Wh-Island Effects and D-Linking Effects Across Languages

Zheng Shen and Beth Chan

1. Background on wh-island effects and d-linking effects

Extraction out of embedded questions is observed to be degraded, often labeled as the wh-island effect (Ross 1967), shown in (1). The wh-island effect is claimed to be (partially) ameliorated when the moved element is lexically restricted and has the form *which NP* (Rizzi 1990, Friedmann et al. 2009, Villata et al. 2016) as shown in (2). We will refer to this effect as the discourse-linking (d-linking) effect.

(1) *What did the waiter wonder [whether the chef burned ____]?

(2) ??Which dish did the waiter wonder [whether the chef burned ____]?

Featural Relativized Minimality (fRM) (Villata et al. 2016, Rizzi 2001) is the prevailing grammatical analysis for wh-island effects and d-linking effects shown in (3) and (4).

(3) Featural Relativized Minimality (Villata et al. 2016: ex. 5)
In. . . X. . . Z. . . Y. . .
A local relation is disrupted between X and Y when
   a. Z structurally intervenes between X and Y
   b. Z matches the specification in morphosyntactic features of X

(4) Intervention is defined in hierarchical terms through c-command:
Z structurally intervenes between X and Y when Z c-commands Y and Z does not c-command X.

The unacceptability of (1) may be attributed to a violation of fRM, and its derivation is schematised in (5). According to fRM, the matrix C bears a [+Q] feature which attracts a lower wh-element bearing [+Q] over a higher wh-element *whether* which also bears the same [+Q] feature. Given that *whether* is c-commanded by the matrix C and c-commands the base-generated position of *what* (or its trace position), the configuration in (1) is disrupted.

(5) a. *$C_{[+Q]}$ did the waiter wonder whether$_{[+Q]}$ the chef burned what$_{[+Q]}$?
   b. *What $C_{[+Q]}$ did the waiter wonder whether$_{[+Q]}$ the chef burned *t*?

The d-linking effect in (2) may also be explained by fRM. Friedmann et al. (2009) proposes that if the intervenor Z (in (3)) partially matches the features of the higher element X, the penalty in acceptability and fRM effect is reduced. For questions with a d-linked wh-element, the matrix C head is specified as [+Q, +N], the intervening wh-element *whether* only partially matches its feature specification, shown in (6). Thus the island effect is ameliorated.

(6) a. ??$C_{[+Q,+N]}$ did the waiter wonder whether$_{[+Q]}$ the chef burned which dish$_{[+Q,+N]}$?
   b. ??Which dish$_{[+Q,+N]}$ $C_{[+Q,+N]}$ did the waiter wonder whether$_{[+Q]}$ the chef burned *t*?

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On the other hand, the d-linking effect has also received processing-based analyses. For example, Hofmeister & Sag (2010) proposes that which-NPs are easier to retrieve and this makes the long distance dependency easier to compute. The improved rating might result from such processing effect.

Against this background, this paper examines two issues related to wh-island effects and d-linking effects: 1. Does the amelioration effect of d-linked wh-elements extend to other languages with wh-movement? 2. How do d-linked wh-elements affect wh-in situ questions?

To investigate these issues, we conducted parallel experiments in American English to replicate the empirical profiles of wh-island and d-linking effects from previous experiments (Villata & Sprouse 2023) and in Colloquial Singapore English (CSE) which allows both wh-fronting and wh-in situ questions. To preview the results, we replicated the wh-island effects and the partial amelioration effects with d-linking wh-elements in American English. However, CSE only shows wh-island effects but no partial amelioration effects. D-linked elements in CSE improve the acceptability of long distance dependencies regardless of whether a wh-island is crossed, indicating a processing but not a grammatical effect. No d-linking effects on long distance dependencies are found in wh-in situ questions in CSE, replicating the results from Chinese (Chen 2022).

2. Wh-fronting questions

2.1. Experiment 1 American English

Villata & Sprouse (2023) uses the factorial design to investigate d-linking effects in multiple island constructions. For each island construction, three factors were manipulated: whether the sentence includes an island construction (Construction), whether a long distance dependency is present (DependencyType), and whether the wh-element is d-linked (WhType). The two way interaction of Construction and DependencyType indicates the island effect. The size of the effect can be measured with the Difference-in-Difference scores (DD scores). If d-linked wh-elements ameliorate the island effect, then the DD score for the d-linked wh-elements should be smaller than that for the bare wh-elements. Statistically, we should observe a significant three way interaction if the wh-element type affects the size of the island effects.

Different theories make distinct predictions regarding the d-linking effects in various island constructions. For example, the grammatical/fRM approach predicts that d-linked wh-elements improve wh-movement out of weak islands (e.g. wh-islands) but not strong islands (e.g. Complex NP islands). The processing approach, on the other hand, predicts that d-linked wh-elements improve sentences with a long distance dependency, regardless of whether an island has been crossed.

Unlike Villata & Sprouse (2023) who tested various island constructions, our paper focuses on wh-islands, and in particular, the *whether* island shown in (1). We conducted two parallel experiments in American English and Colloquial Singapore English. Villata & Sprouse (2023) found a partial amelioration effect of d-linked elements in the *whether* island for English. This result is in line with the prediction of fRM. We first replicate their experiment to establish an empirical baseline.

Our experiment also manipulates WhType (BARE vs. DLINKED), DependencyType (SHORT vs. MOVE), and Construction (NOISLAND vs. ISLAND). The 2*2*2 design results in eight conditions shown in (7). The two way interaction of Construction and DependencyType within bare wh-elements would indicate the wh-island effect. The three way interaction of whType, Construction and DependencyType would be indicative of the d-linking effect.

(7) Experiment 1 materials in American English

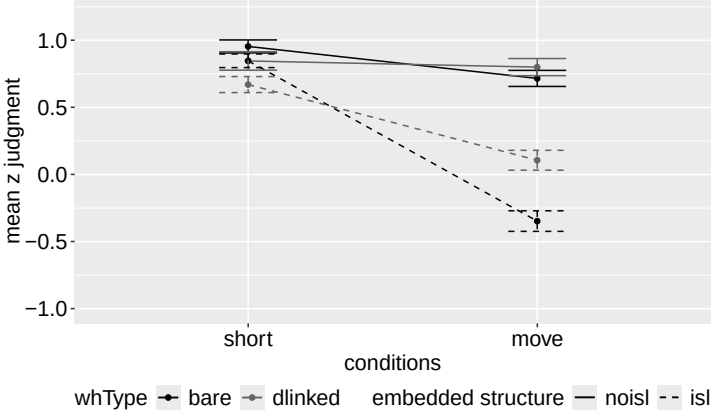
a.	Who said that Liam organised the event?	(bare-short-noisland)
b.	Who wondered whether Liam organised the event?	(bare-short-island)
c.	What did the director say that Liam organised?	(bare-move-noisland)
d.	What did the director wonder whether Liam organised?	(bare-move-island)
e.	Which director said that Liam organised the event?	(dlinked-short-noisland)
f.	Which director wondered whether Liam organised the event?	(dlinked-short-island)
g.	Which event did the director say that Liam organised?	(dlinked-move-noisland)
h.	Which event did the director wonder whether Liam organised?	(dlinked-move-island)

We conducted an acceptability judgment experiment in which participants were tasked to rate the acceptability of the sentences on a slider, the left end being labeled as *completely unacceptable*, the right as *completely acceptable*. The slider has 100 points on the backend but participants could not see the points, but were asked to move the cursor on the slider. The experiment was hosted on PCIbex.

Each participant saw 16 test items (2 items per condition), 32 filler items, and 3 filter items. Two filter items were grammatical checks where subject-verb agreement were manipulated. Participants who gave the sentence with an agreement violation a higher rating than the grammatical sentence were excluded. The third filter item was an attention check where the participants were asked to click on the left end of the slider. Participants who failed to follow this instruction were excluded from the analysis. 45 native speaker participants were recruited via Prolific and responses from 4 participants were excluded from the analysis due to failing the filter items. Responses from 41 participants were included in the analysis.

The z-score transformed condition means for the eight conditions in (7) are plotted in Figure 1. Superadditive effects are observed in the 2×2 comparisons for both bare and d-linked conditions, which indicates the presence of island effects for bare wh-elements and which-NP phrases. The rating of the ISLAND.MOVE condition is higher for DLINKED than BARE while ratings of other conditions are comparable between the two types of wh-elements.

Figure 1: Experiment 1 in American English



Linear mixed effects models were constructed with WhType, DependencyType, and Construction as fixed effects and subject and item as random effects. The maximal model was constructed and random terms were then removed until convergence. The model revealed a significant three way interaction ($t = -2.57$, $p < 0.05$). Both the two way interactions between WhType and DepdendencyType ($t = 5.05$, $p < 0.0001$) and between DependencyType and Construction reached significance ($t = -8.88$, $p < 0.0001$). Main effects of DependencyType ($t = 8.15$, $p < 0.0001$) and Construction ($t = 12.44$, $p < 0.0001$) were also observed.

The results of Experiment 1 show a partial amelioration effect of d-linked wh-elements. The wh-island effect still exists when d-linked wh-elements are used, but its size is smaller than conditions with bare wh-elements. The three way interaction indicates that the effect of d-linked wh-elements is larger for island violating conditions than the non-island violating conditions. Experiment 1 thus replicates the findings of Villata & Sprouse (2023), which is predicted by the fRM analysis. The processing approach, on the other hand, predicts a similar amelioration effect of d-linked wh-elements on both MOVE conditions, regardless of whether an island boundary is crossed. It is worth noting that it's possible that both fRM and the processing analysis are effective in American English, with fRM affecting the ISLAND.MOVE condition and processing affecting both MOVE conditions.

2.2. Experiment 2 Colloquial Singapore English: Part 1

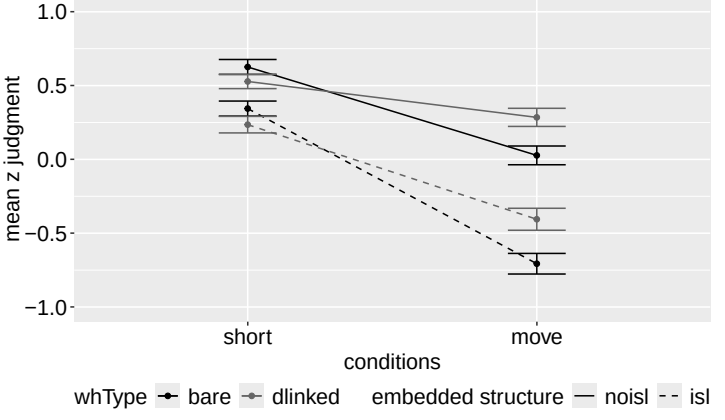
Experiment 2 investigates wh-island effects and d-linking effects in Colloquial Singapore English (CSE). As CSE allows both wh-fronting and wh-in-situ questions, both dependency types were included

in Experiment 2. The same three factors were included: DependencyType (SHORT vs. MOVE vs. SITU), Construction (ISLAND vs. NOISLAND), and WhType (BARE vs. DLINKED). The design yields 12 conditions shown in (8). (CSE allows null tense and agreement morphology, *do*-support may be omitted in MOVE conditions, and the question marker *ah* was included to prevent an echo question reading in SITU conditions.) Each list include 24 test items (2 items per condition), 33 filler items, and 3 filter items. The task and setup are identical to that of Experiment 1. 94 undergraduate students from the National University of Singapore completed the experiment.[1] The analysis includes responses from 81 participants after excluding participants based on their responses to filter items.

(8)
a. Who say that Shao Min solve the problem ah? (bare-short-noisland)
b. The prof say that Shao Min solve what ah? (bare-situ-noisland)
c. What the prof say that Shao Min solve ah? (bare-move-noisland)
d. Who want to know whether Shao Min solve the problem ah? (bare-short-island)
e. The prof want to know whether Shao Min solve what ah? (bare-situ-island)
f. What the prof want to know whether Shao Min solve ah? (bare-move-island)
g. Which prof say that Shao Min solve the problem ah? (dlink-short-noisland)
h. The prof say that Shao Min solve which problem ah? (dlink-situ-noisland)
i. Which problem the prof say that Shao Min solve ah? (dlink-move-noisland)
j. Which prof want to know whether Shao Min solve the problem ah? (dlink-short-island)
k. The prof want to know whether Shao Min solve which problem ah? (dlink-situ-island)
l. Which problem the prof want to know whether Shao Min solve ah? (dlink-move-island)

For the discussion of wh-fronting questions in direct comparison with American English, we focus on the SHORT and MOVE conditions here. Figure 2 shows the z-score transformed condition means of the SHORT and MOVE conditions. Both bare and d-linked wh-elements show superaddivity, which are indicative of wh-island effects for both types of wh-elements. Both MOVE.ISL.DLINKED and MOVE.NOISL.DLINKED have higher ratings than their respective BARE counterparts.

Figure 2: SHORT and MOVE conditions in Experiment 2 in CSE



A linear mixed effects model was constructed following the same structure as Experiment 1, and the three way interaction does not reach significance ($t = -0.32$, $p = 0.75$). The interaction of DependencyType and Construction is significant ($t = -3.93$, $p < 0.001$) as well as the interaction of WhType and DependencyType ($t = 3.86$, $p < 0.001$). There is a main effect of Construction ($t = 7.71$, $p < 0.0001$) and DependencyType ($t = 10.47$, $p < 0.0001$).

The results in CSE are different from American English. Although wh-island effects are also observed in questions with bare and d-linked wh-elements like American English in Experiment 1, the use of d-linked wh-elements did not ameliorate wh-island effects at all. Note that the analysis of CSE is based

[1] An initial group of 47 participants were recruited and a second group of 47 participants were recruited later to ensure the experiment has enough statistical power.

on almost twice as many responses as the American English (n = 81 vs. n = 41). Instead, we observe an improvement in the ratings of MOVE conditions in both ISLAND and NOISLAND conditions (resulting in the significant interaction of WhType and DependencyType). The lack of a three way interaction in CSE is surprising for the fRM approach to d-linking effects. The improvement of questions with d-linked wh-elements regardless of the presence of embedded questions is compatible with the processing analysis of d-linked elements: the use of d-linked wh-elements facilitates the retrieval of the filler and thus makes the processing of long distance dependencies faster. This effect is harder to find in the SHORT conditions as the short dependency is easy to compute in the first place.

2.3. Discussion

Under the factorial design, wh-island effects are observed in questions with bare and d-linked wh-elements in both American English and CSE. However, the d-linking effects show cross-linguistic variation. While the use of d-linked wh-elements partially ameliorated the wh-island effects in American English, it does not change the size of the wh-island effects in CSE. Instead, both MOVE conditions received higher ratings when d-linked elements were used.

Both the fRM analysis and the processing analysis, on their own, fall short in accounting for the entire set of results. The partial amelioration effects in American English are unexpected if only the processing analysis is in action, while the lack of partial amelioration effects in CSE indicates that the fRM analysis is not applicable here. Peter Jenks (p.c.) suggests that the cross-linguistic variation in fRM effects might be captured with variation in feature specification. There are two ways of implementing this idea: 1. the feature of C attracting d-linked wh-elements is [+Q] in CSE and not [+Q, +N] as in American English; or 2. the feature of d-linked wh-elements is [+Q] instead of [+Q,+N]. In either implementation, wh-movement of d-linked wh-elements out of an embedded question would involve a fRM violation with complete feature overlap with the crossed wh-element *whether*$_{[+Q]}$, thus no difference is expected in the size of wh-island effects. The effect of d-linked wh-elements on both MOVE conditions is expected if the processing analysis is in action in CSE: as both MOVE conditions contain a long distance dependency, the use of d-linked wh-elements facilitates the processing of such sentences by having a more specific cue.

Taken together, the results from both experiments can be accounted for if both the fRM analysis and the processing analysis are in action across languages. In CSE, given the feature specification of either C or d-linked wh-elements, movement of bare and d-linked wh-elements out of embedded questions involves a complete overlap of features with the intervening wh-item *whether*. As a result, no partial amelioration effect is observed in CSE. The improved ratings of the MOVE conditions in CSE is due to the facilitation effect of the long distance dependency as predicted by the processing analysis. Regarding American English, as we mentioned above, the partial amelioration of wh-island effects is compatible with a scenario where both the processing and the fRM analysis are on the right track: d-linked elements improve long conditions due to facilitated processing and the island-violating condition is further improved because of the partial feature overlap, an effect of fRM.

The analysis suggested above puts the differences between the languages in feature specification (of the d-linked-wh-attracting C or d-linked wh-elements) in two languages while maintaining that fRM and the d-linking facilitation effect of long distance dependency are in action in both languages. This analysis is not entirely empirically motivated. Strictly speaking, the results show fRM effects in American English and processing effects in CSE. The American English results do not provide evidence for the processing analysis, just like the CSE results do not provide evidence for the fRM analysis of d-linking effects. One could in principle argue that the processing effect of d-linked wh-elements is absent in American English and the fRM effect is absent in CSE (while assuming that the feature specification of C and d-linked wh-elements are identical in CSE and American English). However, such an alternative view would put cross-linguistic variation in more fundamental components of grammatical and processing mechanisms. We leave teasing apart these two approaches to future research.

3. Wh-in situ questions

Whether wh-island effects are observed for wh-in-situ questions is under debate. Huang (1982) observes that the question in (9) in Mandarin Chinese can be answered by either (9a) or (9b), which

indicates that embedded questions do not block the wh-element inside from taking matrix scope. Yang et al. (2021), on the other hand, argues that wh-island effects are present in Mandarin. Moreover, they suggest that sentences like the ones in (9) are only acceptable when the wh-elements are d-linked in the context. Recently, Chen (2022) used the factorial design methodology and found wh-island effects but no d-linking effects in Mandarin Chinese.

(9) Ni xiang-zhidao shei mai-le shenme?
you want-know who bought what

a. Wo xiang-zhidao Lisi mai-le shenme.
I want-know Lisi bought what
'I want to know what Lisi bought.'

b. Wo xiang-zhidao shei mai-le shu.
I want-know who bought book
'I want to know who bought books.'

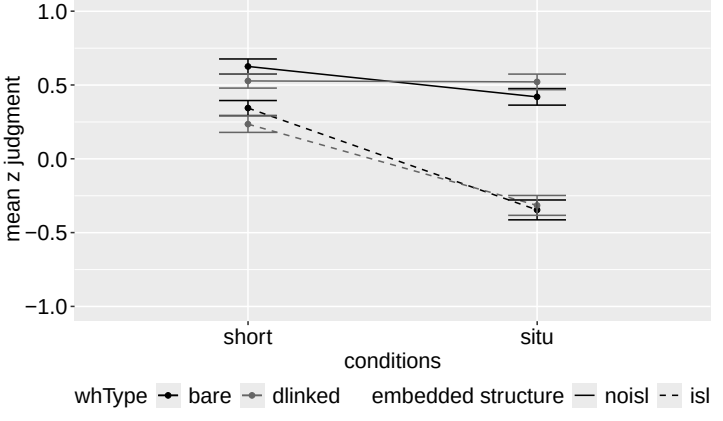
Against this background, we tested wh-in-situ questions in CSE. One advantage of using CSE is that the effects of wh-movement and wh-in-situ can be compared within one language without independent language variation. For example, the *whether* island cannot be straightforwardly tested in Mandarin Chinese as the embedded polar questions are expressed by A-not-A constructions which have a different syntactic structure from their declarative counterpart.

3.1. Experiment 2 Colloquial Singapore English: Part 2

As mentioned above, our CSE experiment include three levels of DependencyType: SHORT (subject questions), MOVE, and SITU. The analysis for wh-fronting questions which was reported in the previous section compares SHORT and MOVE conditions. The analysis reported here compares SHORT and SITU conditions. Using the same SHORT conditions as a baseline, we can observe whether wh-in-situ questions in CSE are sensitive to wh-islands and d-linking effects to the same extent as wh-fronting questions.

The z-score transformed condition means for SHORT and SITU conditions are plotted in Figure 3. Superadditivity is observed for both bare and d-linked wh-elements, which indicates wh-island effects for both WhTypes. No obvious effects of d-linking are observed, either on the island violating condition (like in Amercan English), or on the SITU conditions (like in MOVE conditions in CSE).

Figure 3: SHORT and SITU conditions in Experiment 2 in CSE



The structure of the linear mixed effects model for wh-in-situ questions follows previous analyses. The results do not find a significant three way interaction (t = 0.44, p = 0.66). There is a significant interaction of DependencyType and Construction (t = -4.63, p < 0.0001). Interactions between WhType and DependencyType (t = 1.52, p = 0.14) and betweenWhType and Construction (t = -0.35, p = 0.73) are not significant. When conditions with different WhTypes are analyzed separately, both types of wh-elements show a significant interaction between DependencyType and Construction (Bare: t = -3.11, p < 0.01; D-linked: t = -4.65, p < 0.0001). No main effect of WhType or any interaction with WhType was significant. The results indicate that wh-island effects are observed for wh-in-situ questions in CSE. Moreover, no effect of d-linking was found.

3.2. Discussion

Under the factorial definition of islands, our experiment found wh-island effects in wh-in situ questions in CSE, but did not find any effect of d-linked wh-elements. These findings are similar to the experimental studies done by Chen (2022) in Mandarin Chinese.

Comparing with wh-fronting questions in CSE where the d-linked wh-elements improved the ratings of conditions with long distance dependency, they did not make a difference in any condition with wh-in situ questions. Given that we proposed the amelioration effect here is due to the facilitation long distance dependency processing, this is not surprising. In wh-in-situ questions, there is no long distance filler-gap dependency to be processed in the first place, similar to the subject questions in the SHORT conditions.

Regarding the fRM analysis of the d-linking effects, we have already established that CSE differs from American English in that the partial amelioration effect is not found in wh-fronting questions in CSE (possibly due to different feature specification), we would not expect the effect to be observed in wh-in situ questions. Thus this part of Experiment 2 does no implications for the fRM analysis.

4. General Discussion

Our experiments show robust wh-island effects in American English wh-fronting questions and in CSE wh-fronting and wh-in-situ questions under the factorial design. However, three different patterns were observed regarding the d-linking effect. In wh-fronting questions in American English, the use of d-linked elements partially ameliorates wh-island effects, which is expected following the fRM analysis. In wh-fronting questions in CSE, however, using d-linked elements improves the ratings of sentences with long distance dependencies regardless of whether an island construction has been crossed. We argue that this effect is predicted by the processing approach to d-linking. In wh-in-situ questions, using d-linked wh-elements did not affect any condition. We argue that this is still in line with a version of the processing analysis where the facilitation effect is more obvious in sentences with long distance movement.

Assuming that the processing facilitation of d-linked wh-elements is universal across languages, we suggest that the amelioration of long distance dependency could be present in the American English results as well. However, this effect is masked by the fRM effect which only affects the island-violating condition. One way to probe this facilitation effect in American English would be to test strong islands for which the fRM effect is predicted to be absent. We leave this for future research.

Given the partial amelioration of wh-islands observed in American English which follows from fRM, the absence of a similar ameliorating effect for wh-movement out of wh-islands in CSE is a puzzle. We stipulate that the feature specification of either the d-linked element or the C head that attracts d-linked elements is [+Q] rather than [+Q, +N] as in American English. As a result, as far as fRM is concerned, there is no difference between moving a bare wh-item and a d-linked wh-item in CSE. That being said, it is tricky to come up with independent evidence for the feature specification in CSE. One potential avenue is to test whether bare and d-linked wh-elements behave differently as *interveners* in wh-island configurations (Villata et al. 2016). We leave empirically verifying this stipulation for future research.

We end the paper with a note on the source of wh-island effects in wh-in-situ questions. So far we have assumed that the source of wh-island effects is fRM: forming a filler-gap dependency across an element with overlapping features is degraded. Applying this analysis to wh-in-situ questions requires one to assume an LF movement analysis of wh-in-situ questions where the wh-elements move just as in wh-fronting questions, albeit in a covert component of grammar (Huang 1982, Chen 2022). One potential problem for this approach is the different profiles of island-sensitivity for wh-movement and wh-in-situ questions. It is well known that wh-in-situ questions are less sensitive to certain island restrictions, e.g. subject islands, CNPC (Tian et al. 2022 contra. Lu et al. 2020). However, recent studies show that wh-in-situ questions in Mandarin and CSE are sensitive to definite islands (Shen & Huang 2023, Shen 2024) and the current paper observes wh-island effects in wh-in-situ questions. If one assumes that LF movement does not observe Subjacency as an explanation for the island-insensitivity of wh-arguments (Huang 1982), the presence of definite island and wh-island effects is surprising.

Alternatively, one can assume an unselective binding analysis of wh-in-situ questions (Tsai 1994), where a question operator binds the wh-element in its base-generated position, as shown in (10). This

analysis is compatible with the absence of island effects for argument wh-in-situ questions: since the island restrictions are accounted for by constraints on movement, they do not apply to binding.

(10) OP_i you eat what$_i$ ah? Wh-in-situ question in CSE

Under this approach, the presence of island effects would require alternative explanations (See Shen (2024) for a proposal for definite islands). The wh-island effects observed above may be attributed to a violation of Li (1992)'s minimality condition on operator-variable binding. Li (1992), in discussion of wh-indefinites in Chinese, proposes the following constraint in (11) (Li 1992: ex. 39):

(11) The linking of a Wh-element with an operator is subject to minimality. The linking of A with B [...A...B...] obeys Minimality iff there is no intervening C [...A...C...B] such that C is linked to another element D, D ≠ B ≠ A.

Following (11), wh-island effects in wh-in-situ questions may be explained as the Q operator at C_i is unable to bind the in-situ wh-phrase across the intervening C_j and/or *whether*.[2]

(12) C_i The prof want to know C_j whether$_{[+Q]}$ Shao Min solve what$_{[+Q]}$ ah?

The experiments reported in the current paper do not tease apart LF movement and unselective binding approaches to wh-in-situ questions. However, if the wh-island effects in wh-in-situ questions are accounted for this way, d-linked wh-elements should not make a difference in the operator-variable binding between Q and the wh-phrase, which is compatible with the findings in these experiments.

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[2] Li (1992) made further suggestions to allow wh-island violating sentences in Mandarin, based on the claim that wh-island violation in Chinese is allowed, which Chen 2022's experiments dispute. In light of the experimental results, Li's proposal in (11) can be adapted on its own without the additional fix.

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