

The effect of focus on bridging inferences

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Bridging inferences are specific types of inferences in which the objects or events referred to in sentences are connected in a meaningful way so as to create a coherent discourse (Hawkins 1978, Levinson 2000, Matsui 2001). Imagine a speaker utters the short text in (1):

- (1) The bridge collapsed. The wood was rotten.
- (2) “The bridge collapsed because the wood of the bridge was rotten”.

In most contexts, a hearer would draw the inference in (2). (2) is the bridging inference that enables the hearer to connect the sentences in (1) in a meaningful way. This inference connects both the objects, i.e. ‘the wood’ and ‘the bridge’, and the events, i.e. ‘the bridge collapsed because the wood was rotten’, referred to by the sentences in (1). Bridging inferences are fundamental to conversational dialogue; they are an implicit safeguard against redundancy. Speakers often assume that during a given conversation, hearers can draw inferences without being explicitly told to do so. If bridging inferences are crucial to natural language processing, then the question remains; what licenses bridging inferences such as (2)? Standard accounts (Grice 1967, Levinson 2000) suggest that in (1), there is a stereotypical relationship between the objects and events mentioned in (1) such that the hearer will naturally infer (2). In this case, a hearer’s world knowledge includes the fact bridges are often made of wood, thus allowing for referential usage of ‘the wood’.

We might further ask; what other linguistic factors influence successful bridging inferences? Previous work has largely ignored the effects of prosody on bridging inferences. As illustrated in examples (3)-(4); different pronunciations of “the car smashed the truck” can influence the types of inferences that hearers draw:

- (3a) The car smashed the truck.

(3b) The [WINDSHIELD_F] shattered. (Emphasis on "windshield")

(3b') The windshield [SHATTERED_F]. (Emphasis on "shattered")

(4) "The car smashed the truck causing the windshield of the car to shatter."

(4') "The car smashed the truck causing the windshield of the truck to shatter."

Unlike (1), a hearer's world knowledge about (3b/3b') is not sufficient in determining the relevant bridging inference. The fact that both cars and trucks have windshields does not indicate (4) to be a better inference than (4') and vice versa; it does not unambiguously connect the objects and events of (3b/3b') to (3a). It is the speaker's choice to deaccent or accent "the windshield" and "shattered" that either forces the hearer to infer (4) or (4') respectively. This suggests that a complete account of must take into account the effects of prosody on bridging inferences. There has been little investigation of the role of prosody in bridging inferences. In this paper, I present a pilot perception experiment that suggests that prosody plays an important role in bridging inferences.

The structure of the paper is as follows. Section 1 outlines previous accounts of bridging inferences including both pragmatic and experimental characterizations of the phenomenon. Section 2 outlines the pilot perception experiment. The third section discusses the implications of the experiment.

1. THEORETICAL BACKGROUND There have been several pragmatic accounts of bridging inferences. As previously stated, standard accounts generally assume there is a stereotypical or easily identifiable relationship between sentences that allow for successful bridging inferences. Hawkins argues that there is a sort of a salient class relation at work in bridging inferences. Consider the following examples (Hawkins 1978: 107):

(1a) Mary traveled to Munich. The journey was long and tiring.

(1b) "Mary's journey to Munich was long and tiring."

(2a) Fred was wearing trousers. The pants had a big patch on them.

(2b) “Fred’s pants had a big patch on them.”

In (1.1a), ‘to travel’ implies a set of related words that possibly include ‘the journey’, ‘the trip’, etc. This allows for the bridging inference in (1.1b). In (1.2a) & (1.2b), ‘trousers’ and ‘pants’ are synonyms and therefore may refer to the same object. The hearer can infer this inclusion relations based on the “knowledge” and “rules of the language” (Hawkins 1978: 107). Or more intuitively, imagine (1.1) & (1.2) are uttered by a hearer in conversation. The hearer stores the first sentence into memory, e.g. “Fred was wearing trousers”, and upon hearing the second sentence, e.g. “the pants had a big patch on them”, the hearer can unambiguously infer that ‘the pants’ refer to ‘the trousers’ because ‘the trousers’ is the only salient referent.

Levinson argues similarly; bridging inferences are conversational implicatures generated via the (neo)Gricean injunction “don’t state what can be inferred”¹ (Grice 1967). Consider the following example (Levinson 2000: 182):

(3a) The bridge collapsed. The wood was rotten.

(3b) “The bridge collapsed because the wood of the bridge was rotten.”

Successful bridging inferences occur simply because they meet with our stereotypical assumptions regarding sentences. Because a hearer knows that bridges are commonly made of wood, (1.3b) can be easily inferred.

Matsui (2001) offers a possible experimental design to account for both stereotypical & astereotypical bridging inferences. Consider the following examples (Matsui 2001: 258):

(4a) I unpacked the picnic. The beer was warm.

(4b) The beer was part of the picnic.

¹ Levinson argues that bridging inferences are I-implicatures (Levinson 2000: 182). However, the precise pragmatic classification of bridging inferences is not relevant for the purposes of this paper.

(5a) I had a job interview. The beer was warm.

(5b) “The beer was offered at the job interview.”

Matsui argues that the comprehension latency times of subjects in generating inferences such as (1.5b) should be longer than that of (1.4b) because (1.5) is not as relevant as (1.4), i.e. there is seemingly relation between ‘a job interview’ and ‘the beer’.

The question then remains; are the sorts of stereotypical relationships driving bridging inferences the only linguistic factors responsible for this type of inference pattern? Consider again the following example:

(6a) The car smashed the truck. The windshield shattered.

(6b) The windshield of the car shattered.

(6c) The windshield of the truck shattered.

In (1.6), there is both a class inclusion relation and a stereotypical relationship between ‘the windshield’ and both ‘the car’ and ‘the truck’. Specifically, both cars and trucks have windshields. Therefore, these accounts cannot correctly disambiguate between (1.6b) and (1.6c). But is the bridging inference in (1.6) unrecoverable?

There are examples from the literature referred to as CONTRASTIVE FOCUS in which focus can disambiguate the intended referent. Consider the following example (Roberts 1998: 40):

(7a) Mary called Sue a Republican, and then [SHE]_B insulted [HER]_A.

(7b) Mary_A called Sue_B a Republican, and then [SHE]_B insulted [HER]_A.

(7c) Mary_A called Sue_B a Republican, and then [SHE]_A insulted [HER]_B.

The focus of “she” and “her” can shift the intended antecedents between “Mary” and “Sue”. The purpose of this paper then, is to determine whether focus has a similar effect

upon bridging inferences. Given a bridging inference as in (1.6), does (non)heavy focus on the “the windshield” shift the intended antecedent between “the car” and “the truck”.

2. EXPERIMENT The following experiment aims test the effects of a potentially ambiguous bridging inference as illustrated in Section 1.7. This pilot experiment was a perception experiment in which subjects were tested on the effects of shifting prosody on bridging inferences.

2.1. METHODS 6 adults over the age of 18 participated as volunteers for this experiment. The stimuli consisted of 22 bridging & 22 contrastive scenarios based on the following constructions:

Construction	Sample Stimuli
[TP [vP [DP]]]	The car smashed the truck. The windshield was shattered.
[TP [vP [DP]]]	The knight’s sword clashed with the barbarian’s axe. The blade fell from the hilt.
[TP [vP [DP & DP]]]	The girl put on a blouse and a skirt. The seam ripped while she was walking.

TABLE 1. Sample stimuli by construction

The 22 bridging scenarios were recorded a total of 44 times. The first set of 22 bridging scenarios was recorded with heavy accent on the predicate of the second sentence. This set was referred to as the BNonFocus condition. The second set of 22 bridging scenarios was recorded with heavy accent on the subject of the second sentence. This set was referred to as the BFocus condition. 22 contrastive scenarios served as a baseline condition. The first set of 22 scenarios was recorded with heavy accent on the predicate of the second sentence. This set was referred to as the PNonFocus condition. The second set of 22 scenarios was recorded with a heavy accent on the subject of the second sentence. This set was referred to as the PFocus condition:

Condition	Sample Stimuli
BNonFocus	The car smashed the truck. The windshield was [SHATTERED _F].
BFocus	The car smashed the truck. The [WINDSHIELD _F] shattered
PNonFocus	The car smashed the truck. It was [SHATTERED _F].
PFocus	The car smashed the truck. [IT _F] shattered

TABLE 2. Sample stimuli by condition

There were a total of 88 stimuli. Subjects were randomly assigned a block – *A* or *B*. Each block was tested on 44 randomized scenarios – 22 bridging and 22 contrastive. Subjects were tested in a quiet room with only the experimenter present. Subjects were told to determine the referent of the subject of the second sentence with regards to the first sentence. Subjects were instructed no more. Subjects were encouraged to give their first response and not to change their original answers. One of the experimenters was present to answer questions if necessary, but no additional information or clarification was provided.

2.3. RESULTS Overall, results indicate when the subject noun of second sentence received heavy focus, subjects were more likely to assign the referent of the subject noun of the second sentence to the object noun (or second noun in the coordinated object) of the first sentence as opposed to when the subject noun of the second sentence did not receive heavy focus:

- (1) The car₁ smashed the truck. The windshield₁ was SHATTERED.
- (2) The car smashed the truck₁. The WINDSHIELD₁ shattered

In the BFocus condition, subjects were more likely to assign the referent of the subject noun of the second sentence to the object noun (or second noun in the coordinated object) of the first sentence (77%). This was more likely to occur than the BNonFocus condition (39%). We observed similar results in the contrastive condition. In the PFocus condition, subjects were more likely to assign the referent of the subject noun of the

second sentence to the object noun of the first sentence (68%). This was more likely to occur than the PNonFocus condition (3%). These results are summarized graphically in Figure 2.

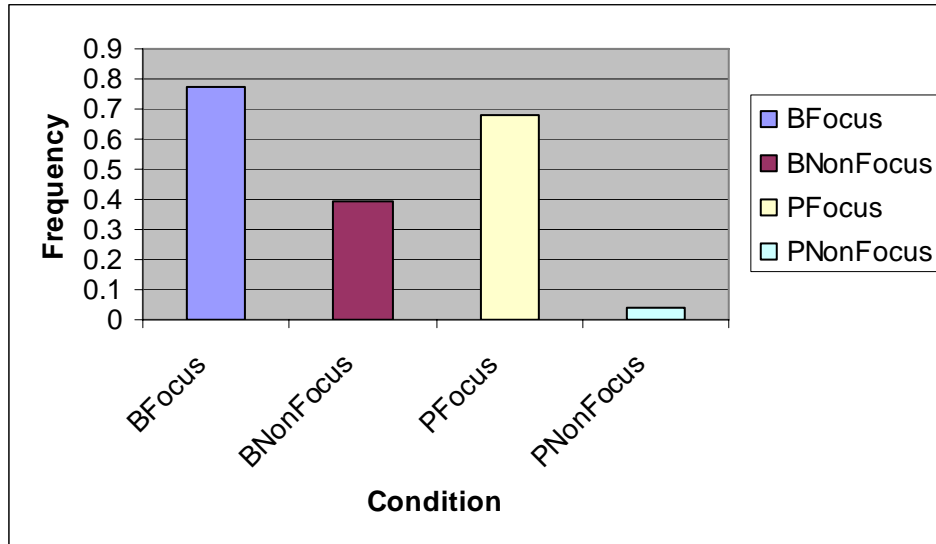


FIGURE 1. Mean frequency of nuclear pitch accent by condition.

Figure 2 represents the results of each subject's performance by condition.

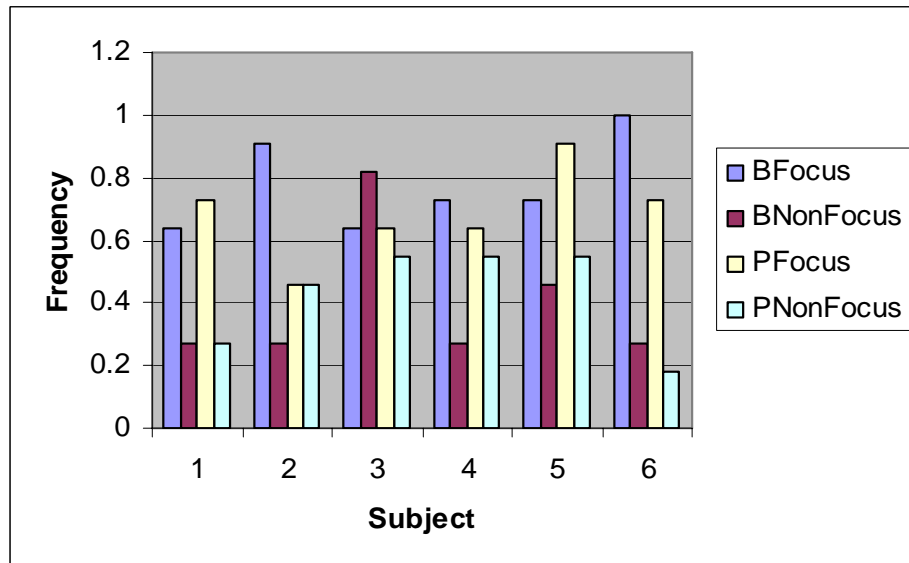


FIGURE 2. Mean frequency of nuclear pitch accent by subject.

Figure 3 represents the shift of referent assignment to the object noun (or second noun in coordinated object), i.e. #FocusObject - #NFocusObject:

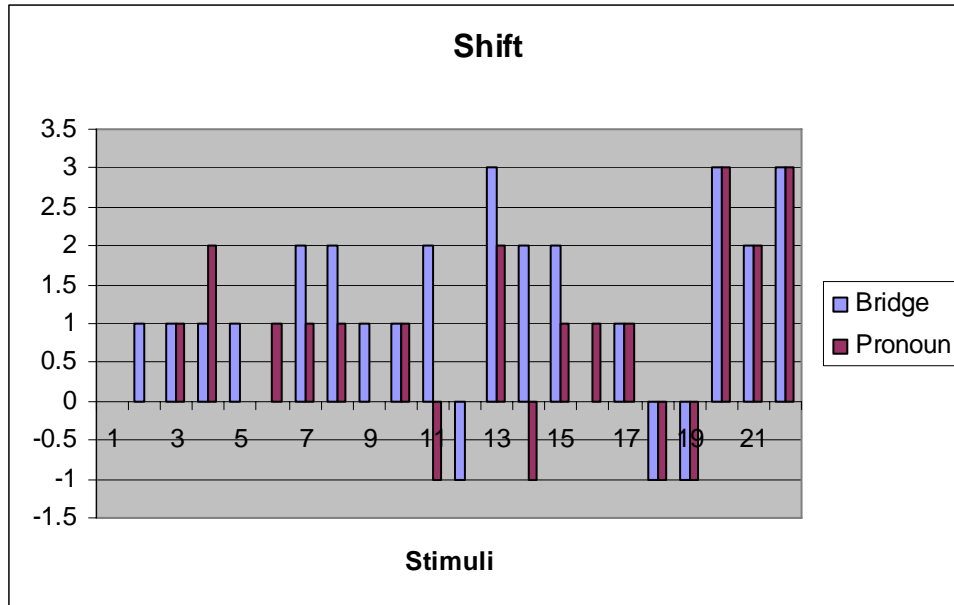


FIGURE 3. Shift of bridge and contrastive condition.

Pooling across subjects, a paired t-test revealed a significant effect between the BFocus and BNonFocus condition ($t = 2.8791, p < 0.035$). A similar effect was found between the PFocus and PNonFocus condition ($t = 2.7948, p < 0.039$). Pooling across conditions, a paired t-test revealed did not reveal a significant effect between the BFocus and PFocus condition ($t = 0.9393, p < 0.40$) or the BNonFocus and PNonFocus condition ($t = -0.378, p < 0.73$). There is not enough data to compute the statistical effects *per* stimuli.

3. DISCUSSION & CONCLUSION The central questions of this paper were simply are subject's choice of referent assignment in ambiguous bridging constructions (ir)regular? And if this assignment is regular, is it due to the effects of prosody? The results in Section 2 suggest that subjects are in fact sensitive to the effects of prosody on bridging inferences, and that they systematically vary their decision of referent assignment based on (heavy) focus on specific lexical items. The fact that both the bridging condition and the contrastive condition patterned similarly suggests that there is an underlying similarity between the effects of focus on both constructions. Reference to formal

theories of contrastives might help develop a more coherent analysis of bridging inferences and the effects of prosody thereof. Because this experiment illuminates an implicit relation between both bridging constructions and contrastives, bridging inferences themselves may be subsumed under general notion of discourse and context as discussed by Roberts (1998).

However, there is much work left to be done. The experiment itself must be retooled and presented on a larger scale as to garner the necessary data to draw more accurate conclusions. The immediate problems of the experiment lie in the stimuli themselves. The number of scenarios must be expanded in number and better controlled as to eliminate potential semantic and pragmatic influence on subject's referent assignment decisions. Consider the following scenario drawn from the perception experiment:

(1a) I played the harp and the violin. The strings sounded beautiful.

(1b) I played the harp and the violin. It sounded beautiful.

It is clear that in (3.1a) & (3.1b), 'the strings' and 'it' can refer to both 'the harp' and 'the violin' simultaneously, as the concatenation of strings can sound beautiful. This is the sort of semantic and pragmatic effect that must be eliminated from each scenario. However, the results from the pilot experiment were statistically suggestive in that prosodic focus does play a role in the process of determining the most salient inference pattern with regards to ambiguous bridging inferences.

References

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