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4 Do We Need a Distinction between Arguments  
5 and Adjuncts? Evidence from Psycholinguistic  
6 Studies of Comprehension  
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13  
14 Abstract

15 Within both psycholinguistic theories of parsing and formal theories of syntax, a  
16 distinction between arguments and adjuncts is central to some theories, while  
17 minimized or denied by others. Even for theories that deem the argument/  
18 adjunct distinction important, the exact nature of the distinction has been difficult  
19 to characterize. In this article, we review the psycholinguistic evidence for an  
20 argument/adjunct distinction, discuss how argument status can best be defined in  
21 the light of such evidence, and consider the implications for how grammatical  
22 knowledge is represented and accessed in the human mind.

23  
24  
25 Introduction

26 The notion of argumenthood is intended to distinguish phrases that represent  
27 core components of an event, relation, or entity from those that supplement  
28 the core meaning. Consider a punching event. Punching logically requires  
29 that some entity be struck, typically with a fist, consistent with the presence  
30 of a direct object (*stuffed animal*) in (1a). However, the fact that this  
31 punching event was accomplished either with glee or on a bed is not an  
32 important or necessary component of the verb's meaning. In contrast, the  
33 verb *put* obligatorily requires that a goal location also be explicitly stated,  
34 as can be seen from the acceptability difference between (1b) and (1c).  
35 Obligatory elements, like the direct object of *punch*, are commonly  
36 deemed arguments, whereas modifying phrases, such as *with glee*, are  
37 commonly deemed adjuncts.

- 38  
39 (1) a. Timmy punched the stuffed animal on his sister's bed with glee.  
40 b. Timmy put the stuffed animal on his sister's bed with glee.  
41 c. \*Timmy put the stuffed animal with glee.  
42

43 In this article, we begin by describing how the argument/adjunct distinction  
44 has played an important, though controversial role, both in formal linguistic  
45 theories of syntactic knowledge and in psycholinguistic theories of

1 syntactic processing. Next, we summarize psycholinguistic evidence that  
 2 we take as support for maintaining the argument/adjunct distinction. Finally,  
 3 we consider psycholinguistic evidence regarding the argument status of  
 4 instruments and agentive *by*-phrases – two types of phrases that have proven  
 5 difficult to categorize using standard tests.

6 Many syntactic theories, including principles and parameters approaches  
 7 (Chomsky 1981), lexical-functional grammar (Kaplan and Bresnan 1982),  
 8 and role and reference grammar (Van Valin and LaPolla 1997), maintain a  
 9 distinction between arguments and adjuncts. Within such theories, two  
 10 types of syntactic knowledge can be identified that are relevant to the  
 11 argument/adjunct distinction. The first involves general principles that  
 12 apply broadly and cross-linguistically. For example, for the subset of  
 13 theories that claim a direct correspondence between lexical-semantic/  
 14 conceptual and syntactic representations, it is the application of general  
 15 principles that is responsible for the mapping of lexical-semantic information  
 16 to syntactic structure (e.g., Jackendoff 1990; Dowty 1991; Levin and  
 17 Rappaport Hovav 1995; Baker 1997; Reinhart 2002). Regardless of  
 18 approach, each serves to determine the placement of arguments and adjuncts  
 19 in the phrase structure tree. The second type of syntactic knowledge is  
 20 idiosyncratic to individual (or classes of) lexical items, for example, the  
 21 transitivity or intransitivity of individual verbs, that is, their subcategorization  
 22 frames. Subcategorization frames specify the number and phrasal types of  
 23 arguments that verbs can take (see Borer 2005 and Hale and Keyser 1993,  
 24 2002 for alternative approaches), thereby providing verb-specific information  
 25 that interacts with, but is separate from the more general principles that  
 26 regulate each phrase's structural instantiation.

27 In short, the traditional view within formal linguistics is that the grammar  
 28 is separate from the lexicon, with argument, but not adjunct slots, lexically  
 29 encoded via argument structure. In this article, we adopt a broad view of  
 30 argument structure, taking it to specify the number of arguments taken  
 31 by a lexical head (i.e., the element that determines the syntactic function  
 32 of the phrase that it projects), and the thematic role each of these arguments  
 33 bears. Despite its foundational importance within syntactic theory, the  
 34 argument/adjunct distinction has never been very well defined and there  
 35 exist gray areas in the taxonomy. For example, the obligatory goal of *put*  
 36 patterns like an argument, because the verb requires it. Yet, its preposition  
 37 is not fixed, in contrast to the more prototypical prepositional argument  
 38 taken by dative verbs (e.g., *give this to Sue*).

39 The gray areas in the argument/adjunct taxonomy arise, in part because  
 40 the classification of arguments and the conditions for their expression  
 41 require an awkward melding of lexical semantics with syntactic principles,  
 42 neither of which is typically construed in a manner that adequately suits  
 43 the needs of the other (see Levin and Rappaport Hovav 2005). For example,  
 44 under one semantically driven approach to identifying arguments, one of  
 45 two necessary criteria for argument status is that an entity be semantically

obligatory for a given verb (Koenig et al. 2003). Yet, obligatory semantic entities need not be overtly realized; the verb *eat* logically entails that some material or substance be ingested, yet *Suzy ate at 8:00* is fully grammatical. Thus, Koenig et al.'s criteria for argument status do not fully comport with syntactic proposals, such as the projection principle, that require arguments to be syntactically realized (Chomsky 1981). Another approach is to use syntactic tests to determine argument status, many of which are described in Schütze and Gibson (1999). However, the sheer number of these tests underlines the fact that no single test is entirely satisfactory. Furthermore, when the tests are applied as a group, phrases often yield contradictory results, patterning as arguments on some tests and adjuncts on others.

The argument/adjunct distinction has also been theoretically important within psycholinguistics, most notably in cases where parsing theories must explain how syntactic representations are built incrementally during sentence comprehension. In some parsing theories, argument status determines the cognitive mechanism by which a phrase will be attached to the developing syntactic representation of a sentence (e.g., Frazier and Clifton 1996; Boland and Boehm-Jernigan 1998; Stevenson 1998). For example, under the construal hypothesis, primary phrases (arguments) are precisely attached according to structural principles, while non-primary phrase (adjunct) attachment is tentative and may be influenced by non-structural information (Frazier and Clifton 1996). Other approaches have used argument status as a decision principle for syntactic ambiguity resolution, favoring attachment as an argument in cases like the prepositional phrase in (2) (e.g., Abney 1989; Koniczny et al. 1997; Liversedge et al. 1998; Schütze and Gibson 1999). Still, other approaches emphasize the rich semantic cues provided by thematic roles, and the potential of argument structure knowledge to serve as a mechanism for integrating syntactic, semantic, and pragmatic processing (e.g., Carlson and Tanenhaus 1988; Taraban and McClelland 1988; Mauner and Koenig 1999).

- (2) The saleswoman tried to interest the man [in . . .  
 a. VP Argument . . . a wallet].  
 b. VP Adjunct . . . a nice way].

Given the importance of argument structure knowledge in psycholinguistics, the lack of a clear distinction between arguments and adjuncts has led to divergent claims. For example, instrumentals such as *with a spoon* have been claimed to function as arguments under some processing theories (Schütze 1995; Schütze and Gibson 1999) and as adjuncts in others (e.g., Spivey-Knowlton and Sedivy 1995). More broadly, some proposals suggest that the argument/adjunct distinction is neither binary nor categorical in nature. For example, the constraint-based lexicalist theory of sentence comprehension outlined by MacDonald et al. (1994) does not maintain

1 any formal distinction between arguments and adjuncts. Likewise, some  
 2 formal linguistic theories assume that the argument/adjunct distinction is  
 3 a gradient property (e.g., Manning 2003).

4 In short, while a distinction between arguments and adjuncts serves as  
 5 a core assumption in some psycholinguistic and syntactic theories, other  
 6 theories in both domains make no such distinction. And even if such a  
 7 distinction was deemed valid, there would still remain many challenges for  
 8 determining what characteristics distinguish arguments from adjuncts. In  
 9 the next section, we review some psycholinguistic evidence germane to the  
 10 argument/adjunct distinction. In doing so, we have in mind two related  
 11 questions: (i) Are arguments and adjuncts comprehended via different  
 12 cognitive mechanisms? (ii) Within our syntactic knowledge, are arguments  
 13 and adjuncts represented differently?

### 14 *Psycholinguistic Evidence*

15  
 16  
 17 All psycholinguistic theories of parsing must explain how listeners and  
 18 readers rapidly build an input string of words into a grammatical unit,  
 19 incrementally building up structure as they recognize each word, despite  
 20 considerable ambiguity as to the appropriate structure. The garden path/  
 21 construal approach proposed that we accomplish this feat by ignoring  
 22 most of the lexical details (e.g., alternative subcategorization frames and  
 23 their relative frequencies) in the input string. This allows general syntactic  
 24 principles to quickly build structure (e.g., Frazier 1987; Mitchell 1989;  
 25 Ferreira and Henderson 1990; Frazier and Clifton 1996), but also leads to  
 26 frequent mis-analyses (garden paths), which must then be revised through  
 27 the use of detailed lexical knowledge. An alternative view, which came to  
 28 be known as the constraint-based lexicalist approach, held that detailed  
 29 lexical knowledge is exploited quickly so that even the initial syntactic  
 30 representations conform with grammatically relevant lexical knowledge,  
 31 that is, argument structure knowledge, such as subcategorization and thematic  
 32 role constraints (e.g., Boland et al. 1990; Tanenhaus et al. 1994).

33 Because the garden path and constraint-based theories were distinguished  
 34 by the relative contributions of generalized syntactic principles vs. detailed  
 35 lexical knowledge, several important studies in the early 1990s were  
 36 designed to determine how quickly argument structure knowledge was  
 37 used during sentence comprehension. For example, Clifton et al. (1991)  
 38 measured local reading times during and after prepositional phrases (PP)  
 39 that were initially ambiguous between analysis as an argument and analysis  
 40 as an adjunct. For half of the critical sentences, the potential argument  
 41 attachment was to the verb phrase (VP) and the potential adjunct attachment  
 42 was to the noun phrase (NP) (e.g., *The saleswoman tried to interest the man*  
 43 *in a wallet/his fifties . . .*). The remaining half had the reverse configuration,  
 44 with the potential argument attachment being to the NP and the potential  
 45 adjunct attachment being to the VP (e.g., *The man expressed his interest in*

1 *a wallet/hurry* . . .). Rather than finding a preference for argument attach-  
 2 ment, as predicted by Abney (1989), Clifton et al. found a VP-attachment  
 3 preference, as predicted by the parsing heuristic of minimal attachment  
 4 (Frazier 1978). The authors did not dismiss the importance of argument  
 5 status – they did in fact find an argument status effect, but it was late in  
 6 that it was not found at the earliest possible word and it was delayed in  
 7 relation to other types of effects.<sup>1</sup> Thus, while Clifton et al.'s conclusions  
 8 support the argument/adjunct distinction, their results fail to show that  
 9 argument status plays an important role in building the initial syntactic  
 10 representation during sentence comprehension. Similar conclusions about  
 11 the delayed use of argument structure knowledge have been reported  
 12 elsewhere, including Kennison (1999) and McElree and Griffith (1998).  
 13 However, several researchers have found early effects of argument status for  
 14 PP-attachment ambiguities (Britt 1994; Schütze and Gibson 1999; Boland  
 15 and Blodgett 2006). For example, contrary to Clifton et al., Boland and  
 16 Blodgett found that readers spent less first pass reading time on argument  
 17 PPs compared to adjunct PPs.

18 Over the past 10–15 years, a broad range of experiments have found  
 19 that verb argument structure is in fact used to guide initial parsing decisions  
 20 (e.g., McElree 1993; Shapiro et al. 1993; Boland et al. 1995; Ferreira and  
 21 McClure 1997; Garnsey et al. 1997; Trueswell and Kim 1998; Altmann  
 22 and Kamide 1999; Kennison 2002; Traxler and Tooley 2007). Importantly,  
 23 the evidence for immediate effects of argument structure knowledge is not  
 24 limited to English; immediate argument structure effects have also been  
 25 found for verb-final structures in German (e.g., Konieczny et al. 1997) and  
 26 Japanese (e.g., Yamashita 1995).

#### 27 28 PURE FREQUENCY VS. ARGUMENT STRUCTURE BASED APPROACHES

29  
30 Despite the current popularity of lexicalist approaches to parsing, the  
 31 nature and the necessity of the argument/adjunct distinction remain as  
 32 controversial as ever. In fact, it is no longer obvious that so called argument  
 33 structure effects depend upon the existence of a categorical distinction  
 34 between arguments and adjuncts. For example, MacDonald et al. (1994)  
 35 assumed that both argument and adjunct constraints are represented lexically,  
 36 allowing much of syntactic analysis during sentence comprehension to be  
 37 accomplished via lexical mechanisms. As each word in a sentence is recognized,  
 38 lexicalized syntactic structures are accessed as well; parsing is a matter of  
 39 selecting the appropriate lexicalized structure and attaching it to the  
 40 developing syntactic representation. In addition, more frequent lexicalized  
 41 structures are accessed more quickly, so frequently occurring arguments  
 42 and adjuncts should be processed more easily and quickly than infrequently  
 43 occurring arguments and adjuncts. Because arguments tend to occur with  
 44 greater regularity than adjuncts, a general advantage for arguments is  
 45 predicted. We call this approach the pure frequency hypothesis (PFH).

1 The PFH predicts that PP-attachment difficulty will be a function of the  
 2 co-occurrence frequency between the PP type and the lexical head type  
 3 at the potential attachment sites.<sup>2</sup>

4 While the PFH presumes that both argument and adjunct phrases are  
 5 attached via a lexical mechanism, a second view, which we call the  
 6 argument structure hypothesis (ASH), posits distinct cognitive operations  
 7 for argument and adjunct attachment: arguments are attached via the  
 8 lexical mechanism, but adjuncts are attached using general (non-lexical)  
 9 grammatical knowledge that is represented as phrase structure rules or the  
 10 equivalent (e.g., Boland and Boehm-Jernigan 1998; Boland and Blodgett  
 11 2006). Because arguments are attached via a lexical mechanism, frequency  
 12 effects are predicted, as under the PFH. For example, when a phrase following  
 13 a verb (or another lexical head) is consistent with a frequent subcategorization  
 14 frame for that verb, the phrase should be easier to integrate into one's  
 15 developing syntactic representation of the sentence, compared to when  
 16 the incoming phrase is consistent with a subcategorization frame that is  
 17 atypical for that verb. In contrast, because adjuncts are not represented in  
 18 the verb's alternative subcategorization frames, they must be attached  
 19 using general grammatical knowledge and therefore the relative frequency  
 20 of various adjuncts should not affect processing difficulty.

21 Crucially then, the PFH predicts frequency effects for adjuncts, while  
 22 the ASH does not, thus, providing one potential means of determining  
 23 whether both adjunct and argument slots are represented in the lexicon.  
 24 Some potential support for the PFH was provided by Spivey-Knowlton  
 25 and Sedivy (1995), who found that the attachment of adjunct *with*-PPs  
 26 appeared to be guided by the co-occurrence frequency between verbs and  
 27 adjuncts. In a corpus analysis, they found that for action verbs, *with*-PPs  
 28 are more likely to modify a verb than a direct object, while, for psych/  
 29 perception verbs, *with*-PPs are more likely to modify a direct object than  
 30 a verb. Furthermore, the results of two phrase-by-phrase reading time  
 31 experiments suggested that when attachment is ambiguous, reading times  
 32 are faster in cases where attachment is made to the more frequent site.  
 33 However, reading time was measured across the full PP, which may not  
 34 provide enough sensitivity to distinguish lexically encoded frequency  
 35 effects on structure generation from other types of effects that would  
 36 be consistent with the ASH, such as a plausibility effect on syntactic  
 37 ambiguity resolution.

38 Other evidence provides support for the ASH. For example, Boland  
 39 and Boehm-Jernigan (1998) contrasted argument structure knowledge with  
 40 probabilistic information about adjuncts (e.g., the frequency of NP attachment  
 41 for a PP beginning with *in*). For sentences with locally ambiguous PPs,  
 42 they found immediate effects of argument structure on both word-by-word  
 43 reading times and word-by-word sensibility judgments. In contrast, effects  
 44 linked to the attachment bias of a preposition heading an adjunct PP were  
 45 either delayed or absent. Boland and Boehm-Jernigan concluded that

1 argument structure is encoded in frequency-weighted lexicalized structures  
 2 that compete for attachment during parsing, whereas adjuncts are attached  
 3 via non-lexicalized (and thus unweighted) mechanisms.

4 Traxler and colleagues have also found evidence that only arguments  
 5 are attached via a lexicalized mechanism. Using a reading task, Traxler  
 6 and Tooley (2007) found that the usual garden path associated with  
 7 reduced relative clauses (e.g., *The defendant examined by the lawyer was*  
 8 *guilty*) was greatly reduced when the critical sentence was preceded by  
 9 another reduced relative clause sentence using the same verb. However,  
 10 the garden path remained if the sentence was preceded by a reduced  
 11 relative clause sentence using a different verb. Traxler and Tooley view  
 12 this finding as evidence that the [verb + *-en* by Agent] argument structure  
 13 of the verb was primed. Given the necessity of repeating the verb,  
 14 priming apparently affects the competing structures represented in the  
 15 lexical entry of a specific verb, rather than general rules for creating a  
 16 reduced relative clause. In contrast to the lexical dependence of argument  
 17 priming, Traxler (forthcoming) found lexically independent priming for  
 18 adjunct PPs, suggesting that the syntactic analysis of adjuncts does rely  
 19 upon general non-lexicalized rules.

#### 20 ARGUMENT STRUCTURE VS. REAL-WORLD KNOWLEDGE

21  
 22  
 23 Central to the PFH is the idea that knowledge about linguistic arguments  
 24 is part of our episodic knowledge about the entities and events described  
 25 by a word. Motivated by this claim, a number of recent experiments have  
 26 employed the visual world eye-tracking paradigm to investigate how argument  
 27 structure knowledge and real-world knowledge jointly constrain visual  
 28 attention to a co-present array of objects. In some cases, the real-world  
 29 knowledge manipulation is linguistic, while in others it is built into the  
 30 co-present scene itself. The critical question, for distinguishing the PFH and  
 31 the ASH, is whether argument structure knowledge has a privileged status,  
 32 relative to real-world knowledge, during sentence comprehension.

33 In one such study, Kamide et al. (2003) manipulated the linguistic  
 34 context for a verb (e.g., *ride*), while presenting a visual scene that included  
 35 potential agents (riders) and themes (rideable objects) compatible with  
 36 both linguistic contexts. Participants who heard *The man will ride . . .* were  
 37 more likely to look to a picture of a motorcycle, whereas participants who  
 38 heard *The girl will ride . . .* were more likely to look at a picture of a  
 39 carousel. In other words, real-world knowledge about likely participants  
 40 for specific events guided anticipatory looks to potential arguments. This  
 41 finding is consistent with the PFH, but it is also consistent with the ASH,  
 42 because argument structure knowledge may have provided the foundation  
 43 (i.e., the expectation of a theme argument) upon which real-world knowledge  
 44 was integrated (i.e., given the current scene and the current agent of the  
 45 just mentioned event, what is the most likely theme?).

1 Boland (2005) manipulated both real-world typicality and argument status  
 2 for PPs corresponding to recipients (arguments), instruments (potentially  
 3 classifiable as arguments), and locations (adjuncts). When both typical and  
 4 atypical arguments/adjuncts were pictured, listeners tended to look at the  
 5 typical recipients, instruments, and locations, regardless of argument status,  
 6 shortly after hearing the critical verb. For example, upon hearing *The newspaper*  
 7 *was difficult to read, but the mother suggested it anyway . . .*, participants were  
 8 more likely to look at a picture of a teenager than a toddler as the potential  
 9 recipient of *suggest*. The same typicality effect was found for action verb  
 10 instruments and intransitive verb locations. However, when only one  
 11 argument/adjunct was pictured, listeners were more likely, across trials, to  
 12 look at the potential argument than the potential adjunct, regardless of  
 13 real world typicality. In fact, the atypical recipients received just as many  
 14 fixations as the typical recipients. Thus, Boland concluded that argument  
 15 structure does play a privileged role in directing visual attention during  
 16 sentence comprehension.

17 In another study, Chambers et al. (2004) compared the impact of  
 18 argument structure and situational affordances on the interpretation of  
 19 temporarily ambiguous PPs. Affordances are properties of the real-world  
 20 environment that allow particular actions to occur (e.g., something must  
 21 be a liquid to be poured). Under the PFH, real-world knowledge should  
 22 be just as effective as argument structure knowledge in guiding PP-attachment,  
 23 and could even override argument structure under certain conditions.  
 24 Chambers et al. had participants follow spoken instructions, such as *Pour*  
 25 *the egg in the bowl over the flour*. There were always two eggs in front of each  
 26 participant, one of which had been cracked into a bowl. The experimenters  
 27 manipulated whether the second egg was in liquid or solid form. If there  
 28 was only one liquid egg, participants were likely to look at an empty  
 29 bowl, suggesting that they had incorrectly interpreted the first PP *in the*  
 30 *bowl* as the goal argument of *pour*. However, when there were two liquid  
 31 eggs, looks to the empty bowl fell to baseline levels, suggesting that  
 32 participants correctly interpreted the initial PP as modifying the NP,  
 33 despite the fact that the verb *pour* requires a goal. Thus, in resolving the  
 34 PP-attachment ambiguity, the need to know which egg to pour (NP  
 35 modification as an adjunct) temporarily overrode the verb's need for a  
 36 goal (attachment as a VP argument). This experiment demonstrates that  
 37 argument structure knowledge is not privileged in the sense that it always  
 38 overrides pragmatic constraints during syntactic ambiguity resolution,  
 39 thereby ruling out some versions of the ASH.

40 A number of other experiments have provided similarly convincing  
 41 demonstrations that the properties of a real world or depicted situation  
 42 have consequences for syntactic ambiguity resolution (e.g., Tanenhaus et al.  
 43 1995; Spivey et al. 2002; Knoeferle et al. 2005; Knoeferle et al. 2007).  
 44 Together, these findings could be taken as evidence for a 'grammatical  
 45 knowledge proposes, real-world knowledge disposes' architecture, which

1 would be entirely consistent with versions of the ASH proposed by  
 2 Boland (1997, 2005). That is, for Chambers et al. (2004), grammatical  
 3 knowledge would have specified the options of an NP adjunct or a VP  
 4 argument, and situational affordances would have directed selection of the  
 5 most likely option. However, other interpretations of these findings are  
 6 possible, including accounts that are consistent with the PFH, but not the  
 7 ASH. For example, Chambers et al. considered the possibility that ‘a  
 8 restricted domain might first be defined in terms of the actions afforded  
 9 by the scene objects. This domain could then be narrowed by linguistic  
 10 information’ (Chambers et al. 2004: 693).

#### 11 STATUS OF INSTRUMENTS AND PASSIVE *BY*-AGENTS

12 We now turn our discussion to a review of psycholinguistic evidence  
 13 regarding the argument status of PP instruments and agentive *by*-phrases.  
 14 Before doing so, we note two points regarding the import of the data.  
 15 First, both types of phrases have proven difficult to classify as arguments  
 16 or adjuncts using standard tests, and second, as discussed above, it is not  
 17 a foregone conclusion that a distinction between arguments and adjuncts  
 18 is actually required. Thus, it is not clear whether the goal should be to  
 19 find a methodology that will neatly categorize such borderline cases on  
 20 one side of the argument/adjunct distinction, or if the goal should be to  
 21 document the continuum of subtypes that lie between phrases that have  
 22 traditionally been deemed arguments and phrases that have traditionally  
 23 been deemed adjuncts, without making a commitment as to the presence of  
 24 a categorical distinction. Regardless of one’s ultimate goal, the experimental  
 25 data described below illustrate both the strengths and weaknesses of  
 26 sentence comprehension data for illuminating processing distinctions that  
 27 correspond to contrasts between arguments and adjuncts. As in our discussion  
 28 above, we continue to assume that, if there is an argument/adjunct  
 29 distinction, arguments are lexically specified but adjuncts are not. This is  
 30 consistent with dominant traditions in linguistics, and just as importantly  
 31 – for our purposes – it suggests that experimental data might play a useful  
 32 role in determining what counts as an argument.

33 We begin by briefly discussing two studies that investigate PP instruments,  
 34 using experimental data to evaluate the claim that PP instruments bear  
 35 argument status. As mentioned above, Boland (2005) used a visual world  
 36 eye-movement paradigm to investigate argument status. Regarding the  
 37 argument status of instruments, Boland’s Experiment 1 provided some  
 38 evidence that instruments pattern in between definitive arguments (such  
 39 as recipients) and definitive adjuncts (such as locations). Looks to potential  
 40 instruments in sentences such as *The donkey would not move, so the farmer*  
 41 *beat . . .* were more likely than looks to potential adjunct locations in  
 42 sentences such as *The girl slept. . .*. This finding runs counter to text  
 43 co-occurrence statistics, so it is not predicted by the PFH. Rather, it  
 44  
 45

1 suggests that instruments have some of the same properties as arguments.  
 2 However, on balance, Boland's results suggest that the action verbs used  
 3 in her experiments do not take instrument arguments, because she found  
 4 no evidence that the action verbs implicitly introduced an instrument in her  
 5 Experiment 3.<sup>3</sup> In contrast, both experiments produced empirical evidence  
 6 supporting the argument status of the uncontroversial dative argument.

7 Koenig et al. (2003) maintained that some action verbs have instrument  
 8 arguments, while some action verbs do not. They motivated this distinction  
 9 based on intuitions collected from a pair of trained raters concerning whether  
 10 an instrument (apart from the agent's own body) is logically necessary in  
 11 the event specified by each verb. For example, by this criterion, *behead*  
 12 takes an instrument as an argument, but *kill* does not, though it does allow  
 13 an instrument adjunct. They tested this distinction in a reading time  
 14 experiment, using sentences such as *Which sword did the rebels behead/kill*  
 15 *the traitor king with during the rebellion?* If the verb takes an instrument  
 16 argument, the *wh*-phrase can be assigned as the appropriate thematic role  
 17 at the verb. If the verb only takes a theme as its internal argument, the  
 18 *wh*-phrase cannot be assigned as a thematic role (and gap-filler position)  
 19 until the proposition *with* is encountered. Koenig et al.'s finding that reading  
 20 times for the direct object were shorter in the *behead* sentences than for  
 21 the *kill* sentences supports their claim that *behead* takes an instrument  
 22 argument whereas *kill* does not.

23 Together, these experiments suggest that most action verbs do not take  
 24 instruments as arguments, though the Koenig et al.'s finding suggests that  
 25 a small subset of action verbs do. These psycholinguistic data are highly  
 26 relevant for determining the linguistic status of instruments as event  
 27 participants stored with, and introduced by, verbs.

28 Next, we briefly consider the case of agentive *by*-phrases in passive  
 29 sentences, as in *The shrubs were planted by the apprentice*. Agentive *by*-phrases  
 30 are always optional in English, and as such, they must either be optional  
 31 arguments, adjuncts, or something in-between, as in Grimshaw (1990).  
 32 Syntactically, the phrases have often been treated as adjuncts (e.g., Jackendoff  
 33 1990; Van Valin and Lapolla 1997) or in some cases as arguments of elements  
 34 other than the verb, such as the passive morpheme *-en* (Jaeggli 1986). In  
 35 contrast, some approaches allow the *by*-phrase to be an argument or a  
 36 doubled argument of the verb (Baker et al. 1989; Collins 2005). Semantically,  
 37 agentive *by*-phrases seem to be arguments, as they arguably receive their  
 38 thematic role the same way active verbs do – from the verb (e.g., Liversedge  
 39 et al. 1998), as can be seen in the correspondence of thematic roles between  
 40 active and passive counterparts. For example, *Chris* is an agent in both  
 41 *Chris planted the flowers* and *The flowers were planted by Chris . . .* and an  
 42 experiencer in both *Chris witnessed the shooting* and *The shooting was*  
 43 *witnessed by Chris . . .*

44 As shown in a series of experiments by Mauner and colleagues (e.g.,  
 45 Mauner et al. 1995; Mauner and Koenig 2000), an agent can be introduced

1 into the discourse even if a *by*-phrase is not overtly present. The intro-  
 2 duction of this *implicit agent* is demonstrated by its ability to control the  
 3 empty subject position of an infinitive clause, as in *The shrubs were planted*  
 4 *to please the owner*. Furthermore, when a *by*-phrase occurs in a passive  
 5 sentence, it often refers to that implicit agent. However, it does not  
 6 follow that the *by*-phrase is itself an argument. As Lasnik (1988) points  
 7 out, the thematic role assigned to the *by*-phrase could be transmitted by  
 8 the preposition *by*, just as it transmits the locative role in *The shrubs were*  
 9 *planted by the greenhouse*.

10 Additional psycholinguistic evidence has yet to provide clear answers as  
 11 to the argument status of the *by*-phrase. Liveseidge et al. (1998) found  
 12 faster reading times on *apprentice*, compared to *greenhouse* in sentences such  
 13 as *The shrubs were planted by the apprentice/greenhouse* (a similar finding was  
 14 reported by Hanna et al. 1996). This reading time difference is predicted  
 15 by an argument/adjunct difference, combined with a 'prefer argument'  
 16 ambiguity resolution heuristic (Abney 1989). However, what appears to  
 17 be an argument preference could actually be a meaning dominance effect  
 18 for the lexically ambiguous preposition *by*, because, as Liveseidge et al.  
 19 report, the agent form of *by* is more frequent in a passive clause than the  
 20 locative form of *by*. Yet, another possible explanation for the presumed  
 21 argument preference is that the verb introduces an implicit agent prior to  
 22 encountering the *by*-phrase; what makes reading times faster for *apprentice*  
 23 than for *greenhouse* is that only the former can be mapped onto that  
 24 pre-existing, but underspecified, discourse referent. In short, while the  
 25 Liveseidge et al. data are consistent with the claim that agentive *by*-phrases  
 26 are arguments, there are also accounts of their data consistent with the  
 27 claim that all passive *by*-phrases are adjuncts.

28 While psycholinguistic data may help to resolve the argument/adjunct  
 29 status of instruments, we think that psycholinguistic data are less likely to  
 30 be helpful in resolving the status of *by*-phrases. For phrases that are clearly  
 31 internal arguments, such as themes and recipients, the verb uncontroversially  
 32 assigns the thematic role to the subcategorized phrase (the direct or indirect  
 33 object) if the phrase is explicit in the sentence. Thus, psycholinguistic  
 34 evidence that recognition of the verb automatically introduces such an  
 35 entity into the discourse, or that comprehension of the phrase itself is  
 36 facilitated, can be taken as evidence that the verb's argument structure has  
 37 been active during sentence comprehension. The logic can be extended fairly  
 38 straightforwardly to phrases that may or may not be internal arguments.  
 39 For example, psycholinguistic evidence that the verb *behead* introduces an  
 40 instrument into the discourse can be taken as evidence that *with a guillotine*  
 41 is an argument in *Elizabeth beheaded Mary with a guillotine*. However, the  
 42 logic changes when we try to evaluate the argument status of a *by*-phrase  
 43 in a passive construction. Passive verbs clearly allow for an external  
 44 argument (most typically agent or experiencer), but it is not clear that the  
 45 external argument role is assigned directly to an agentive *by*-phrase when

1 it is present. Examples such as *The ship was sunk by a torpedo to win the war*  
 2 (Lasnik 1988) demonstrate that *by*-phrases and implicit agents are not  
 3 always co-referential. Thus, psycholinguistic evidence that a passive verb  
 4 introduces an implicit agent into the discourse is neutral with respect to  
 5 whether the *by*-phrase actually *is* the argument or is merely co-referential  
 6 with an implicit argument.

7 These examples suggest that psycholinguistic research on sentence  
 8 comprehension holds promise for resolving some, but certainly not all,  
 9 linguistic questions. If an argument/adjunct distinction is reflected directly  
 10 in processing differences, psycholinguistic evidence can reveal subtle distinctions  
 11 that we are unaware of, and which therefore cannot be readily  
 12 examined by our intuitions. Nevertheless, we maintain that psycholinguistic  
 13 data should continue to be considered alongside traditionally gathered  
 14 linguistic evidence, using native speaker acceptability judgments. A given  
 15 experiment can only investigate a small set of verbs in a small set of sentences,  
 16 while a careful linguist can evaluate the acceptability of broad range of  
 17 sentences in a larger span of contexts.

### 18 19 Summary

20  
21 The argument/adjunct distinction remains an active research topic, relevant  
 22 to both formal linguistics and psycholinguistics. The evidence is not  
 23 entirely conclusive on either front, but on balance, the psycholinguistic  
 24 evidence supports a formal distinction between arguments and adjuncts.  
 25 Throughout this article, we assumed that argument knowledge is specified  
 26 in the lexical entry of the head, while adjunct knowledge is not. If this  
 27 is correct, questions about the argument status of a phrase are, in effect,  
 28 questions about the learned mental representations of the lexical heads. As  
 29 such, psycholinguistic evidence is highly relevant. However, as discussed  
 30 above, the logic only holds if there is a clear mapping between the phrase  
 31 in question and the thematic role assigned by the head. This was not true  
 32 for *by*-phrase agents. Thus, psycholinguistic data cannot resolve questions  
 33 of argument status in all cases.

34 In closing, we summarize some of the open questions that may be  
 35 useful for guiding future research. Is the argument/adjunct distinction  
 36 binary? Is it categorical? As noted above, Grimshaw (1990) posited a  
 37 three-way distinction, while MacDonald et al. (1994) and Manning (2003)  
 38 suggest a gradient distinction, based upon co-occurrence patterns. What  
 39 kind of data is relevant to resolving questions about argument status? Is it  
 40 possible to classify problematic cases in terms of whether linguistic or  
 41 psycholinguistic tests are most useful? We have focused mainly on verbs,  
 42 but the argument/adjunct distinction is relevant for other lexical heads  
 43 (nouns, prepositions, etc.) as well. Do these categories introduce implicit  
 44 arguments into the discourse as well, or are verbs a special case due to  
 45 their event-defining properties? Answering these and related questions is

1 central to understanding how syntactic and semantic knowledge is represented  
 2 in the mind and accessed during sentence comprehension.

### 3 4 *Short Biographies*

5  
6 Julie Boland has spent much of her career investigating the interfaces  
 7 among lexical, syntactic, and semantic processing, and argument structure  
 8 has been at the heart of much of this research. Her research has been  
 9 published in *Cognition*, *Journal of Memory and Language*, *Language and*  
 10 *Cognitive Processes*, *Proceedings of the National Academy of Sciences*, and  
 11 other scholarly outlets. Boland is currently an Associate Professor of  
 12 Psychology and Linguistics at the University of Michigan. Before taking  
 13 her current position, Boland held appointments at Ohio State, Rutgers,  
 14 and the University of Louisiana. Her PhD is in Psychology, from the  
 15 University of Rochester.

16 Damon Tutunjian is a PhD candidate in Linguistics at the University  
 17 of Michigan. His primary interests are in psycholinguistics, sentence  
 18 comprehension, and the syntax–semantics interface. His current research  
 19 examines the effect of discourse prominence on argument structure activation  
 20 as well as the argument structure of short passive constructions. Tutunjian  
 21 holds a BA in English from the University of Massachusetts, Boston.

### 22 23 *Notes*

24  
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28 <sup>1</sup> It should, however, be noted that apart from these two considerations, we do not make  
 29 finer-grained distinctions here as to exactly how early an ‘immediate’ effect has been detected.  
 30 Dependent measures vary widely in terms of their temporal granularity and some dependent  
 31 measures may conflate early and late processing. We thus include studies using a wide range of  
 32 experimental paradigms, only noting methodological limitations where they are clearly relevant.

33 <sup>2</sup> To compute the co-occurrence frequencies from a corpus, one needs to define the relevant  
 34 types. For (2) in the text, one could compute the probability that a VP headed by *try* contains  
 35 a PP headed by *in* vs. the probability that a NP headed by *man* contains a PP headed by *in*.  
 36 Alternatively, PP type might be construed as the semantic role of the phrase (e.g., instrument,  
 37 manner, and location), or the lexical string itself.

38 <sup>3</sup> Ferretti et al. (2001) came to the opposite conclusion, based on priming between verbs and  
 39 prototypical instruments. However, as outlined in Boland (2005), the priming methodology is  
 40 not ideal for determining argument status.

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