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Author
Beecher, Henry

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Pragmatic Inference in the Interpretation
of Sluiced Prepositional Phrases[*]

Henry Beecher
University of California, San Diego

An in-depth examination of sluiced prepositional phrases reveals sluices for which interpretation is unobtainable by parallelism with an antecedent. To accommodate these, I propose sluices are licensed by serving to question an inferred argument of a semantically compatible and salient antecedent. Both a corpus investigation and a grammaticality survey provide corroboration.

1.   Introduction

An extensive body of literature devoted to *sluicing* has accrued since Ross (1969) first coined the term to describe a *Wh*-phrase functioning in lieu of a complete embedded question. Frequently discussed examples like (1)a, in which a *Wh*-term alone comprises the sluice, contrast with ones involving a preposition like (1)b, a sub-variety seldom considered.

(1)   a.   Somebody just left – guess who.   (Ross 1969)
       b.   I actually got a book for a prize once but I can't remember what for![1]

Interpreting the embedded question corresponding to a sluice is contingent upon association with an antecedent clause. In (1)a the sluice is straightforwardly understood as *who left* which is semantically parallel to the proposition, *...somebody left,* conveyed by the antecedent VP. The same parallelism, however, does not hold in (1)b. Substituting the antecedent proposition, *...I got a book*, predicts that the sluice is understood as *what I got a book for*, which is at odds with the most natural interpretation, *what the prize was for*.

  This critical distinction has far-reaching implications for prevailing accounts[2] that cannot accommodate examples like (1)b in which semantic parallelism with an antecedent does not hold. Nevertheless, sluices involving prepositions are relegated to the sidelines on the following perceptions: 1) their most theoretically alluring aspect is word-order alternation[3] of the preposition and *Wh*-term; and 2) the inverted, *Wh*+prep, order constitutes a non-systematic variation involving only very few prepositions[4]. Culicover (1999) differentiates these word orders by using *sluice-stranding* for *Wh*-terms preceding prepositions versus *sluice-piedpiping* for prepositions followed by *Wh*-terms[5]. Whether or not displaced, the *Wh*-term is interpreted as the

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[1] www.ageconcern.org.uk/discuss/messageview.cfm?catid=8&threadid=2400&startpage=65
[2] *e.g.* Chung, Ladusaw and McCloskey (1995), and Merchant (1999).
[3] *cf* Riemsdijk (1978), Lobeck (1993), Culicover & Jackendoff (2005) and Merchant (2002).
[4] The position explicitly taken by Culicover (1999) and Culicover & Jackendoff (2005) *inter alia.*
[5] On analogy to *Wh*-movement of just the *Wh*-term or the entire PP to [Spec,CP] prior to IP deletion.

preposition's complement; thus the combination semantically functions as a prepositional phrase regardless of word order. Viewing these as 2 variants of the same phenomena, I adopt the more inclusive term *sluiced prepositional phrase* (SPP) except where using *stranded* or *piedpiped* may be more perspicuous.

   This paper demonstrates the ill-founded nature of these perceptions based on new empirical evidence for 1) stranded SPPs encompassing a broad degree of systematicity; and 2) SPPs with NP as opposed to VP antecedents constituting a significant and previously unrecognized sub-class. Counter-evidence to some claims about SPPs is provided in §2 and the motivating hypothesis discussed in §3. A corpus investigation into the range of prepositions participating in stranded SPPs is described in §4. A supplemental survey of grammaticality judgments on a small number of prepositions not found in the primary investigation is detailed in §5. The import of the corpus investigation and survey findings on understanding some factors constraining pragmatic inference in interpreting SPPs is discussed in §6.

2.   Some counter-evidence to claims about SPPs

No comprehensive investigation into the empirical extent of SPPs in English exists in the literature. Some claims exist about *stranded* SPPs specifically.[6] *Per* Culicover & Jackendoff (2005), prepositions in stranded SPPs are limited to 10: *about, at, by, for, from, in, of, on, to,* and *with*. They further claim that: 1) 9 of these (all but *by*) combine with *what*; 2) 7 of these (all but *on, in* and *about*) combine with *who*; and 3) the only other combinations are *where to, where from* and *how much for*. Based on these claims, stranded SPPs are perceived as idiosyncratic and not derived from the basic, and presumably commonplace, piedpiped SPPs.

   Results of some cursory Internet searching readily counter-exemplify these claims and minimally suggest them to be too restrictive. The items in (2) show some putatively non-existing combinations are in fact used by some speakers, *contra* C&J (2005).

(2)   a.   I have wasted my pathetic little life and I can't remember who on.[7]
         b.   I have heard the phrase benign dictator - but I can't remember who about.[8]
         c.   Then we were stung but we weren't quite sure what by.[9]

Items in (3) show stranded SPPs involve prepositions beyond those reported by C&J (2005).

(3)   a.   The style and intention of this site has changed, but I'm not sure what into yet.[10]
         b.   Main character, Sam, is obsessed and his daughter is named Lucy - I'm sure you can
              guess who after.[11]

Thus basic questions about the distribution of prepositions and *wh*-terms in SPPs are raised.

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3. Motivating Hypothesis

Superficially SPPs appear to be syntactic fragments which are semantically interpreted as full interrogative clauses. At the crux of the matter is accounting for the process or mechanism by which interpretation succeeds and correspondingly what is necessary and sufficient for SPPs to be grammatical. In (4) below the SPP is naturally interpreted as "who the presentation was by" derived from the proposition *...a presentation is by someone.* Yet this is not obviously parallel to the semantics of the antecedent clause, [REMEMBER(John, presentation)].

(4)   John remembers a presentation but does not remember who by.

I claim the SPP in (4) is interpretable via a pragmatic inference process through which the antecedent NP, *presentation*, is associated with having a 'PRESENTER/AGENT' semantic argument being indirectly questioned. The relationship between the SPP and this inferred semantic argument underlies the interrogative semantics for the SPP represented in (5).

(5) $\Downarrow$who by$\Diamond^w = \lambda p \exists x[\text{person}(x) \wedge p=\,^\wedge[\text{BE-BY}(\text{presentation},x)]]$

The logic formula[12] in (5) denotes the set of propositions comprising the answer space to the indirect question in (4), and where *who* translates into a variable *x* (restricted to being a person) which is semantically bound by an existential operator.
   This approach also accounts for SPPs whose *wh*-term correlates with either an explicit or an implicit syntactic argument of an antecedent predicate as in (6).

(6)   John might flirt at the dance, but I can't imagine who with.

The activity of flirting can have a 'goal' argument (*i.e.* the individual targeted by the flirter) which is grammaticalized as an object, and which for *flirt* is subcategorized to be expressed as a prepositional phrase headed by *with*. Based on the implicit object in (6) being a semantic argument of the VP, *John might flirt,* the SPP is interpreted as an indirect question with the semantics $\lambda p \exists x[\text{person}(x) \wedge p=\,^\wedge[\text{FLIRT}(\text{John},x)]]$[13] where FLIRT represents the activity of flirting and the identity of FLIRT's goal argument is being questioned.
   The same characterization of SPPs extends to other syntactic arguments or adjuncts for which a predicate may not be subcategorized as illustrated in (7) below.

(7)   Jack called, but I don't know where from.

While not grammaticalized like subjects or objects, 'location' is still a semantic argument of activities like calling that occur in space and time. Ergo the SPP in (7) is interpretable as an indirect question with the semantics $\lambda p \exists x[\text{place}(x) \wedge p=\,^\wedge[\text{CALL\_FROM}(\text{Jack},x)]]$ where the calling activity's location is being questioned.
   When viewed this way SPP interpretability is not contingent on parallelism with an antecedent clause, while at the same time not incompatible with that possibility. Furthermore, this characterization provides a unified approach to analyzing the full range of SPPs. Central to this pragmatic approach is the association between the SPP and an inferred semantic argument of the

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[12] Following Karttunen (1977) and Berman (1991), *inter alia.*
[13] Modality is ignored here for the sake of simplicity.

antecedent. SPP grammaticality is claimed to depend on two aspects of this association: 1) *semantic compatibility* between the antecedent and SPP preposition (*cf* §6.1); and 2) the association being *sufficiently salient* (*cf* §6.2). Results from a corpus investigation into stranded SPPs (*cf* §4) and grammaticality survey (*cf* §5) provide insight into factors that determine semantic compatibility and salience for the purposes of SPP interpretation.

4.   A Corpus Investigation into Stranded-SPPs

The SPP characterization in §3 constrains neither which prepositions occur in SPPs, nor the word order. Indeed this approach predicts that potentially any preposition can head a SPP as long as the antecedent clause has a semantically compatible and salient constituent. Apart from prosodic constraints, either word order is possible for any *meaningful* combination. This is necessarily qualified in two ways. The 'inverted' *Wh*+prep order is only attested for limited combinations involving other than monomorphemic *Wh*-terms[14]. Furthermore, not all *Wh*-terms meaningfully combine with all prepositions. Seemingly none combine with *why* or *how* and a very limited number with *when* or *where*. Effectively, either word order is predicted to be possible in SPPs for any combination of a single-word preposition and *who* or *what.*

4.1   Stranded-SPP investigation: objective and limitations

To determine to what extent these predictions hold, a comprehensive effort was made to find stranded SPPs containing *who* or *what* for as many single-word prepositions as possible. Early testing revealed that large corpora like *Brown, Wall Street Journal* or *British National Corpus* do contain stranded SPPs; however, generally ones with frequent prepositions. Thus searching the World-Wide Web was the best option. Google was used for its breadth across domain types and its application programming interface (API) which supports large-scale searching. Python code was used to filter out examples with sentence-final punctuation which is ignored by the Google engine. Google also limits API searches to the first 1000 matches. The *Oxford American Dictionary* online lists 55 single-word prepositions out of which 17 were excluded: 9 often not used as prepositions (*as, concerning, regarding, except, like, unlike, opposite, round* and *past*); 6 of the overall least frequent (*aboard, along, amid, among, despite,* and *par*); and 2 orthographic variants (*besides* and *toward*). Inability to restrict searches by part of speech combined with Google ignoring punctuation made including the first 9 too problematic, while needing to keep the project manageable excluded the remainder.

4.2   Stranded-SPP investigation: method

Extensive searches were executed using Perl scripts to communicate with the Google API directly. For each term 20 search strings were created. Half contained 10 predicates (*believe, clear, find out, forget, guess, know, recall, remember, say,* and *sure*) followed by *who* and a candidate preposition. The other half had the same predicates followed by *what* and the same preposition. These predicates can select clausal complements - the only valid context for sluicing. Including the predicates was necessary due to Google ignoring punctuation. Searching on a *wh*-term and preposition alone produced such vast results that within Google's 1000 hit limit there were likely no sluiced examples. Including the predicate greatly improved pinpointing stranded SPPs. On the downside, examples involving other predicates or forms of these predicates (*e.g.* past, gerund, *etc.*)

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[14]*e.g. how long for, how much for, how many to* which Merchant (2002) ascribes to prosodic conditioning factors

were automatically excluded. Initial results were filtered to extract only examples with sentence-final punctuation, and then further manually examined to ensure each item was actually a 'well-formed' stranded SPP.[15] Each result included the URL address should examining the source be required.

4.3   Stranded-SPP investigation: objective and limitations

The most striking and significant outcome is finding stranded SPPs containing 26 of the 38 candidate prepositions, roughly two-thirds and 40% more than claimed by C&J (2005). This is clear evidence stranded SPPs involve a much greater degree of systematicity than previously acknowledged. In addition to the 10 undisputed prepositions (*cf* §2), the results newly document another 16 to occur in SPPs: *after, against, around, before, behind, between, into, off, out, over, since, through, towards, under, until,* and *up*. In all the investigation netted some 3000 well-formed sluices[16] which, when categorized by type of antecedent constituent, produced the following breakdown: 45% VP, 45% NP, and 10% AP.[17] Nearly 2800 contained undisputed prepositions and the remainder newly attested ones. The results also reveal prepositions in SPPs to be used predominately in an abstract as opposed to spatial manner, as the newfound examples in (8) illustrate.

(8)   a.   We're on to the semi-finals, though I don't know who against.[18]
         b.   I cried yesterday, but I can't remember what over.[19]
         c.   She and I had met each other some years previously, I can't remember who through.[20]

The prepositions in (8) can be used to denote physical location in space (*e.g.* an awning *over* the window); however, no such spatial uses were found among the 10 most frequent prepositions and only in very few of the newly attested ones. Finally, the results lacked stranded SPPs for 12 candidates: *above, across, below, beneath, beside, beyond, down, during, inside, near, outside,* and *without*. Among the least frequent prepositions, these are also the most likely not to be found due to search method limitations. While it is uncertain whether these 12 do not or cannot occur in SPPs, the motivating hypothesis predicts they could in a context that sufficiently strengthens their association with an antecedent.

5.   A Supplemental Grammaticality Survey

This grammaticality survey was conducted specifically to probe whether strengthening the association of a sluiced preposition with its antecedent could result in native speakers judging as grammatically acceptable any SPPs containing one of the 12 prepositions for which the investigation (*cf* §4.3) lacked naturally occurring examples.

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[15] *i.e.* a complete sentence with an identifiable antecedent clause (not examples like *He didn't say with who.*)
[16] As of the publishing date, preparations were underway to post these results online at: ling.ucsd.edu/~hbeecher/
[17] The APs were exclusively adjectival phrases. Adverbs can be the target of a sluice as in *I'll be done soon, I just don't know how soon.* However, no such occurrences were found in connection with SPPs.
[18] wolfangel.calltherain.net/index.php?s=against&submit=ww
[19] altopiccolo.mindsay.com/
[20] www.hereinmyhead.com/artimp/cindy/interview.html

5.1   Survey design

Only stimuli with the more 'canonical' piedpiped SPPs were used to avoid the possibility that merely the low frequency of the target prepositions may reduce their acceptability in stranded SPPs. A 50/50 ratio of distractor to target stimuli was used. The 12 target prepositions were allotted 2 stimuli each to include both spatial and abstract uses. The 24 target stimuli, like that in (9), were constructed to give each preposition the best chances of being judged acceptable.

(9)   The evidence is buried but we have no idea beneath what.

Using *buried* in the antecedent clause provides the SPP containing *beneath* with a more optimally supportive context thereby strengthening their association. To match these target stimuli, another 24 were evenly divided into good and bad distractors. The 12 bad ones included 3 lacking SPPs. These intentionally mimicked the other stimuli in being complex (*i.e.* multi-clausal) with ungrammatical word orders such as inversion of subject and auxiliary in finite complements. The other 9 bad ones were sabotaged SPPs including ones that: sluiced the particle of verb-particle constructions (VPC); contained semantically incompatible (*i.e.* irrelevant) prepositions; or used predominantly abstract prepositions in low frequency spatial associations (*cf* §6). The 12 good distractors also included 3 lacking SPPs corresponding to the same 3 bad ones except with the expected word order. The other 9 good ones contained an even mixture of VP, NP and AP antecedent constituents.   All distractors with SPPs contained only the 10 most frequent, undisputed prepositions. The entire 48 stimuli set was randomized and counter-balanced across subjects.

5.2   Survey Procedure: participants, task and evaluation

Participants. 50 students from 2 undergraduate linguistics and human development classes at the University of California, San Diego participated. Volunteers received additional course credit. All participants attested to being native English speakers by indicating English to be their sole native language, their primary language of instruction in elementary and high school, and among the languages they are most comfortable with.

Task. The survey cover sheet contained general directions and 4 practice items. Participants were asked to rate each of the 48 sentence stimuli for acceptability on a scale of 1-5 where 1 was completely unacceptable and 5 was perfectly fine. There was no preset time limit to finish the survey, although the directions encouraged participants to rely on their intuitions and not analyze the sentences.

Evaluation. Results were tallied by calculating the mean value of responses to each stimulus.

5.3   Survey Results

Out of the 12 target prepositions, 10 received a mean value of 3 or more for at least 1 of the 2 stimuli containing it; and for 3 (*above, inside* and *near*) both received a mean value of 3 or more. The only 2 prepositions receiving a mean value below 3 were *during* and *without*. The stimuli included spatial versus abstract uses for 6 prepositions for which 3 received a mean value below 3, and the other 3 received a mean value at or above 3. Consequently no asymmetry along this dimension was observed.   This is perhaps not unexpected given that these least frequent

prepositions have almost exclusively spatial connotations.[21] Surprisingly, individuals rated at least some of the good distractor stimuli at 3 or below. Such native speaker judgments seem peculiar, especially as none of these good distractors received judgments of 4 or 5 across the board. A likely explanation lies in the decision to use only piedpiped SPPs. It is a highly probable that participants were sensitive to SPP word order in these good distractors. All the same, most good distractors received a mean value of 4 or more, with *in who* receiving the lowest 3.42 mean. Thus none of the good distractors received a majority negative judgment. Prepositions like *about* or *by* used in a spatial context were among the bad distractors and, as expected, received mean values of 2 or less. All in all, these results indicate that SPPs with low frequency spatial prepositions in optimally supportive contexts can be judged grammatical despite not being found in the corpus investigation.

6. Constraining SPP Interpretation: Semantic Compatibility & Salience

As described in §4.3, the high percentages of both VP (45%) and NP (45%) antecedents is significant because NP antecedents typically give rise to SPPs for which interpretability is independent of parallelism with an antecedent clause. The prevalence of such cases contrasts starkly with their lack of treatment in the literature, although focusing on sluices which involve a *Wh*-term alone (as nearly all the literature does) is unlikely to detect these cases. Lack of parallelism with an antecedent clause also precludes constraining SPP interpretation by reconstructing any unpronounced (or elided) syntax. Instead, the hypothesis herein (*cf* §3) proposes that the ability of SPPs (and by extension any sluice) to indirectly question an inferred semantic argument of an antecedent constituent is constrained by at least two factors: semantic compatibility and salience.

6.1 Semantic Compatibility

Semantic compatibility exists when a meaningful lexical relationship holds between a sluiced preposition and an antecedent constituent. Examples (10)a-b illustrate how semantic compatibility serves to constrain the inference process underlying SPP interpretation.

(10)   a.   The only thing I can come up with is contamination but I do not know what from.
       b.   *The only thing I can come up with is contamination but I do not know what about.

The SPP in (10)a is licit because *from* can be used in relation to SOURCE, a plausible semantic argument of the antecedent constituent *contamination*. In contrast, (10)b is illicit because *about* cannot be used in relation to any plausible semantic argument of *contamination*.[22] Thus, semantic compatibility holds between *contamination* and *from*, but not between *contamination* and *about*. Other semantic arguments related to *contamination* are INSTRUMENT and AGENT (or CAUSER), thereby making equally licit SPPs headed by *with* or *by*, respectively. Uttering (10)a in more contextually specific situations in which the contamination is understood to involve several target mediums (*e.g.* air, water or some test samples) can also make *in, of* or *to* licit.

   Given appropriate contextual and pragmatic conditions, semantic compatibility of these prepositions with *contamination* contrasts sharply with the unsuitability of other prepositions. The preposition *for* is associated with PURPOSE which is not a plausible semantic argument of

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[21] One exception is *promote over.*

[22] *Contamination* has no association with being 'about' something in the way a noun like *agreement* does.

contamination. Prepositions *on* and *at* have no abstract uses applicable to *contamination* and their licit use in a spatial sense requires a high degree of contextual support (*e.g.* the contamination suspected as being specifically on the surface of something). Prepositions beyond the 10 most frequent have increasingly spatial connotations and correspondingly fewer abstract ones; thus prepositions like *off, over, into, under, etc.* are unlikely to be semantically compatible in (10). However, one of these, *through,* has the abstract connotation 'by means of' making it licit by association with INSTRUMENT. Thus semantic compatibility determines whether a particular preposition heading a SPP is appropriate for questioning a particular semantic argument of an antecedent constituent.

6.2   Salience

Salience is a direct function of the strength of association between the SPP and the semantic argument of the antecedent constituent being questioned. Precisely because such association is established via a contextually conditioned inference process, salience is necessarily a proportionate as opposed to an absolute constraint. Salience is also distinct from, and secondary to, semantic compatibility. The distinction is quite apparent with prepositions like *about* or *by* which are most frequently used in SPPs in an abstract way. In examples like *coins scattered about a gutter* or *horses passing by a barn* these prepositions have a spatial connotation and are arguably semantically compatible with *scattered* or *passing,* respectively. Yet despite this semantic compatibility*,* SPPs with either preposition and corresponding antecedent fail to be grammatical as shown in (11).

(11)   a.   *He found coins scattered but didn't remember what about.
        b.   *He saw horses passing but didn't know what by.

At issue is not lack of semantic compatibility but rather insufficient salience. Results of the grammaticality survey indicate, given an elaborate enough context, SPPs with *about* or *by* could retain spatial associations to *scatter* or *pass* if the salience is sufficiently strengthened.
  The results of the investigation and survey also indicate salience is affected by several factors including: the availability of abstract use(s) for a preposition; the relative frequency of individual prepositions; and the comparative frequency of constituent-preposition pairs. For the 10 most frequent prepositions, the investigation yielded a conspicuous lack of examples in which the SPP's association to its antecedent constituent was of a purely spatial nature. Such examples were quite limited among the additional 16 prepositions as well. These facts corroborate that, for discourse purposes, the typically more salient properties of entities and events are those for which prepositions have been grammaticalized (*e.g.* for encoding thematic roles), conventionalized (*e.g.* for indicating topic, theme, focus, *etc.*) or otherwise idiosyncratically linked to a predicate (*e.g.* "register under"). These specialized associations considerably strengthen abstract features of antecedents in comparison to spatial characteristics which, by being perhaps so unremarkable, are essentially indistinct with the background. Consequently abstract preposition use is predominant in SPPs. Nevertheless, as the grammaticality survey results clearly indicate, SPPs with non-abstract connotations are judged grammatical given a context making a spatial aspect of an antecedent prominent.

7.   Conclusion

Both the evidence for stranded-SPP systematicity and the viability of SPPs with spatial prepositions provide corroboration that interpretation crucially relies on SPPs functioning to question a pragmatically inferred semantic argument of an antecedent.   Furthermore, this approach accommodates SPPs with NP antecedents, a previously unrecognized sub-class not amenable to prevailing accounts of sluicing.

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Henry Beecher
Department of Linguistics
University of California, San Diego
hbeecher@.ucsd.edu