

# Prosody and the *That-Trace* Effect: An Experimental Study

Amanda Ritchart, Grant Goodall, and Marc Garellek

## 1. Introduction

The “*that-trace* effect” refers to the sharp decline in acceptability that occurs when an embedded subject is extracted in the presence of an overt complementizer such as *that*, as in (1).

(1) \*Who do you think that \_\_ will arrive late?

This phenomenon, studied since at least Perlmutter (1968), has been subject to two broad types of analysis (see Pesetsky (forthcoming)). In one, the effect derives from constraints on the *wh*-dependency related to the hierarchical structure of the sentence, while in the other, it derives from constraints on the linear order of elements. In the latter type of analysis, some have argued that the constraints take the form of a prosodic filter (Kandybowicz, 2006; Ha, 2010; Sato & Dobashi, 2013). Kandybowicz (2006), for instance, posits a prosodic filter that disallows adjacency between a complementizer and a gap (*wh*-trace) when they are within the same prosodic phrase and the complementizer is aligned with the left edge of that phrase. This accounts for (1), assuming that *that* is at the left edge of the prosodic phrase, and it also accounts for the amelioration that occurs when *that* and the gap are not adjacent, as in (2) (Bresnan, 1977; Barss and Deprez, 1986; Culicover, 1993), or when they are in separate prosodic phrases, as in (3) (De Chene, 1995, 2000, 2001).

(2) Who do you think that after years and years of cheating death \_\_ finally died?

(3) Who does John doubt whether and Bill suspect that \_\_ cheated on the exam?

Kandybowicz claims that further evidence for this approach comes from two additional ways that the prosodic filter can be avoided: by placing contrastive focus on the embedded verb, as in (4), or by contracting the complementizer and an auxiliary across the gap site, as in (5).

(4) ? Who do you think that \_\_ WROTE Barriers? (cf. \*Who do you THINK that \_\_ wrote Barriers?)

(5) ? Who do you suppose that’ll leave early?

These cases are particularly interesting, because unlike (2)-(3), there is no obvious change in the syntactic structure here, so to the extent that there is amelioration, we would seem to have evidence against approaches that attribute the *that-trace* effect to structural properties of the *wh*-dependency. (4) and (5) thus have the potential to provide crucial evidence regarding the proper account of *that-trace* phenomena. Unfortunately, though, informal judgments of the acceptability of these sentences are not clear-cut, so it is difficult to be confident about the results.

In this paper, we explore this question experimentally, by means of formal acceptability experiments with audio stimuli. We perform two experiments of this type, one exploring the effects of

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contrastive focus, as in (4), and the other the effects of contraction between *that* and the following auxiliary, as in (5). We see that in both cases, the reported amelioration does not materialize, thus weakening support for prosodic approaches to the *that*-trace effect.

## 2. Methods

### 2.1. Participants

A total of 28 native English speakers (18 female, 10 male, M: 20 years old, range: 18-27) participated in both experiments. Four participants were removed from analysis due to native proficiency in another language in addition to English (3) and experimenter error (1). Thus, a total of 24 speakers were included in analyses (14 female, 10 male). All participants were undergraduate students at UC San Diego, and all received course credit for their participation.

### 2.2. Stimuli

All stimuli were recorded by the first author, a trained phonetician, in a soundproof booth in UC San Diego's Phonetics Lab. Each stimulus included both a context and a test sentence. The test sentence will be described first, followed by the context that was added to each test sentence.

In Experiment 1, all test sentences were *wh*-questions with a gap in the embedded clause, following a 3x2x3 design: presence of *that* (*that* vs. no *that*), gap site (subject vs. object), and placement of contrastive focus (matrix verb vs. embedded verb vs. none ("broad" focus)). Contrastive focus is generally defined as marking "a constituent that is a direct rejection of an alternative, either spoken by the speaker himself ('Not A, but B') or by the hearer" (Gussenhoven, 2007, p. 91). An example of a complete stimuli set (with context and test sentence) is given in Table 1.

All test sentences consisted of one of six matrix verbs: *think*, *assume*, *hope*, *suppose*, *guess*, *insist*. Unlike a verb like *believe*, for example, these verbs do not allow a human DP complement and the possibility of a garden path effect in the stimuli is thus avoided. All embedded verbs (36 total) had human subject and object DPs in order to make stimuli as similar as possible across the gap site condition.

Each test sentence was preceded by a context that made the contrastive focus felicitous (Culicover & Rochemont, 1983). In the matrix verb focus condition, one of three possible contexts was added:

(6) I know you don't KNOW...

(7) I know you aren't SURE...

(8) I know you can't CONFIRM...

In the embedded verb focus condition, we used the same contexts as in the matrix verb focus condition, except that *know*, *sure*, and *confirm* were not focused. Instead, a contrastive verb was added to the context and accented so that it could be contrasted with the embedded verb in the stimulus sentence (see Table 1). In all cases, the embedded verb chosen in the context was contrastive to the embedded verb in the test sentence, so that the contrast could be easily comprehended (e.g., *hugged* vs. *kissed*). In the broad focus condition (i.e., no contrastive focus), one of three possible contexts was added:

(9) I was meaning to ask you this yesterday, but...

(10) I didn't want to ask you this, but...

(11) I'm embarrassed to ask you this, but...

A context was added to the broad focus condition in order to match the presentation of the other Focus conditions. An equal number of stimuli sets received each of the three possible contexts across Focus conditions.

	Subject Gap	Object Gap
Matrix verb focus	(I know you don't KNOW who hugged John, but...) Who do you THINK (that) __ hugged John?	(I know you don't KNOW who John hugged, but...) Who do you THINK (that) John hugged __?
Emb. verb focus	(I know you don't know who KISSED John, but...) Who do you think (that) __ HUGGED John?	(I know you don't know who John KISSED, but...) Who do you think (that) John HUGGED __?
Broad focus	(I didn't want to ask you this, but...) Who do you think (that) __ hugged John?	(I didn't want to ask you this, but...) Who do you think (that) John hugged __?

Table 1. Sample stimuli set for Experiment 1 (contrastive focus). Contexts for each test sentence are shown in parentheses.

Stimuli were recorded with default contrastive or broad focus intonation: each test sentence consisted of one intonational phrase (IP) with no IP-medial intermediate phrases. Sentences with contrastive focus had a nuclear L+H\* pitch accent on the focused word followed by de-accenting (Pierrehumbert & Hirschberg, 1990), and broad focus *wh*-questions had a L+H\* pitch accent on the *wh*-word followed by a gradual fall (Bartels, 1997). Each stimulus was subsequently analyzed intonationally to ensure that the prosody was consistent and appropriate across stimuli and experiments.

Individual examples of each Focus condition are given to demonstrate the F0 contour using intonational phonology in Figures 1, 2, and 3. Figure 1 demonstrates a typical contour for the matrix focus condition. There is a L+H\* pitch accent on the matrix verb followed by de-accenting and a shallow L-H% rise. Figure 2 demonstrates a typical contour for the embedded focus condition, with a L+H\* pitch accent on the focused word, followed by a L-H% shallow rise, just as with the matrix focus condition. Figure 3 demonstrates a typical contour for a *wh*-question with no contrastive focus (i.e., broad focus) in American English. In this example, the broad focus contour contains a L+H\* pitch accent on *who* followed by several other (less prominent) pitch accents, and finally, a fall (L-L% boundary tone).

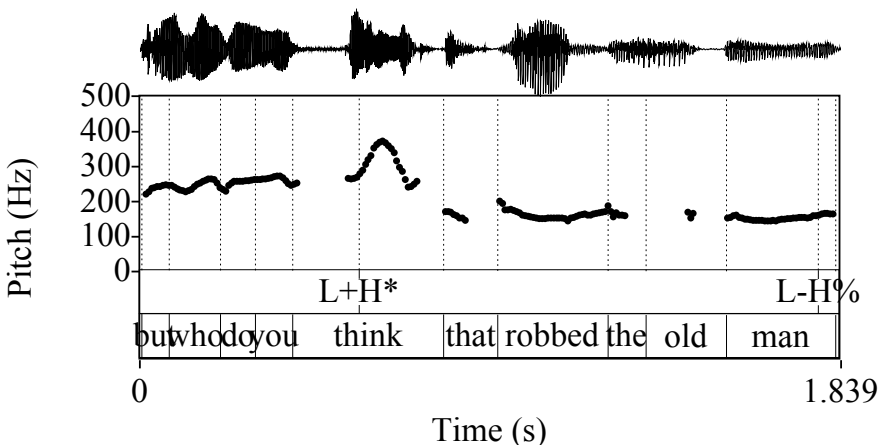


Figure 1. Example waveform and F0 contour of matrix verb focus test sentence. The intonation is labeled using MAE\_ToBI (Mainstream American English Tones and Break Indices), according to the guidelines by Veilleux, Shattuck-Hufnagel, & Brugos (2006).

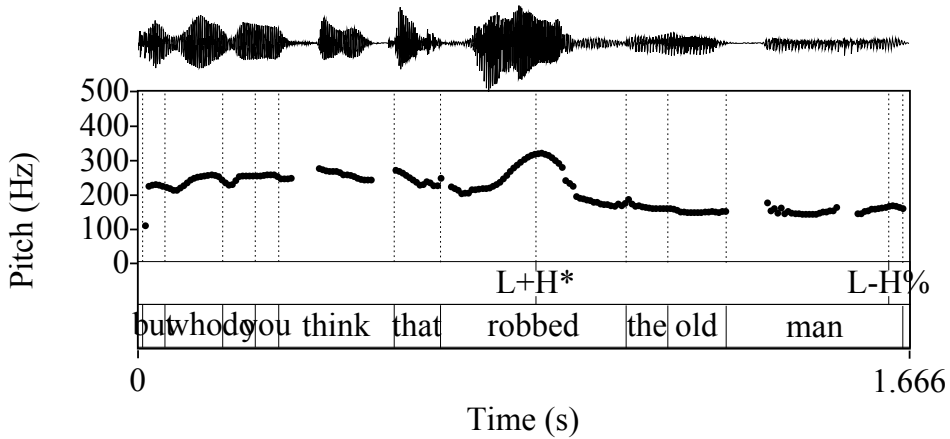


Figure 2. Example waveform and F0 contour of embedded verb focus test sentence. The intonation is labeled using MAE\_ToBI.

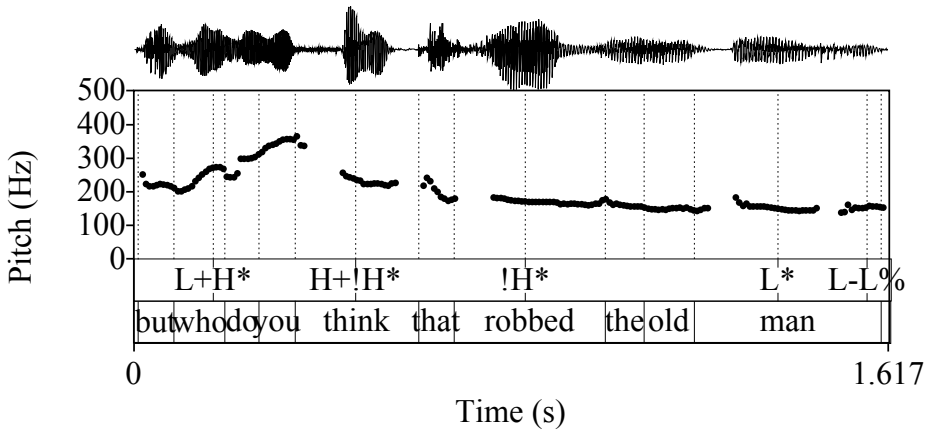


Figure 3. Example waveform and F0 contour of broad focus test sentence. The intonation is labeled using MAE\_ToBI.

Thirty-six lexically matched sets of experimental sentences were distributed using a Latin Square design among twelve lists consisting of three tokens of each of the twelve conditions. Each list included 36 fillers (half from Experiment 2), for an experimental/filler ratio of 1:1. All lists were randomized.

In Experiment 2, all test sentences were *wh*-questions with a subject gap, following a 2x3 design: sentence type (gap in embedded clause vs. gap in matrix clause followed by relative clause) and presence/type of *that* (non-contracted *that* vs. *that* contracted with following auxiliary (*that'll*) vs. no *that*). An example of a complete stimuli set is given in Table 2.

	Matrix Gap	Embedded Gap
Contracted <i>that</i>	Who do you guess that'll irritate the judge?	Who talked to the man that'll irritate the judge?
<i>that</i> / no <i>that</i>	Who do you guess (that) __ will irritate the judge?	Who talked to the man (that) __ will irritate the judge?

Table 2. Sample stimuli set for Experiment 2 (contraction across subject trace). Each test sentence in this set was preceded by the same context, "I didn't want to ask you this, but".

All matrix verbs in the *wh*-questions were the same as used in Experiment 1. The same criteria were used for the embedded verbs, though they were all novel in comparison to Experiment 1. For the *wh*-questions with a relative clause, the following six verbs were used: *talked*, *called*, *greeted*, *helped*, *saw*, *invited*. The object of the matrix clause in the *wh*-questions with a relative clause consisted of one of the following six DPs: *the man*, *the woman*, *the boy*, *the girl*, *the guy*, *the lady*.

Eighteen lexically matched sets of experimental sentences were distributed using a Latin Square design among six lists consisting of three tokens of each of the six conditions. Each list included 54 fillers (36 from Experiment 2), for an experimental/filler ratio of 1:3. All lists were randomized. *That'll* and *that will* were consistently pronounced as [ðærl] and [ðæʔwɪl], respectively. Each test sentence in Experiment 2 was also preceded by an appropriate context to match the presentation of stimuli in Experiment 1. The possible contexts used in the broad focus condition from Experiment 1 were also used in this experiment, as shown in (9) – (11). As in Experiment 1, each stimulus was subsequently analyzed intonationally to ensure that the prosody was consistent and appropriate across stimuli and experiments.

### 2.3. Procedures

Both experiments were interleaved as sub-experiments comprising a single larger experiment. The experiment was conducted in a soundproof booth in UC San Diego's Phonetics Lab and was presented on a PC using Praat (Boersma & Weenink, 2014). Each stimulus was heard only once, and participants could not ask to hear the stimulus again. Subjects were instructed to rate the acceptability of what they just heard using a 7-point scale (with 1 being "very bad" and 7 being "very good"). The experiment generally took about 15-20 minutes to complete.

### 2.4. Statistical Analyses

Results from each speaker were standardized prior to analysis and were analyzed using mixed-effects model comparisons with subject and item as random intercepts. This was the maximal random-effects structure that converged. For each experiment, the dependent variable was the numerical acceptability rating, and the fixed effects included each factor of the stimuli design as specified above. The Chi-squared statistic and corresponding *p*-value is given when presenting the results of the model comparisons. These values represent the comparison of the full model to the smaller nested model.

## 3. Results

The results from Experiment 1 are illustrated in Figure 4. Main effects were found for all factors: That ( $\chi^2(1) = 91.858$ ,  $p < .001$ ), Gap ( $\chi^2(1) = 47.996$ ,  $p < .001$ ), and Focus ( $\chi^2(2) = 14.508$ ,  $p < .001$ ), as well as significant interactions between That x Gap ( $\chi^2(1) = 57.926$ ,  $p < .001$ ) and Gap x Focus ( $\chi^2(2) = 21.368$ ,  $p < .001$ ). However, there was no significant interaction found between That and Focus ( $\chi^2(2) = 3.696$ ,  $p = 0.158$ ). Thus, in the broad focus case, as expected, subject gaps with *that* are significantly worse than the other three conditions (i.e., participants clearly show a *that*-trace effect, as shown in the That x Gap interaction). This *that*-trace sentence improves in the two contrastive focus cases, but a very similar amelioration occurs in the subject gap cases without *that* (i.e., there is no interaction between presence of *that* and focus type in the subject gap cases, as shown in the non-significant That x Focus interaction). The ameliorating effect that contrastive focus has been claimed to have on the *that*-trace phenomenon is thus real, but misleading: it is not specific to the *that*-trace sentence, and is part of a general amelioration that occurs in all the subject gap cases.

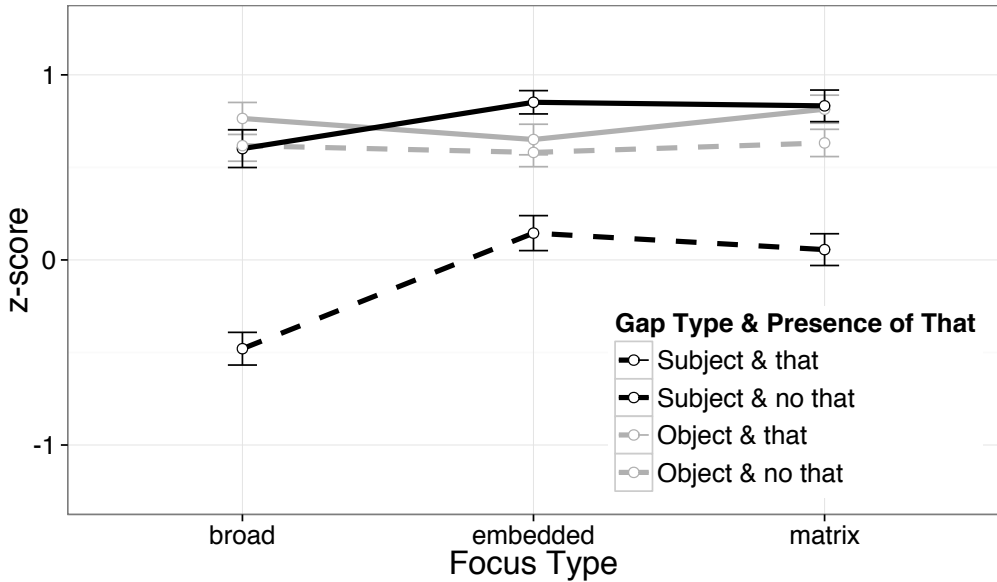


Figure 4. Results from Experiment 1. Error bars represent Standard Error. The dashed black line represents the subject gap condition with the presence of *that*, while the solid black line represents the subject gap condition without *that*.

The results from Experiment 2 are illustrated in Figure 5. There were main effects for both Sentence Type ( $\chi^2(1) = 13.341$ ,  $p < .001$ ) and That ( $\chi^2(2) = 6.09$ ,  $p = 0.048$ ), as well as a significant interaction of Type x That ( $\chi^2(2) = 168.46$ ,  $p < .001$ ). A summary of the best-fit model reveals that relative clause sentences were rated higher than *wh*-questions with an embedded gap overall ( $\beta = -0.374$ ;  $SE = 0.114$ ;  $t = -3.289$ )<sup>1</sup>. Also, for the That condition, there is a significant difference between no *that* and *that* ( $\beta = -1.247$ ;  $SE = 0.114$ ;  $t = -10.962$ ) and no *that* and *that'll* ( $\beta = -1.15$ ;  $SE = 0.114$ ;  $t = -10.108$ ), but no significant difference between *that* and *that'll* ( $\beta = 0.097$ ;  $SE = 0.114$ ;  $t = 0.854$ ).

Thus, here too, there is a clear *that*-trace effect: embedded subject gaps are significantly worse with *that* than without. Unlike what has been claimed, though, the effect remains even when *that* is contracted with the following auxiliary (as shown in the post-hoc comparison of *that will* vs. *that'll*). Such contraction also has no effect on relative clause *that*, although absence of *that* in that case leads to severe degradation, as expected.

<sup>1</sup> Following Baayen, Davidson, and Bates (2008),  $t$ -values greater than  $|2|$  are considered significant.

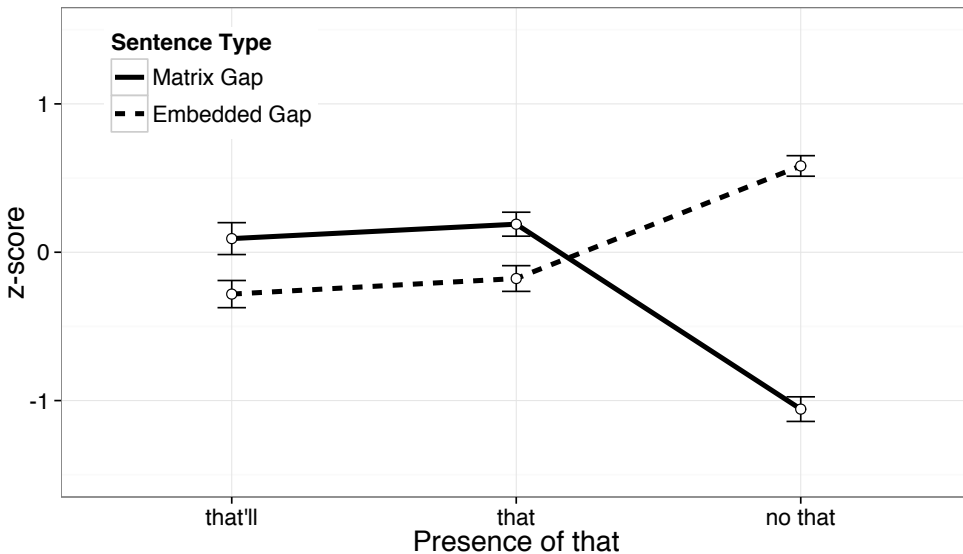


Figure 5. Results from Experiment 2. Error bars represent Standard Error.

#### 4. Discussion

As we saw in section 1, contrastive focus and contraction between *that* and an auxiliary both provide particularly interesting test cases for the analysis of the *that*-trace effect. Neither focus nor contraction results in a clear change in the syntactic structure, so if either one significantly ameliorates the *that*-trace effect, this would be difficult to explain in an approach in which the effect is due to constraints on the *wh*-dependency that are formulated in terms of syntactic structure. Since focus and contraction do result in clear prosodic effects, any amelioration would lend important support to approaches in which the *that*-trace effect results from constraints on prosodic structure. Our experiments were designed to test whether any such amelioration in fact occurs.

In Experiment 1, we found that contrastive focus does have a significant ameliorating effect on *that*-trace sentences. In isolation, this finding is in accord with Kandybowicz's (2006) claim, but when viewed more fully, the results do not support a prosodic account of the *that*-trace effect. First, the increase in acceptability that contrastive focus produces in the case of embedded subject extraction with *that* also occurs in the case of embedded subject extraction without *that*. Second, the amelioration occurs whether the contrastive focus is on the matrix verb or the embedded verb, contrary to Kandybowicz's prediction that it should only occur when the embedded verb is focused. The amelioration induced by contrastive focus thus appears to be a very general phenomenon and not specific to *that*-trace. Any placement of the focus, whether on the matrix or the embedded verb, seems to increase the acceptability of any case of embedded subject extraction, whether or not *that* is present. Why contrastive focus should increase acceptability, and why it should only do so with embedded subject extraction (as opposed to embedded object extraction), are still intriguing questions, which we shall leave unaddressed here. But crucially, we find no evidence that contrastive focus interacts in any interesting way with the *that*-trace phenomenon.

The results from Experiment 2 are even more straightforward. There we see that in non-*that*-trace environments (in matrix extraction in relative clauses), contraction seems to have no effect on acceptability; in *that*-trace environments, contraction likewise seems to have no effect. The claim from Kandybowicz (2006) that contraction results in amelioration of what would otherwise be *that*-trace violations thus receives no support in this experiment.

In both experiments, then, we find no support for the idea that prosodic factors can result in amelioration of the *that*-trace effect; neither contrastive focus nor contraction produced the result that has been claimed for them in the literature. As with any negative finding, there is a concern that the apparent lack of an effect might be due to insufficient sensitivity in the experiment, rather than to a

true lack of contrast in acceptability. In the present experiments, however, this seems unlikely. In Experiment 1 in particular, we did find the amelioration that has been claimed, in a sense, but we also found other types of amelioration that suggest that there are very general factors at play (i.e. increases in acceptability with embedded subject extraction when any type of contrastive focus occurs) and that there is nothing specific here to the *that*-trace effect. The fact that previously unnoticed effects were detected suggests that the experiment had a very high degree of sensitivity. Likewise in Experiment 2, a variety of contrasts were detected, suggesting a high degree of sensitivity. Both the *that*-trace effect and the effect of the absence of *that* in subject relative clauses resulted in very sharp contrasts, and the difference between the two types of grammatical *wh*-questions in the experiment (embedded subject extraction without *that* and matrix subject extraction with an embedded subject relative with *that*) was also significant. We would not expect the latter difference to be very large, since it is presumably due only to the somewhat greater complexity of the *wh*-questions containing relative clauses, but the fact that it was found suggests that the experiment was capable of detecting very subtle contrasts. Any effect that contraction might have on the *that*-trace phenomenon must then be, at a minimum, smaller than the effects that were detected in this experiment.

The two types of potential amelioration that we have explored here are notable because if true, they would be especially difficult to account for in analyses that attribute the *that*-trace effect to constraints on configurational properties of the *wh*-dependency. As we have seen, however, these two putative cases of amelioration do not appear to be real, and as a result, two of the most striking arguments in favor of a prosodic approach to *that*-trace disappear. This of course does not mean that a prosodic approach is necessarily incorrect or that there may not be other types of evidence in favor of it. Similarly, although the findings here may seem encouraging for an account of *that*-trace in terms of phrase-structure configurations, they do not provide any direct evidence for such a view.

## 5. Conclusion

As we saw at the outset, analyses of the *that*-trace effect have historically been divided between those that attribute the effect to constraints on the phrase structure representation and those that attribute it to constraints on linear adjacency, with some of the latter attributing it more specifically to prosodic constraints. If a prosodic approach is correct, we expect to find cases where the *that*-trace effect can be ameliorated by manipulating the prosody, while leaving the syntactic configuration essentially intact. Kandybowicz (2006) has claimed that such cases exist, and we have examined two of them in detail in this paper by means of carefully designed acceptability experiments with audio stimuli. Our results suggest that these putative cases of prosodic amelioration are at best illusory. Contrastive focus does increase acceptability of *that*-trace sentences, but this is part of a more general phenomenon in which contrastive focus improves all cases of embedded subject extraction, with or without *that*. Contraction between *that* and a following auxiliary, on the other hand, does not appear to lead to any amelioration at all. These findings remove what would be very striking evidence in favor of a prosodic approach, but otherwise leave open the question of the proper analysis of the *that*-trace effect.

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