

What and how we can learn from mixed-*wh* interrogatives

Neal Whitman
The Ohio State University

1 Introduction

Attested sentences such as (1) pose an interesting problem for formal grammars.

- (1) Examples of optional NP-gap mixed-*wh* interrogatives
- a. You will learn to ... control **what and when** you eat.
<http://www.zonehome.com/whyzone.htm>
 - b. The Standards don't tell teachers **how or what** to teach.
<http://www.firn.edu/doe/curric/prek12/over.htm>

The interrogatives in (1) are different from other conjoined-*wh* interrogatives because they contains ‘mixed’ *wh* elements: a *wh* NP (*what*), and an adverbial *wh* (*when*, *how*). For *you eat* and *to teach* to serve as the factors for these coordinations, they must be parsed as both having and not having an NP gap. For *you eat* and *to teach* to have an NP gap, *eat* and *teach* must be taken as transitive verbs; for them not to have an NP gap, *eat* and *teach* must be taken as intransitive verbs. Thus, it seems that *eat* and *teach* are each being used simultaneously as transitive and intransitive verbs—that is, they are neutral with respect to their transitive and intransitive subcategorizations. This fact defies the conventional wisdom that words with different subcategorizations must occupy separate lexical entries (that is, they must be ambiguous), and cannot be used with more than one subcategorization simultaneously.

Mixed-*wh* interrogatives (MWIs) like those in (1) are not grammatical for everyone, but there are speakers for whom they are grammatical to the point of complete unremarkability. For example, when I asked one speaker what her reaction would be upon hearing (1a), she said, “I’d want to learn more!” Furthermore, simple searches on the Internet turn up too many MWI attestations for them to be dismissed as speaker error. However, even though a good deal has been written about multiple-*wh* interrogatives (e.g., *What did you do when?* or *When did you do what?*), MWIs have received scant attention in the literature. The only mention of them to my knowledge is in Giannakidou and Merchant (1998), who discuss sentences parallel to those in (1), noting that there is “variability in judgments” (239).

In this paper, an analysis of MWIs like those in (1) will be developed. The discussion of MWIs will proceed in three parts: Section 2 will give the results of a corpus search; section 3 discusses psycholinguistic experimental results; section 4 presents a type-logical analysis. Afterwards, section 5 discusses related issues; and section 6 offers a conclusion.

2 Corpus search

The corpus search was performed because attestations of MWIs needed to be found in greater numbers than they would be by simply watching and listening for them, for several reasons. First, many people (including me) find MWIs ungrammatical, rendering introspection useless for analysis. Second, having just a few attestations will not be sufficient; they need to be found in quantity in order for one to conclude that they are not (all) just instances of speaker error. Finally, many attestations are needed in order for one to see the range of the phenomenon, and be able to observe patterns that may occur. The corpus employed was the Internet, since it is easily accessible, and large.

2.1 Procedure

The search for optional NP-gap MWIs was conducted as follows. Between October 2000 and February 2001, the search engine AltaVista was used to search for each string in the following set: $(\{where, when, how, why, whether, if\} \times \{and, or\} \times \{what, who, which, whose\}) \cup (\{what, who, whom, which, whose\} \times \{and, or\} \times \{where, when, how, why, whether, if\})$. The first ten hits for each search were inspected by using “view source” to see the page’s source text, and then searching for the relevant string. Sometimes it happened that the string was not part of a MWI; for example, *what and when* might occur in *Something happened, but I don’t know what. And when I found out ...* Sometimes the strings were parts of elliptical titles, as in *The why, what, and when of motorcycle maintenance*. And sometimes, for whatever reason, the string could not be found in the source text at all. However, when a qualifying sentence was found, it was added to the list of attestations. In addition, several attestations seen in the newspaper or heard on the radio during this time were also included.

2.2 Results: other kinds of mixed-*wh* interrogatives

The results of the corpus search were surprising, in that in addition to many attestations of MWIs parallel to those shown in (1), there were also MWIs with different syntactic properties. In (1), each of the *wh* words was separately construable with the body of the interrogative; for example, both *what you eat* and *when you eat* is well-formed. However, there were also MWIs in which one or the other of the *wh* words was not construable with the body of the interrogative.

In cases like those shown in (2) and (3), the body of the interrogative has to be parsed as having an NP gap. This might be an object gap following an exclusively transitive verb (as in (2a)) or a stranded preposition (as in (2b)), or it might be a subject gap (as in (3)). In these cases, it is the adverbial *wh* word that does not seem to fit, indicated by the underlining.¹ These kinds of MWI will be known as OBLIGATORY NP-GAP MIXED-WH INTERROGATIVES.

- (2) Obligatory NP-gap mixed-*wh* interrogatives (object gap)
- a. She was very concerned that she didn't know **how or what** to say.
<http://www.sonlife.com/wwwboard/messages/43.html>
 - b. You find out everything about someone: who their friends are, what their opinion is on a wide range of matters, **whether and who** they are having sex with, the full range of someone's activities and emotions.
<http://member.newsguy.com/~mayday/crypto/crypto6d.html>
- (3) Obligatory NP-gap mixed-*wh* interrogatives (subject gap)
- a. Does anyone have any idea **where or who** would be able to locate parts?
<http://www.siriusweb.com/Fremlin/forum/messages/181.html>
 - b. It is not known exactly **why or who** burned the village.
<http://www.madison.k12.wi.us/whitehorse/ss/walls.htm>

In other cases, the body of the interrogative can not be parsed as having an NP gap at all, as in (4). In these cases, the nominal *wh* word is the odd one. These kinds of MWI will be known as MISSING NP-GAP MIXED-WH INTERROGATIVES.

- (4) Missing NP-gap mixed-*wh* interrogatives
- a. So **who or why** would you even need this thing.
<http://www.biznetonline.com/07-00/designtech.htm>
 - b. However, due to the nature of dating historical facts, there are opinions and disagreements as to **who or when** the actual event took place.
<http://www.rocheclan.com/html/antiquetimeline.html>

In addition to the above three kinds of MWI, there were also MWIs involving the copula, as in *Who and where are you?*, which will not be considered further here.

In light of the existence of obligatory NP-gap and missing NP-gap MWIs, MWIs parallel to those in (1) need a more specific name. They will be referred to as OPTIONAL NP-GAP MWIs.

It was claimed earlier that an analysis of optional NP-gap MWIs would have to hinge on the fact that verbs such as *eat* and *teach* could be both transitive and intransitive; otherwise, the sentences projected from them would not be able to combine with both *wh* elements. Implicit in this claim was the assumption that the interrogative would be well-formed only if each *wh* conjunct could individually combine with the factor into a well-formed sentence, an instantiation of what Pullum and Zwicky (1986) have dubbed Wasow's Generalization.

However, the interrogatives in (2) show that Wasow's Generalization is subject to exception with regard to *wh* interrogatives.

2.3 A competing analysis of mixed-*wh* interrogatives

In fact, a neutrality-based analysis of optional NP-gap MWIs is at a disadvantage now, accounting for only one out of three classes of MWI. By contrast, without referring to neutrality, one could neatly summarize the data thus far by noting that the odd *wh* words in (2) are never adjacent to the body of the interrogative, and positing a rule stating that any *wh* word can be coordinated with a well-formed *wh* interrogative to yield another well-formed *wh* interrogative. Such an analysis is similar to the one proposed by Giannakidou and Merchant (1998) for obligatory NP-gap MWIs in Greek; they take them to be generated by a rule similar to the one that licenses sluicing. That is, in their analysis, a Greek sentence parallel to *why or who burned the village* would be analyzed in much the same way as *who burned the village, or why*. For this reason, they propose the name REVERSE SLUICING for this kind of construction. Therefore, the hypothesis outlined above will be known as the Reverse Sluicing analysis.

Under Reverse Sluicing analysis, in an obligatory NP-gap MWI, the nominal *wh* word appears adjacent to the body of the interrogative, while the odd adverbial *wh* word is nonadjacent to it. This can be seen in those with an object gap: *how or what to say* in (2a), and *whether and who they are having sex with* in (2b). It also holds true in those with a subject gap: *where or who would be able to locate parts* in (3a), and *why or who burned the village* in (3b). Conversely, in a missing NP-gap MWI, the adverbial *wh* appears adjacent to the body of the interrogative, while the odd nominal *wh* word is nonadjacent. This pattern holds for *who or when the actual event took place* in (4a), and *who or why would you even need this thing* in (4b). In an optional NP-gap MWI, either a nominal or an adverbial *wh* word works equally well adjacent to the body of the interrogative, which can be parsed both with and without an NP gap. Thus, nominal or adverbial *wh* words would be expected to be adjacent to the body of the interrogative in comparable numbers. An example of each was seen in (1).

The pattern seen in the selected examples is true for the set of attestations as a whole. Table 1 shows that among optional NP-gap MWIs, the nominal and adverbial *wh* words appear adjacent to the body of the interrogative in approximately equal numbers, while for obligatory NP-gap MWIs, the nominal *wh* word is adjacent 39 out of 43 times, and for missing NP-gap MWIs, the adverbial *wh* word is adjacent 35 out of 35 times.

Kind of mixed- <i>wh</i> interrogative	Total attestations	<i>Wh</i> word adjacent to body of interrogative	
		Nominal	Adverbial
Optional NP-gap	58	31	27
Obligatory NP-gap	43	39	4
Missing NP-gap	35	0	35

Table 1
Ordering of *wh* words in three kinds of mixed-*wh* interrogatives

Thus, the data are consistent with the hypothesis that all three kinds of MWIs are generated by a rule of Reverse Sluicing. Since this analysis captures all the data instead of just the cases of optional NP-gap MWIs, it should be favored, unless there is some other reason to believe that optional NP-gap MWIs require an analysis different from that for MWIs in general. As it turns out, there is such a reason, revealed in data from psycholinguistic experimentation, the focus of the next section.

3 Psycholinguistic experimental data

If optional NP-gap and other mixed-*wh* interrogatives are generated by the same grammar rule, then (*ceteris paribus*) speakers' grammaticality judgments for the two kinds of sentences should be approximately the same. However, experimental results to be discussed in this section show that this is not the case.

3.1 Procedure

Questionnaires were constructed, in accordance with guidelines given in Chapter 9 of Cowart (1997), to test the difference between speakers' grammaticality judgments of optional NP-gap MWIs and similar obligatory NP-gap MWIs. (Missing NP-gap MWIs were not considered.) Each questionnaire consisted of 40 sentences, eight of which were the experimental items; the other 32 were fillers of varying grammaticality (including nine that were straightforwardly grammatical). The experimental items were (or contained) MWIs introduced by a binary coordination of nominal *wh* word and adverbial *wh* word (either *where*, *when*, *how*, or *why*). Four of these eight were (or contained) optional NP-gap MWIs; four of them were (or contained) obligatory NP-gap MWIs. Within each of these sets of four, two items had the adverbial *wh* word as the first conjunct, and two items had the adverbial *wh* word as the second conjunct. Thus, there were four kinds of experimental item, each of which appeared twice per questionnaire. A sample token set illustrating the four possibilities is given in (5), in which the template [___] *can I* [___]? is filled out with either *When and what* or *What and when*, and the verb *eat* or *do*. Since the (optional) gap in optional NP-gap MWIs

is always an object gap, the parallel obligatory NP-gap MWIs have only object gaps.

- (5) Sample token set for mixed-*wh* questionnaire
- a. When and what can I eat? (opt. NP-gap, nominal adjacent)
 - b. What and when can I eat? (opt. NP-gap, adverbial adjacent)
 - c. When and what can I do? (oblig. NP-gap, nominal adjacent)
 - d. What and when can I do? (oblig. NP-gap, adverbial adjacent)

Eight such token sets were constructed, and shuffled and distributed into four “preliminary scripts” (i.e. sets of experimental items). Each preliminary script was combined with the 32 filler items to form a script, and each script was put into two orders, so that there were eight versions of the questionnaire.

Each version of the questionnaire was filled out by at least two informants, so that $N \geq 16$. (In actuality, $N = 18$.) Informants were native English speakers in undergraduate linguistics classes at Ohio State University during the fall quarter 2001. They were instructed to rate each item, as quickly and accurately as possible, on a scale of 1 through 5, with 5 indicating an item was “completely normal and acceptable”, and 1 indicating an item was “very odd, awkward, or difficult for you to understand.”

3.2 Results: optional NP-gap cases clearly distinguished

Results of the questionnaires are shown in Figure 1, in which higher scores indicate higher grammaticality. Scores have been converted to *z*-scores (standardized scores), so that the mean rating for each informant is 0, and the standard deviation for each is 1.

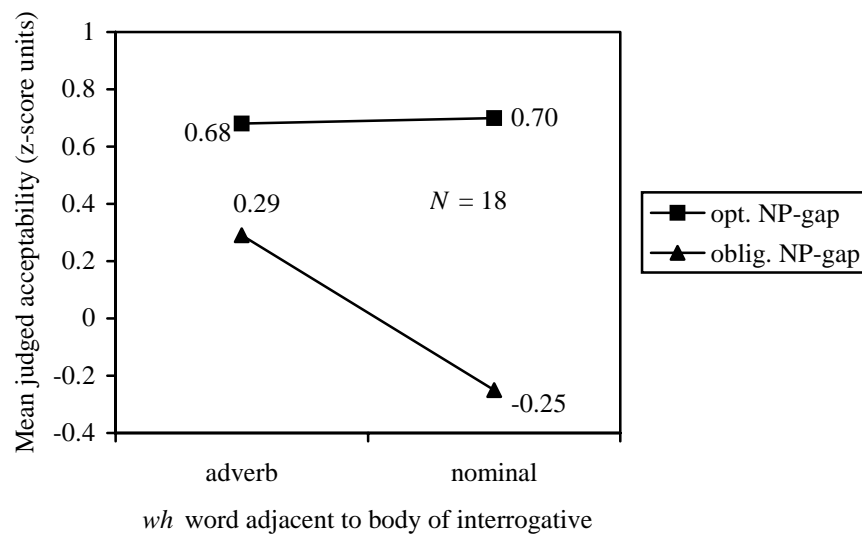


Figure 1
Different acceptability of optional NP-gap and obligatory NP-gap mixed-*wh* interrogatives

The most obvious effect seen here is the effect of the ordering of the nominal and adverbial *wh* in obligatory NP-gap MWIs: These interrogatives are much less acceptable when the nominal *wh* word is not adjacent to the body of the interrogative. This finding accords well with the pattern seen in the Internet attestations, where the nominal *wh* word was adjacent to the body of the interrogative 39 out of 43 times. In optional NP-gap MWIs, on the other hand, it can be seen that ordering of the nominal and adverbial *wh* has no significant effect on acceptability. This finding, too, mirrors the pattern seen in the Internet attestations, where 27 attestations had one order, and 31 had the other.

However, the most important finding is one that the corpus data could not show: When the nominal *wh* word is adjacent to the body of the interrogative, obligatory NP-gap MWIs are still less acceptable (0.29) than optional NP-gap ones (0.68). To calculate the significance of this difference, a repeated-measures by-subject ANOVA was performed on just the adverb-first items using SPSS software, and *p* (the probability that this difference could happen by chance if optional NP-gap MWIs were only a special case of obligatory NP-gap ones) was found to be .001. A similar univariate by-item ANOVA also yielded a probability of .001. Therefore, experimental results strongly support the hypothesis that optional NP-gap and NP-gap MWIs are different phenomena.

However, the fact that optional NP-gap MWIs have a higher mean score than NP-gap ones does not necessarily mean they are grammatical. For comparison, the mean score for the completely grammatical filler sentences was 1.29, far above 0.68. The question that arises, then, is whether all speakers have approximately this rating, or whether there are there some for whom these

interrogatives are completely grammatical. To judge whether a given speaker's mean score for optional NP-gap MWIs indicated that they were grammatical in his/her grammar, it was compared to his/her mean score for the grammatical filler sentences. Specifically, the standard deviation for this speaker's ratings for just the grammatical fillers was calculated, and subtracted from the mean score for just these sentences. If the mean score for the optional NP-gap MWIs was greater than or equal to this number, it was concluded that the speaker found optional NP-gap MWIs to be grammatical.

The results of this comparison are shown in Table 1. The mean scores for optional NP-gap MWIs are given in the second column; mean scores for the grammatical fillers, in the third. The standard deviation for the grammatical fillers appears in the fourth column; the difference between it and the mean score for the grammatical fillers is shown in the column labeled "threshold." If the mean score for the optional NP-gap MWIs meets or exceeds this threshold (i.e., if it is within one standard deviation of the mean score for grammatical fillers), a "yes" appears in the last column. Among the 18 informants, there were four (3, 36, 32, 6) whose mean score for MWIs fell within the standard deviation for their scores for the grammatical filler items. In fact, one informant's mean scores for the two kinds of items were identical (1.14 for informant 3). Looking further down the chart, there are four informants (9, 19, 11, 1) whose scores for the grammatical fillers were so uniform (i.e., all 5's) that the standard deviation is 0.² With such little leeway, the only chance for optional NP-gap MWIs to meet the threshold was for each of them to receive the same score as all the grammatical fillers received. However, each of these four informants, gave three out of four of the optional NP-gap MWIs they saw a 5; in other words, there was a clear mode that met the threshold requirement, even though the mean score did not. Therefore, these four informants are included with the previous four whose scores met the threshold. Overall, then, almost half of the informants found optional NP-gap MWIs grammatical. To the extent that the sample here represents the population at large, there is a significant population of speakers who find optional NP-gap MWIs to be grammatical.

Informant	mean for optional NP-gap mixed-wh	mean for grammatical fillers	σ for grammatical fillers	threshold	Threshold met?
3	1.14	1.14	0	1.14	yes
36	1.08	1.27	0.33	0.95	yes
32	1.03	1.28	0.42	0.86	yes
6	0.71	1.25	0.57	0.68	yes
9	1.27	1.41	0	1.41	no
19	0.97	1.4	0	1.4	no
11	0.91	1.06	0	1.06	no
1	0.91	1.08	0	1.08	no
30	0.84	1.37	0.2	1.17	no
13	0.72	1.21	0	1.21	no
40*	0.52	1.3	0	1.3	no
5	0.48	1.24	0.32	0.91	no
37	0.47	1.6	0.28	1.32	no
33	0.42	1.48	0.45	1.03	no
28	0.37	1.32	0.23	1.09	no
14	0.37	1.29	0	1.29	no
31	0.19	1.17	0.35	0.83	no
29	0.06	1.62	0.41	1.21	no

Table 1
Comparison of mean scores for
optional NP-gap mixed-*wh* interrogatives
and grammatical filler sentences

The next question to consider is whether there are (as predicted) any speakers who accept optional NP-gap MWIs but reject obligatory NP-gap ones. To determine the answer, speakers' mean scores for obligatory NP-gap MWIs (with the nominal *wh* adjacent to the body of the interrogative) were compared with their mean scores for the grammatical fillers. The comparison was done in precisely the same way as the previous one; results are shown in Table 2. It can be seen here that only one informant (number 11) found obligatory NP-gap MWIs grammatical. As can be verified with reference Table 1, this informant also found optional NP-gap MWIs grammatical; therefore, there were seven informants (3, 36, 32, 6, 9, 19, 1) who found optional NP-gap MWIs grammatical, but found obligatory NP-gap ones ungrammatical, or at least less grammatical.

informant	mean for obligatory NP-gap mixed- <i>wh</i>	mean for grammatical fillers	σ for grammatical fillers	threshold	Threshold met?
11	1.06	1.06	0	1.06	yes
5	0.81	1.24	0.32	0.91	no
1	0.74	1.08	0	1.08	no
40*	0.68	1.3	0	1.3	no
13	0.56	1.21	0	1.21	no
14	0.55	1.29	0	1.29	no
19	0.54	1.4	0	1.4	no
3	0.39	1.14	0	1.14	no
28	0.37	1.32	0.23	1.09	no
36	0.31	1.27	0.33	0.95	no
29	0.22	1.62	0.41	1.21	no
6	0.12	1.25	0.57	0.68	no
33	0.1	1.48	0.45	1.03	no
31	0.02	1.17	0.35	0.83	no
32	0	1.28	0.21	1.07	no
30	-0.06	1.37	0.2	1.17	no
37	-0.47	1.6	0.28	1.32	no
9	-0.74	1.41	0	1.41	no

Table 2
Comparison of mean scores for
obligatory NP-gap mixed-*wh* interrogatives
(with nominal *wh* word adjacent to body of interrogative)
and grammatical filler sentences

If the seven informants who found optional (but not obligatory) NP-gap MWIs grammatical have a means of licensing the former that did not license the latter, the patterns seen in the data are neatly explained. Under the Reverse Sluicing analysis, the patterns are a mystery. Thus, motivation seems to exist for a separate analysis of optional NP-gap MWIs, based on native speaker grammaticality judgments.

The conclusion is that obligatory NP-gap (and possibly missing NP-gap) MWIs are licensed by a rule of Reverse Sluicing (for speakers who allow them), while optional NP-gap MWIs are licensed because of the category neutrality of the verbs that head them. At this point, obligatory and missing NP-gap MWIs are of no further concern. Focus will shift to providing a neutrality-based analysis of optional NP-gap MWIs (1).

4 Analysis of optional NP-gap mixed-*wh* interrogatives

MWIs will be analyzed in the same way as conjoined-*wh* interrogatives such as *where and when did this happen?*, or *what or whom did you see?* The only difference is that certain verbs such as *eat* and *teach* will be permitted to have multiple categories. This is represented via the conjunctive type constructor \wedge (Lambek 1961, Morrill 1994, Moortgat 1997). This multiple categorization will these verbs to project phrases that can combine with coordinations of *wh* words with unlike categories, such as *where and what*, or *whether and who*.

4.1 Derivation of an optional NP-gap mixed-*wh* interrogative

The optional NP-gap mixed-*wh* interrogative to be derived will be *what and when you eat*. The categories for *what* and *when* will be as in (6), where S_w is the category for *wh* interrogatives, following the notation of Carpenter (1997):

(6) Categories for *what* and *when*

what: $S_w/(S/NP)$ *when*: S_w/S^3

The next step is to conjoin *what* and *when*. This is done by deriving both *what* and *when* to have category $S_w/((S/NP)\wedge S)$ via Argument Strengthening (**ASt**), a theorem proven in Bayer (1996) In the derivation below, X abbreviates $S_w/((S/NP)\wedge S)$.

(7) Conjoining *what* and *when*, $X = S_w/((S/NP)\wedge S)$

<i>what</i> :	<i>and</i> :	<i>when</i> :
$S_w/(S/NP)$	$X/(X/X)$	S_w/S
$\frac{\text{ASt}}{\text{---}}$		$\frac{\text{ASt}}{\text{---}}$
$S_w/((S/NP)\wedge S)$		$S_w/((S/NP)\wedge S)$
$\frac{\text{---}}{\text{---}} \backslash E$		
X/X		
$\frac{\text{---}}{\text{---}} /E$		
$S_w/((S/NP)\wedge S)$		

The phrase *you eat* needs to be derived as category $(S/NP)\wedge S$, in order to serve as the argument to *what and when*. This can be done if *eat* is assigned the category $(VP/NP)\wedge VP$ (where VP is a convenient abbreviation for NP/S). The derivation of *you eat* is shown in (8), in Gentzen sequent style because the natural deduction presentation of the derivation is more difficult to read.

$$\begin{array}{c}
(8) \quad \text{Deriving } \textit{you eat} \text{ as category } (S/NP)\wedge S \\
\frac{\frac{\frac{}{\text{NP, VP/NP, NP} \Rightarrow S} /L, \text{ etc.} \quad \frac{}{\text{VP} \Rightarrow \text{VP}} Ax \quad \frac{}{\text{NP, VP} \Rightarrow S} \backslash L, \text{ etc.}}{\text{NP, VP/NP, NP} \Rightarrow S/NP} /R \quad \frac{}{\text{NP, VP, S} \backslash S \Rightarrow S} \backslash L}{\frac{}{\text{NP, (VP/NP)} \wedge \text{VP} \Rightarrow S/NP} \wedge_1 L \quad \frac{}{\text{NP, (VP/NP)} \wedge \text{VP} \Rightarrow S} \wedge_2 L} \wedge R \\
\textit{you: NP, eat: (VP/NP)} \wedge \text{VP} \Rightarrow \textit{you eat: (S/NP)} \wedge S
\end{array}$$

The final step is to combine *what and when* with *you eat*.

$$\begin{array}{c}
(9) \quad \text{Combining } \textit{what and when} \text{ with } \textit{you eat} \\
\frac{\textit{what and when:} \quad \textit{you eat:}}{S_w / ((S/NP) \wedge S) \quad (S/NP) \wedge S} /E \\
S_w
\end{array}$$

For the optional NP-gap MWI just derived, the only assumption was that the verb *eat* was assigned to multiple categories, namely VP/NP and VP. Everything else followed from the Lambek calculus.

4.2 Two readings for optional NP-gap mixed-*wh* interrogatives?

As just derived, *what and when you eat* will have the same semantics as *what you eat and when you eat*. Under this reading, an answer to *what and when you eat* could be thought of as two lists, one of them a list of things that you eat, and the other a list of times when you habitually take your meals. There would not necessarily be any mapping between these lists, with particular items of food corresponding to particular times; the lists would be independent of each other. (In other words, this reading is not a pair-list reading.) For this reason, this reading of an optional NP-gap MWI will be referred to as an INDEPENDENT QUESTIONS (IQ) reading.

However, at least one other reading is possible for optional NP-gap MWIs. For some speakers, a more accurate expansion of *what and when you eat* would be *what you eat and when you eat IT* (or *when you eat something, and what IT is*). In this way, this interrogative is closer semantically to the analogous multiple-*wh* interrogative *what you eat when*, or sluiced interrogative *what you eat, and when*. This reading is the same reading given by Giannakidou and Merchant (1998) for reverse sluices, and it is a pair-list reading: An answer could be thought of as a list of pairs, each of which contains an item *x* that you eat, and a time *y* at which you eat *x*. This reading will be referred to as a DEPENDENT QUESTIONS (DQ) reading.

I suspect that the DQ reading of an optional NP-gap MWI exists only because optional NP-gap MWIs can be seen as special cases of obligatory NP-gap MWIs. That is, a speaker whose grammar licenses obligatory NP-gap MWIs will have DQ readings for them, as well as for optional NP-gap MWIs, since they can be seen as a special case of obligatory NP-gap MWIs. Moreover, if a speaker also has a separate analysis for optional NP-gap MWIs, then s/he will have IQ readings for them in addition to the DQ readings. On the other hand, if a speaker's grammar licenses only optional NP-gap MWIs, then s/he should have only an IQ reading for them. These predictions have not been tested, but have some tentative anecdotal support. For example, one speaker who accepted *what and when you eat* as completely normal while rejecting obligatory NP-gap MWIs emphatically judged it to have an IQ reading, dismissing the DQ reading entirely.

Further research on this issue will have to carefully control for pragmatic influences. For example, it might be that a speaker who rejects obligatory NP-gap MWIs could still have a DQ reading for *what and when you eat* depending on the context. For example, in the context of a discussion of a diet, it would be quite natural to assume that the items eaten and the times are linked, since many diets recommend eating particular things at particular times of the day.

Semantics also points to a difference between obligatory NP-gap MWIs and missing NP-gap MWIs. Whereas obligatory NP-gap MWIs (judging from the context of the attestations) always seem to be paraphrasable as multiple-*wh* interrogatives or sluiced interrogatives, this is not always the case for missing NP-gap interrogatives. In some cases, a DQ reading seems reasonable if the nominal *wh* is understood to replace some NP in the factor; for example, the most plausible reading in (4a) seems to be, "who would need this, and why would s/he need it?" That is, the *who* replaces the *you*, and the sentence is in essence recast as an obligatory NP-gap MWI: *Why or who would need this thing?* In other cases, though, a sensible reading depends much more on the context. For example, in (4b), *who or when the actual event took place*, my best guess is that the meaning is "who was involved, and when the actual event took place."

5 Other issues

Optional NP-gap MWIs offer strong evidence of category neutrality for certain kinds of verbs, namely, verbs participating in the unspecified object transitivity alternation. The attested verbs exhibiting this alternation are: *buy, call back, celebrate, eat, foolproof, hire, immunize, judge, learn, love, marry, pack, pay, play, read, recycle, remember, , report, ride, , teach, test, think, write*, and possibly *respond* and *speak*. In addition, there are verbs exhibiting essentially the same understood object alternation, except that instead of involving strictly VP/NP and VP, the categories are of form (VP/_wNP)/NP_{prep} and VP/NP_{prep}, where *prep* indicates a prepositional marking, such as *about, with, or for*, and /_w indicates a Wrapping modality defined in Dowty (1997). These verbs are: *know (about), negotiate (with), pay (for)*, and ditransitive *pay* (i.e., *pay someone something* vs. *pay someone*).

However, there are other transitivity alternations—for instance, there is the understood definite object alternation. Giannakidou and Merchant (1998) create some optional NP-gap MWIs involving this alternation (specifically, in the verbs *win* and *approve*), and label them as ungrammatical:

- (10) (from Giannakidou and Merchant 1998, (23))
a. *The runner was unsure **if and what leg** of the race he would win.
b. *It's anyone's guess **if and what** the censors will approve.

However, this alternation is attested in the corpus data, with the verbs *ask*, *believe*, *call*, *join*, *resign*, and *win*; an example is shown in (11).

- (11) We will notify you if and which award you have won as well as include you on our Winners Circle.
<http://woodcraftdesign.com/fullindex/awards.htm>

Another transitivity alternation is the understood reflexive object alternation exhibited by verbs such as *shave* or *bathe*. Giannakidou and Merchant construct an optional NP-gap MWI with these verbs, and judge them ungrammatical:

- (12) *I can't remember **whether or which patient** he had bathed/shaved.
(Giannakidou and Merchant 1998, (23c))

There are no attestations of these verbs in the corpus data, so the judgment above may indeed be true for all speakers. There are still other transitivity alternations, including causative alternations, and the middle alternation (as in *Kim frightens easily*). None of the attestations involve these kinds of alternations, either.

Moreover, transitivity alternations are not the only kind of argument alternations; others include Dative Shift, *spray/load* verbs, or verbs that take an infinitive with or without a specified subject. Whether MWIs involving these verbs are possible remains an open question.

Finally, there is the question of how neutrality of verb subcategorizations extends to declarative sentences. Even verbs participating in the understood-object transitivity alternation, so widely attested in optional NP-gap MWIs, can sound horrible in a declarative, as illustrated in (13):

- (13) *John ate quickly and a grilled cheese sandwich. (Schachter 1977, (4))

These issues are taken up in detail in Whitman (2002).

6 Conclusion

Optional NP-gap MWIs are an underreported and underanalyzed phenomenon in English (and possibly other languages). This paper has presented a simple analysis of them in a type-logical framework, by allowing the relevant verbs to have multiple categories and deriving the MWIs in the same way as ordinary conjoined-*wh* interrogatives are derived. In addition, optional NP-gap MWIs provide *prima facie* evidence against the claim that a word with different categories must be ambiguous rather than neutral, complicating the issue of what the true distinction between ambiguity and neutrality really is, if it exists at all.

Acknowledgements

Thanks to David Dowty for invaluable assistance throughout this research; to Chris Barker for suggesting that I look for MWIs involving *whether*; and to Chris Brew, Keith Johnson, and Pauline Welby for advice and technical assistance in the statistical analyses. Remaining errors are of course my own.

Notes

¹ For purposes of this paper, complementizers *whether* and *if* are referred to as *wh* adverbs, since the important point is that they (like *wh* adverbs) require that the body of their interrogative not have an NP gap.

² Informant 40 is asterisked because one of his/her filler sentence scores was thrown out. All eight other grammatical fillers were rated A, while one of them was rated D. This single result, so different from the other grammatical fillers, on a filler that was rated highly all other informants, was deemed an anomaly.

³ Adverbial *wh* words should more accurately be represented as requiring an adverbial gap in the body of the interrogative, but for a simpler presentation, they are assumed here to take an S for the body of the interrogative.

References

- Bayer, Samuel. 1996. The coordination of unlike categories. *Language* 72/3:579-616.
- Carpenter, Bob. 1997. *Type-Logical Semantics*. Cambridge, MA: The MIT Press.
- Cowart, Wayne. 1997. *Experimental Syntax*. London: SAGE Publications.
- Dowty, David. 1997. Non-constituent coordination, wrapping, and multi-modal categorial grammars: syntactic form as logical form. *Structures and Norms in Science*, ed. by M. L. Dalla Chiara et al., 347-68.
- Giannakidou, Anastasia, and Jason Merchant. 1998. Reverse sluicing in English and Greek. *The Linguistic Review* 15/2-3:233-256.
- Lambek, Joachim. 1961. On the calculus of syntactic types. In R. Jakobson (ed.) *Structure of Language and its Mathematical Aspects*. Proceedings of the twelfth symposium in applied mathematics. Providence, Rhode Island.
- Moortgat, Michael. 1997. Categorial type logics. *Handbook of Logic and Language*, ed. by Johan van Benthem and Alice Ter Meulen, 93-177. Cambridge, MA: MIT Press.
- Morrill, Glyn. 1994. *Type Logical Grammar: Categorial Logic of Signs*. Boston: Kluwer Academic Publishers.
- Pullum, Geoffrey, and Arnold Zwicky. 1986. Phonological resolution of syntactic feature conflict. *Language* 62/4:751-773.
- Schachter, Paul. 1977. Constraints on coordination. *Language* 53/1:86-103.
- Whitman, Neal. 2002. *Category neutrality: A type-logical investigation*. Ohio State University dissertation.