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Do We Need a Distinction between Arguments and Adjuncts? Evidence from Psycholinguistic Studies of Comprehension

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Abstract

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

Introduction

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

(1) a. Timmy punched the stuffed animal on his sister's bed with glee.
b. Timmy put the stuffed animal on his sister's bed with glee.
c. *Timmy put the stuffed animal with glee.

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

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

Many syntactic theories, including Principles and Parameters based approaches (Chomsky 1981), Lexical-Functional Grammar (Kaplan and Bresnan 1982), and Role and Reference Grammar (Van Valin and LaPolla 1997), maintain a distinction between arguments and adjuncts. Within such theories, two types of syntactic knowledge can be identified that are relevant to the argument/adjunct distinction. The first involves general principles that apply broadly and cross-linguistically. For example, for the subset of theories that claim a direct correspondence between lexical-semantic/conceptual and syntactic representations, it is the application of general principles that is responsible for the mapping of lexical-semantic information to syntactic structure (e.g., Jackendoff 1990; Dowty 1991; Levin and Rappaport Hovav 1995; Baker 1997; Reinhart 2002). Regardless of approach, each serves to determine the placement of arguments and adjuncts in the phrase structure tree. The second type of syntactic knowledge is idiosyncratic to individual (or classes of) lexical items, for example, the transitivity or intransitivity of individual verbs, that is, their subcategorization frames. Subcategorization frames specify the number and phrasal types of arguments that verbs can take (see Borer 2005 and Hale and Keyser 1993, 2002 for alternative approaches), thereby providing verb-specific information that interacts with, but is separate from the more general principles that regulate each phrase's structural instantiation.

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

The gray areas in the argument/adjunct taxonomy arise, in part because the classification of arguments and the conditions for their expression require an awkward melding of lexical semantics with syntactic principles, neither of which is typically construed in a manner that adequately suits the needs of the other (see Levin and Rappaport Hovav 2005). For example, under one semantically driven approach to identifying arguments, one of 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; Konieczny 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

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

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

Psycholinguistic Evidence

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

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

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

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

PURE FREQUENCY VS. ARGUMENT STRUCTURE BASED APPROACHES

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

The PFH predicts that PP-attachment difficulty will be a function of the co-occurrence frequency between the PP type and the lexical head type at the potential attachment sites.[2]

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

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

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

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

Traxler and colleagues have also found evidence that only arguments are attached via a lexicalized mechanism. Using a reading task, Traxler and Tooley (2007) found that the usual garden path associated with reduced relative clauses (e.g., *The defendant examined by the lawyer was guilty*) was greatly reduced when the critical sentence was preceded by another reduced relative clause sentence using the same verb. However, the garden path remained if the sentence was preceded by a reduced relative clause sentence using a different verb. Traxler and Tooley view this finding as evidence that the [verb + *-en by* Agent] argument structure of the verb was primed. Given the necessity of repeating the verb, priming apparently affects the competing structures represented in the lexical entry of a specific verb, rather than general rules for creating a reduced relative clause. In contrast to the lexical dependence of argument priming, Traxler (2008) found lexically independent priming for adjunct PPs, suggesting that the syntactic analysis of adjuncts does rely upon general non-lexicalized rules.

ARGUMENT STRUCTURE VS. REAL-WORLD KNOWLEDGE

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

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

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

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

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

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

STATUS OF INSTRUMENTS AND PASSIVE *BY*-AGENTS

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

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

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

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

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

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

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

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

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

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

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

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

Summary

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

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

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

Short Biographies

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

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

Notes

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[1] It should, however, be noted that apart from these two considerations, we do not make finer-grained distinctions here as to exactly how early an 'immediate' effect has been detected. Dependent measures vary widely in terms of their temporal granularity and some dependent measures may conflate early and late processing. We thus include studies using a wide range of experimental paradigms, only noting methodological limitations where they are clearly relevant.
[2] To compute the co-occurrence frequencies from a corpus, one needs to define the relevant types. For (2) in the text, one could compute the probability that a VP headed by *try* contains a PP headed by *in* vs. the probability that a NP headed by *man* contains a PP headed by *in*. Alternatively, PP type might be construed as the semantic role of the phrase (e.g., instrument, manner, and location), or the lexical string itself.
[3] Ferretti et al. (2001) came to the opposite conclusion, based on priming between verbs and prototypical instruments. However, as outlined in Boland (2005), the priming methodology is not ideal for determining argument status.

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