or second noun we did not include the position of the recalled noun in the analyses. All participants were presented with the same questionnaire. To see whether focus affected recall, the percentage of correct recall responses was recorded according to the experimental condition in which the recalled nouns were presented in the lexical decision task. The memory task also served to encourage participants to understand the spoken stimuli and not simply monitor these items for the lexical decision targets. Because we alerted participants to this memory task before the experiment (in fact, as is explained above, we had them perform a short version of this task after an initial practice block), participants knew that they should comprehend the test items so as to be able to answer questions about them at the end of the experiment.

Results

Lexical decision. The data from one participant were removed due to lexical decision accuracy below the 80% criterion. The overall error rate in the remaining data for lexical decisions in all items, critical and distractor, was 4.3% and the overall lexical decision error rate for the critical items was 3.8%. Error rates and the mean correct lexical decision times with standard error of the mean in all conditions are shown in Table 2. Note that the somewhat long RTs are an artifact of measuring response latencies from the

beginning of the sentence (the onset of the definite article). A 2 × 2 ANOVA of correct lexical decision times was conducted with factors Construction type (it vs. wh) × Antecedent position (first vs. second) following the removal of outlier responses more than 2 standard deviations from the mean of each condition calculated across all participants (affecting 2.1% of the data). This analysis was repeated once with participants (F_1) and once with items (F_2) as random factors. This analysis revealed no main effect of syntactic construction, F_1, $F_2 < 1$, a main effect of antecedent position which was significant by participants but not by items, $F_1(1, 50) = 11.36$, $MSE = 42965$, $p < .002$, $F_2(1, 19) = 3.05$, $MSE = 51491$, $p < .1$ (with lexical decisions of anaphors referring to the first antecedent made 98 ms faster than lexical decisions of anaphors referring to the second antecedent), and a significant interaction of the two factors, $F_1(1, 50) = 6.20$, $MSE = 33629$, $p < .02$, $F_2(1, 19) = 9.17$, $MSE = 10426$, $p < .007$. To further explore the interaction between syntactic construction and antecedent position, we contrasted the mean latencies to anaphors with focused and unfocused antecedents. The focused condition consisted of references to the first antecedent following an 'it' construction, and references to the second antecedent following a 'wh' construction. The unfocused condition consisted of references to the second antecedent following an 'it' construction and references to the first antecedent following a 'wh' construction. A one-way ANOVA with factor Focus (focused vs. unfocused) found a significant effect, $F_1(1, 50) = 5.20$, $MSE = 17024$, $p < .03$, $F_2(1, 19) = 5.94$, $MSE = 5226$, $p < .03$, with lexical decisions for anaphors with focused antecedents made 62 ms faster than lexical decisions for anaphors with unfocused antecedents. We also conducted a series of Tukey HSD post hoc tests to identify significant differences between individual condition means. These tests indicated that lexical decisions for anaphors with antecedents in the first position were significantly faster than lexical decisions for anaphors in the second position in the IT conditions (1906 ms

TABLE 2
Lexical decision latencies (in milliseconds), standard error of the mean, and error rates in Experiment 1. The underlined numbers are the lexical decision latencies for nouns embedded in anaphors with focused antecedents

	Antecedent position	
Construction	*First* (*e.g., The bird*)	*Second* (*e.g., The fruit*)
IT (e.g., It was the bird that ate the fruit.)	<u>1906</u> (4%) *SE* = 91	2067 (2%) *SE* = 102
WH (e.g., What the bird ate was the fruit.)	1979 (4%) *SE* = 93	<u>2013</u> (6%) *SE* = 105

vs. 2067 ms, $p_1 < .001$, $p_2 < .001$), but not in the WH conditions, (1979 ms vs. 2013 ms, p_1, $p_2 > .9$). The difference between lexical decision latencies for anaphors in the IT and WH conditions was not significant either for anaphors with antecedents in the first position (1906 ms vs. 1979 ms, $p_1 < .2$, $p_2 < .13$) or for anaphors with antecedents in the second position (2067 ms vs. 2013 ms, $p_1 < .44$, $p_2 < .26$).

Overall, lexical decision latencies in this experiment showed a facilitative focus effect and a possible first mention advantage (Carreiras, Gernsbacher, & Villa, 1995; Gernsbacher, 1990), but the effect of focus was not universally reflected in individual contrasts between the means of individual conditions.

Recall task. Table 3 shows the percentages of correct recall of nouns according to the condition of the lexical decision task in which they appeared. Accuracy performance was analysed similar to the lexical decision data with 2×2 ANOVA with factors Construction type (it vs. wh) $\times$ Antecedent position (first vs. second). This analysis was repeated once with participants (F_1) and once with items (F_2) as random factors. The analysis revealed no main effect of syntactic construction, F_1, $F_2 < 1$, no main effect of antecedent position, $F_1(1, 50) = 2.41$, $MSE = .03$, $p < .13$, $F_2(1, 19) = 1.79$, $MSE = .011$, $p < .2$, and a significant interaction of the two factors, $F_1(1, 50) = 5.79$, $MSE = .03$, $p < .02$, $F_2(1, 19) = 5.85$, $MSE = .013$, $p < .03$. As for the lexical decision data, we explored the interaction between syntactic construction and antecedent position by contrasting the mean accuracy from trials in which the antecedent was focused and trials in which it was unfocused. A one-way ANOVA with factor Focus (focused vs. unfocused) found a significant effect showed a significant difference between the mean recall accuracy in the focused conditions (29%) and the unfocused conditions (35%), $F_1(1, 50) = 5.79$, $MSE = .02$, $p < .02$, $F_2(1, 19) = 5.83$, $MSE = .006$, $p < .03$. We also examined the differences between recall rates in individual conditions with Tukey HSD post hoc tests. These tests indicated that recall for anaphors from items in which the antecedent was in the first position was significantly worse (albeit marginally so in the items analysis) than for items in which the antecedent was in the second position for the IT conditions (28% vs. 37%, $p_1 < .04$, $p_2 < .07$), but not in the WH conditions, (32% vs. 30%, p_1, $p_2 > .8$). The difference between recall rates for items in the IT and WH conditions was not significant for items with antecedents in the first position (28% vs. 32%, $p_1 < .6$, $p_2 < .54$) or for items with antecedents in the second position (37% vs. 30%, $p_1 < .16$, $p_2 < .21$). Thus, as for the lexical decision data, although focus had an effect that was attested in the overall pattern of results across all four conditions, it was not reflected in individual contrasts between the means of individual conditions. Overall, in contrast to its facilitative effect on lexical decision performance, focus had an adverse effect on recall performance.

TABLE 3
Per cent correct recall responses in Experiment 1

	Antecedent position	
Construction	*First* (*e.g., The bird*)	*Second* (*e.g., The fruit*)
IT (e.g., It was the bird that ate the fruit.)	28%	37%
	SE = 3.3	*SE* = 3.5
WH (e.g., What the bird ate was the fruit.)	32%	30%
	SE = 3.2	*SE* = 3.6

Discussion

Lexical decision was faster for nouns that were included in NP anaphors with focused antecedents than for nouns that were included in NP anaphors with unfocused antecedents, consistent with the idea that focus facilitates referent identification of repeated anaphors. At the same time, memory performance was worse for nouns that were presented in trials in which the anaphor had a focused antecedent than for nouns that were presented in trials in which the anaphor had an unfocused antecedent. Thus, although lexical decision times showed a facilitatory focus effect, recall patterns indicated that repeated reference to a focused antecedent interfered with the resulting memory representation of the discourse. The memory results show that there is an effect similar to the repeated name penalty in spoken language comprehension (Almor, 1999; Gordon et al., 1993) such that discourse with repeated NP anaphors with focused antecedents are remembered worse than discourse with repeated NP anaphors with unfocused antecedents.

The present pattern of results also suggests that a lexical decision task is sensitive to referent activation and identification but not to the integrative processes that yield the repeated name penalty. Consistent with the ILH, the integration of the anaphors into the representation of the discourse, as was reflected in the recall results, must have taken place following the processes that affected referent identification and that were tapped by the lexical decision task.

Although the effect of focus was strongly attested in the overall pattern of results, the contrasts between the means of individual conditions varied in whether they showed a focus effect. This suggests that other factors besides focus (e.g., first mention advantage; Carreiras et al., 1995; Gernsbacher, 1990) may have affected both the lexical decision and the recall measures. Importantly for the present purpose, the effect of these other factors appears to add to the effect of focus but not eliminate it.

EXPERIMENT 2

Although the results of Experiment 1 show that focus plays a similar role in processing repeated NP anaphors in spoken language comprehension and in reading, it is not clear whether these results are specific to repeated NP anaphors. Experiment 2 therefore employed the same methodology as in Experiment 1, but used items in which the target sentence started with a non-repetitive definite NP category anaphor co-referring with either a focused or an unfocused category member antecedent. Thus this experiment was identical to Experiment 1 with the exception that the first sentence in the critical items now referred to two category members (see Table 4). Results that are similar to Experiment 1 would indicate that the repetitiveness of the referential expression was not essential for the results of Experiment 1 and would support the view that these effects were driven by the focus manipulation regardless of repetition (Birch et al., 2000; Birch & Garnsey, 1995). Different results from Experiment 1 would however indicate that the repetition of referential expressions affects spoken language comprehension. Specifically, based on the ILH, the interference effect observed in the memory recall performance in Experiment 1 should not replicate in this experiment. This is because non-repetitive anaphors are less costly to process than repetitive anaphors, and should therefore not interfere with the construction and maintenance of the discourse representation when their antecedent is focused.

Method

Participants. Fifty-three undergraduate students recruited from the University of South Carolina Psychology Department participant pool

TABLE 4
An example of an item in all four conditions in Experiment 2. For expository purpose, the focused noun is underlined and the target of the lexical decision (always the subject of the second sentence) is shown in bold face

	Antecedent position	
Construction	*First*	*Second*
	(i)	(ii)
IT	It was the robin that ate the apple. The **bird** seemed very satisfied.	It was the robin that ate the apple. The **fruit** was already half rotten.
	(iii)	(iv)
WH	What the robin ate was the apple. The **bird** seemed very satisfied.	What the robin ate was the apple. The **fruit** was already half rotten.

participated for class credit. All participants were native speakers of American English and were naive about the goals of the experiment.

Materials. The same materials from Experiment 1 were used except that the first sentence in the critical items referred to two typical category members which were determined on the basis of the Battig and Montague (1969) typicality norms and were matched for word frequency and length. These items were therefore identical to those used in Experiment 1 in Almor (1999). The spoken lexical targets were the same category terms used in the previous experiment. Table 4 shows an example of an item in all four conditions.

Design and procedure. This experiment was conducted with identical method, apparatus and procedure to Experiment 1.

Results

Lexical decision. The data from three participants were excluded from further analysis because their accuracy in the lexical decision task fell below the 80% criterion. The overall error rate for the lexical decision in all items, critical and distractor, was 6.4% and the overall lexical decision error rate for the critical items was 6.8%. The slightly higher error rate and longer RTs in this experiment in comparison to Experiment 1 likely reflect the fact that lexical decision accuracy and speed benefit from repetition. Error rates and mean correct lexical decision times with standard error of the mean in all conditions are shown in Table 5. A 2×2 ANOVA, Construction type (it vs. wh) $\times$ Antecedent position (first vs. second) was done as in Experiment 1 following the removal of incorrect lexical decisions and outlier responses (affecting 2.6% of the data). This analysis found no effect of syntactic construction, F_1, $F_2 < 1$, a main effect of antecedent position that was significant by participants but not by items, $F_1(1, 49) = 4.87$, $MSE = 41909$, $p < .04$, $F_2(1, 19) = 1.34$, $MSE = 62242$, *n.s.*, with anaphors referring to the first antecedent responded to 65 ms faster than anaphors that referred to the second antecedent, and a significant interaction effect, $F_1(1, 49) = 7.40$, $MSE = 42072$, $p < .009$, $F_2(1,19) = 6.76$, $MSE = 28076$, $p < .02$. As in Experiment 1, we explored the interaction between syntactic construction and antecedent position by contrasting the mean latencies to anaphors with focused and unfocused antecedents. A one-way ANOVA with factor Focus (focused vs. unfocused) found an effect of focus that was significant by participants but not quite by items, $F_1(1, 48) = 6.30$, $MSE = 20317$, $p < .02$, $F_2(1, 19) = 3.19$, $MSE = 14048$, $p < .09$, with lexical decisions for anaphors with focused antecedents made 72 ms faster than lexical decisions for anaphors with unfocused antecedents. We also conducted a series of Tukey

TABLE 5
Lexical decision latencies (in milliseconds), standard error of the mean, and error rates in Experiment 2. The underlined numbers are the lexical decision latencies for nouns embedded in anaphors with focused antecedents.

	Antecedent position	
Construction	*First* (*e.g., The bird*)	*Second* (*e.g., The fruit*)
IT (e.g., It was the robin that ate the apple.)	<u>1944</u> (6%) $SE = 92$	2105 (9%) $SE = 107$
WH (e.g., What the robin ate was the apple.)	1989 (7%) $SE = 89$	<u>1998</u> (6%) $SE = 96$

HSD post hoc tests to identify significant differences between individual condition means. These tests indicated that lexical decisions for anaphors with antecedents in the first position were significantly faster than lexical decisions for anaphors in the second position in the IT conditions (1944 ms vs. 2105 ms, $p_1 < .002$, $p_2 < .04$), but not in the WH conditions, (1989 ms vs. 1998 ms, p_1, $p_2 > .9$). The difference between lexical decision latencies for anaphors in the IT and WH conditions was not significant for anaphors with antecedents in the first position (1944 ms vs. 1989 ms, p_1, $p_2 > .59$) and was only significant by participants for anaphors with antecedents in the second position (2105 ms vs. 1998 ms, $p_1 < .05$, $p_2 < .12$). Thus, as with the repeated anaphors in Experiment 1, lexical decision latencies for non-repeated anaphors in this experiment showed a focus facilitation effect, and also a possible first mention advantage (Carreiras et al., 1995; Gernsbacher, 1990). Also similar to Experiment 1, the facilitative effect of focus was attested in the overall pattern of results across all four conditions, but was not universally reflected in individual contrasts between the means of individual conditions.

Recall task. Table 6 shows the percentages of correct recall of nouns according to the condition of the lexical decision task in which they appeared. Similar to Experiment 1, accuracy performance was analysed with an ANOVA with factors Construction type (it vs. wh) × Antecedent position (first vs. second). The analysis revealed no main effect of syntactic construction, F_1, $F_2 < 1$, no main effect of antecedent position, F_1, $F_2 < 1$, and no significant interaction of the two factors, $F_1(1, 48) = 1.39$, *n.s.*, $F_2(1, 19) = 1.41$, *n.s.* As for the lexical decision data, we explored the interaction between syntactic construction and antecedent position by contrasting the mean accuracy from trials in which the antecedent was

TABLE 6
Per cent correct of recall responses in Experiment 2

	Antecedent position	
Construction	*First* (*e.g., The bird*)	*Second* (*e.g., The fruit*)
IT (e.g., It was the robin that ate the apple.)	36% *SE* = 4.2	35% *SE* = 3.9
WH (e.g., What the robin ate was the apple.)	35% *SE* = 3.4	40% *SE* = 3.1

focused and trials in which it was unfocused. A further one-way ANOVA with factor Focus (focused vs. unfocused) also failed to find a significant difference between the mean recall accuracy in the focused conditions (38%) and the unfocused conditions (35%), $F_1(1, 48) = 1.39$, *n.s.*, $F_2(1, 19) = 1.13$, *n.s.* Similarly, a series of Tukey HSD post hoc tests found no significant differences between the recall rates in individual conditions. Thus, in this experiment, focus had no effect on recall performance.

Discussion

Experiment 2 lexical decision results were strikingly similar to those of Experiment 1. Together, the lexical decision results of the two experiments show that although non repetitive anaphors may lead to slightly more errors and possibly slightly slower lexical decisions than repetitive anaphors, the two kinds of anaphors are similar in how their lexical processing and referent identification are facilitated by focus.

The recall results of Experiment 2 were, however, quite different from those of Experiment 1. Although recall was numerically better for discourses with focused antecedents, this trend was not statistically significant, thus suggesting that for non-repeated anaphors, antecedent focus does not affect the representation of the discourse in long-term memory. We pursue the implication of this finding in the general discussion.

The results of Experiment 2 also address a possible concern about the results of Experiment 1 which, in and of themselves, could have been attributed to an interaction of the lexical decision and recall tasks such that faster responses in the lexical decision task interfered with the memory encoding of the discourse. The fact that in Experiment 2 there was no inverse relation between lexical decision latencies and later recall accuracy shows that there is no general interaction between the two tasks and that it is therefore not likely that the results of Experiment 1 reflect such interaction.

As in Experiment 1, although the effect of focus was strongly attested in the overall pattern of results, the contrasts between the means of individual conditions varied in whether they showed a focus effect. This reinforces our interpretation that although other factors besides focus may have affected performance in our experiments, these factors did not override or eliminate the effect of focus.

GENERAL DISCUSSION

Together, the results of the two experiments show that focus affects the processing of a subsequent anaphoric reference in spoken language comprehension similar to reading in that repeated but not non-repeated anaphors interfere with processing when the antecedent is focused. Experiment 1 found that the memory representation of spoken discourse is impaired by the use of repeated NP anaphors when the antecedent is focused. This result shows that the repeated name penalty (Almor, 1999; Gordon et al., 1993) is not a reading-specific phenomenon but also affects the comprehension of spoken language. This is important because all the theoretical accounts of the repeated name penalty that have been proposed so far are not specific to reading but rather apply to language comprehension more generally (Almor, 1999, 2000, 2004; Cowles & Garnham, 2005; Gordon, 1993; Gordon & Hendrick, 1998). Most relevant to these accounts is the fact that in spoken as well as in written language comprehension, the performance decrement that is associated with the use of repetitive NP anaphors when the referent is focused (the recall results in Experiment 1) is specific to the use of repetitive anaphors and does not characterise the use of NP anaphors in general.

The differences between repetitive and non-repetitive anaphors speak against explanations of the repeated name penalty that attribute this effect to a failure to use a pronoun (Gordon et al., 1993; Gordon & Hendrick, 1998) because repetitive and non-repetitive anaphors equally deprive listeners of that cue. Rather, this finding supports the ILH's thesis that the repeated name penalty is related to the relationship between the antecedent and the anaphor which can be different for anaphors of the same form (Almor, 1999, 2000, 2004).

The fact that the repeated name penalty found in the present study was only detected in the representation of the discourse in memory as gauged by the recall task but not in the lexical decision task, can be explained in terms of the Informational Load Hypothesis (Almor, 1999) as reflecting the distinction between processing stages in terms of how they are affected by processing cost, discourse function, and the balance between them. The lexical decision task used in the present research appears to only be sensitive

to one function of anaphors, which is to identify a referent. The facilitatory effect that focus had on lexical decision latencies in both experiments indicates that the referent of both repeated and non-repeated anaphors is more easily identified if it is focused than if it is not focused. This can reflect greater priming associated with focused antecedents (and to a lesser degree first-mentioned antecedents; Carreiras et al., 1995; Gernsbacher, 1990) which may be more actively represented in short-term memory. Such priming may facilitate both the lexical processing of the anaphor and the identification of the referent. Importantly, the lexical decision task does not appear to be sensitive to the balance between function and cost in that focus had a similar effect on lexical decision for both repeated and non-repeated anaphors. Thus, even if McKoon and Ratcliff (McKoon & Ratcliff, 1994; McKoon et al., 1994; Ratcliff & McKoon, 1995) are correct in that the lexical decision task depends on a combined representation of the lexical decision target and the discourse, this combined representation does not reflect the final product of discourse integration.

In contrast, the recall task appears to tap the product of the entire integrative processing of the discourse and thus show the effects of the balance between processing cost and function. According to the ILH, the negative effect of focus on recall performance in Experiment 1 reflects the unfavourable balance between discourse function and processing cost that is linked to the use of repetitive NP anaphors when the referent is focused.

In summary, the different performance patterns in the two tasks map onto what the ILH construes as two distinct stages in the processing of anaphors: lexical decision latencies reflect an aspect of the initial processing of anaphors associated with lexical processing and referent identification. When referents are focused, these processes become easier. In contrast, recall accuracy reflects the outcome of the integration of anaphors into the representation of the discourse, which shows the effects of the balance between the processing cost associated with maintaining distinct active representations that are overlapping, and discourse function.

The present results are also informative about how focus and referential form interact to affect the memory representation of discourse. The present experiments found that focus may affect memory, but only under certain conditions. In Experiment 1, which used repetitive NP anaphors, focus had a negative effect on memory performance (the repeated name penalty – see discussion above). Interestingly, in Experiment 2, in which non-repetitive NP anaphors followed the focus manipulation, there were no focus effects on memory. These results conflict with the results of Birch and colleagues who found a facilitative effect of focus on memory for discourse (Birch et al., 2000; Birch & Garnsey, 1995). The seemingly contrastive results of the present study and of the Birch studies suggest that while focus may affect the local processing and interpretation of discourse, it does not normally

leave any trace in the resulting memory representation. Rather, it appears that focus only affects memory under conditions which are not typical of regular discourse. One such condition is the use of repetitive NP anaphors for referring to a focused referent. As explained above, this violates the conversational principles underlying anaphor use and thus compromises the coherence of the discourse. The present finding that memory performance shows a repeated name penalty is thus compatible with the fact that incoherent discourse is generally more poorly remembered than coherent discourse (Murphy & Shapiro, 1994).

This interpretation also explains why the results of Experiment 2 did not match the self-paced reading results of Almor (1999) who used the same materials in a self-paced reading task and found shorter reading times for anaphors with focused antecedents than for anaphors with unfocused antecedents. This difference between the recall results of the present study and the reading times results of Almor (1999) simply shows that the recall task is not equivalent to self-paced reading. Whereas self-paced reading taps online local processing, the recall task reflects the final product of this processing. As we just argued, this final product of processing is not affected by local discourse factors such as antecedent focus unless a violation of conversational principles occurs. According to the ILH, the general category anaphors used in Experiment 2 did not perturb the balance between cost and function in any condition and therefore did not violate any conversational principle. As a result, focus did not affect the resulting memory representation in this experiment. In Almor (1999), reading times of the same items showed focus facilitation because focus facilitated referent identification and did not slow further processing because there was no violation of the balance between cost and function.

The other condition under which focus has been shown to affect the memory representation of discourse is incomplete discourses wherein facilitatory and delayed effects of focus have been reported (Birch et al., 2000; Birch & Garnsey, 1995). One possible explanation of these effects is that because these studies used incomplete discourses, participants were able to allocate resources that would normally be used for processing the subsequent discourse, for the encoding of focus information. Alternatively, the absence of subsequent discourse may provide a cue for the importance of the focus information, which otherwise is likely to only be important for the local processing of the discourse. However, the fact that these studies used reading based paradigms also leaves open the possibility that the differences between these studies and the present results reflect differences between spoken and written language comprehension. Future research will have to assess this possibility in order to better understand the effects focus has on the memory representation of discourse.

Overall the present results are compatible with a general framework of discourse processing in which basic memory processes such as priming affect immediate processing, and the processing of discourse coherence affects the resulting memory representation. The ILH offers a compelling specific account that is compatible with this framework and that is unique in that it explains the relation between coherence and the processing of different referential forms and of repeated vs. non-repeated definite NP anaphors.

Conclusion

The present research reports a memory-based repeated name penalty in the processing of spoken language, thus supporting theories that view the repeated name penalty as a characteristic of general referential processing and not as a reading-specific phenomenon. The finding that this effect is unique to the use of repetitive NP anaphors but is not observed with non-repetitive NP anaphors further supports the ILH (Almor, 1999, 2000, 2004), which, on the basis of a general pragmatic principle of balancing processing cost with discourse function, predicts differences between repetitive definite NP anaphors and non-repetitive definite NP anaphors that mirror differences between repetitive definite NP anaphors and pronouns. Although these results place important boundary conditions on theories of anaphor processing in spoken language comprehension, more research is required in order to uncover the precise timing of the different processes involved. However, the present results nevertheless support the ILH's distinction between different processing stages in anaphor resolution and its predictions about the processing of repeated vs non-repeated definite noun phrase anaphors.

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