Abstract

This paper presents an analysis of the English instrumental markers *with* and verbal *use*. As with other thematic roles, the semantic generalizations encoded by the role Instrument have been difficult to precisely characterize. In this study, we analyze the distinct semantic contributions of *with* and *use*, illuminating several properties of instrumental meaning. In particular, *use* specifies that the agent must act intentionally, which we formalize as universal quantification over possible worlds within a Montague-style compositional framework. By contrast, *with* encodes a constraint whereby an instrument is a direct extension of the force initiated by the agent. This analysis is most consistent with theories in which thematic roles are clusters of event properties, rather than categories defined in terms of necessary and sufficient conditions; our analysis does not make use of Instrument as a primitive role.

1 Introduction

A key semantic issue concerns how event participants are categorized in language. One possibility is that abstract roles such as Agent and Patient are part of a fundamental, even language universal, vocabulary for understanding events (Fillmore 1968, 1977; *inter alia*). The difficulty in formulating necessary and sufficient conditions for any single role, however, is well-documented (Jackendoff 1987; Pinker 1989; Dowty 1991; DeLancey 1991; van Valin & Wilkins 1996; Reisinger *et al.* 2015). An alternative approach is that participants are categorized in terms of a range of semantic properties, and terms such as Agent are convenient labels reflecting salient combinations of these properties (Dowty 1989, 1991; Jackendoff 1990). In this second approach, the salient clusters of properties need not even
be identical across languages. In this paper, we address this debate through the case study of participants often referred to as ‘instruments’:

(1)  
   a. Brutus stabbed Caesar with a knife.  
   b. Brutus used a knife to stab Caesar.

Instrumental participants have been studied extensively (Lakoff 1968; Nilsen 1973; Talmy 1976; Marantz 1984; Rappaport & Levin 1988; Schlesinger 1989; Jackendoff 1990; Croft 1991; Brunson 1992; Ono 1992; Parsons 1995; Schlesinger 1995; Schutze 1995; Goldberg 2002; Koenig et al. 2003, 2008; Koenig & Davis 2006; Rissman et al. 2015). Nonetheless, there is little consensus as to which properties a hypothetical ‘Instrument’ role might encode (if it exists) and therefore little consensus as to how the behavior of instruments such as in (1) speaks to theoretical debates about the nature of thematic roles and their relevance to cognition and grammar.

Thematic roles serve at least three major explanatory functions in linguistic theory: explaining argument realization patterns, expressing common sets of entailments across verbs and capturing robust ways of categorizing event participants that are stable across event types, that is as Experiencers, Sources, or Instruments (Gruber 1965; Fillmore 1968; Talmy 1976; Jackendoff 1983; Marantz 1984; Baker 1988; Dowty 1989, 1991; Pinker 1989; Grimshaw 1990; Langacker 1991; Croft 1991; Parsons 1995; Schlesinger 1995; van Valin & Wilkins 1996; Levin & Rappaport-Hovav 2005). This paper focuses on the third type of explanatory role: assuming a participant category that includes the knives in (1a–b) but not Brutus or Caesar, what is the semantic structure of this (instrumental) category?

Addressing this issue for Instruments, as for any thematic role, involves answering two interrelated questions: (1) how do we know when a particular noun phrase (NP) is serving an Instrumental role, and 2) what are the event properties shared by all instruments? A widely accepted heuristic for answering the first question was proposed in Lakoff (1968): that a sentence contains an Instrument iff the *with*- and *use*-versions of this sentence are both grammatical and convey the same meaning (see Nilsen 1973; Koenig et al. 2008, for discussion).

Answering the second question, what participant properties are shared by the resulting set of instruments, has proven difficult, in part due to data such as in (2):

(2)  
   a. John smashed the zombie’s head with a club.  
   b. Lucy ate the cereal with a spoon.  
   c. Martha changed the light bulb with a ladder.

These instruments have been analyzed as playing different roles in their respective events (Marantz 1984; Schlesinger 1995; Koenig et al. 2008). Intuitively, the club in (2a) directly links John and the zombie: John causes the club to come into contact with the zombie, which causes his head to become smashed. By contrast, the spoon and the ladder in (2b–c) are causally more indirect: Martha’s standing on the ladder does not *cause* her to change the light bulb. The spoon and the ladder play an intuitively helping role, that is, the spoon seems to *help* Lucy eat the cereal but does not *cause* her to eat the cereal. Characterizing and accounting for these differences, while identifying what these different roles have in common such that they are all Instruments, remains a serious challenge.

In this paper, we assume that there is a participant category containing the knives in (1a–b) that is interestingly different from the categories that Brutus and Caesar are members of. We refer to this participant category as Instrument, without assuming that this role
can be defined in terms of necessary and sufficient conditions. We propose a new answer to the question of what participant properties are relevant to Instrumenthood by adopting a different approach to the question of how Instruments should be identified. Rather than employ the intersective with/use diagnostic described above, we analyze with and use separately, giving a precise account of their meaning and their semantic interaction with lexical verbs such as stab. This approach is driven by the contrasts in (3–5), which indicate that with and use make non-trivial contributions to the truth conditions of an instrumental sentence (where the ‘#’ indicates for these examples that a native speaker will judge the sentence as odd, because it is a false or an inappropriate description of the salient event in the scenario):

(3) (where Nancy is holding scissors and trips)
   a. Nancy cut her dress with the scissors.
   b. #Nancy used the scissors to cut her dress.

(4) a. John used his connections to further his career.
    b. #John furthered his career with his connections.

(5) (where Nigel is chopping lettuce on top of his desk)
   a. Nigel used his desk to chop the lettuce.
   b. #Nigel chopped the lettuce with his desk.

Although Lakoff (1968) and Chomsky (1972) noted the contrasts in (3) and (4), respectively, these data have received relatively little attention. The contrast in (5) has not been previously noted, as far as we are aware.

Research on thematic roles has often been conducted independently from research utilizing compositional, truth-conditional analyses of semantics. The truth-conditional approach pursued in this paper leads to new sources of data and insights into the semantic properties of instruments (see Cruse 1973; Dowty 1989; Beavers 2010, for discussion and support of a truth-conditional approach to thematic roles). We propose in particular that sentences with use-instruments encode intentionality: the agent acts on the instrument in worlds compatible with her intentions. With is agnostic with respect to intentionality, but with-instruments are more constrained than use-instruments as to their structural position in an event. Given the divergent behavior of use and with, the role Instrument is best understood as a cluster concept (see Croft 1991; Dowty 1991; Langacker 1991). In our analysis, there is no single characterization of Instrumental meaning other than the following broad generalization: that an Instrument is an entity, either concrete or abstract, acted on by an agent as part of a larger event. We develop this generalization in detail below, showing how this category shares features of Agent-like roles as well as Theme/Patient-like roles.

As described above, one function of thematic roles is to capture robust ways of representing event participants. If the role Instrument as encoded in English reflects a cognitively salient way of categorizing event participants, then the event properties encoded by English instrumental use and with should be found across languages and be accessible to young language learners. This paper provides a specific analysis of English use and with, providing a road map for testing this hypothesis. That is, precisely identifying what meanings are
encoded in the instrumental sentences of a single language is a precondition for assessing the cross-linguistic stability of these meanings (see Rissman 2013a).

Section 2 of this paper describes previous studies of instruments and some limits of these studies. In particular, many previous studies focus on verbal contributions to instrumental interpretation, leaving open how with and use themselves contribute to instrumental meaning, and why with and use contrast in various ways, as shown in (3–5). In section 3, we propose a modal analysis of use in which use quantifies over possible worlds compatible with the agent’s intentions. In section 4, we argue that with sentences may implicate but do not entail an intentional reading and also propose that with constrains the relationship between the instrument and the force exerted by the agent. We conclude in section 5, arguing that this analysis of use and with supports a proto-property theory of participant roles. In this paper, we use the capitalized term ‘Instrument’ when referring to an event participant category. We use the lowercase term ‘Instrument’ when referring to the NP itself, that is the direct object of either with or use.

2 Background

2.1 Previous analyses of the instrumental role
Since Lakoff (1968), NPs have been identified as Instruments if they are permissible in both with- and use versions of a sentence, as described in section 1. This diagnostic rules out various non-instrumental senses of with, such as the manner sense in (6):

(6) a. Chloe presented her arguments with confidence.
   b. *Chloe used confidence to present her arguments.

Instrumental and manner NPs are intuitively distinct as to their thematic role, and the with/use diagnostic provides independent evidence for this distinction.

Given this diagnostic for identifying Instruments, researchers have asked what semantic properties are shared by all Instruments. A common characterization is that Instruments are causal intermediaries (Talmy 1976; Croft 1991; Goldberg 2002), i.e., that an Instrument is ‘intermediate in a causal chain between the subject (initiator) and the direct object (final affected entity)’ (Croft 1991: 178). Koenig & Davis (2006) describe the Instrument as ‘both the acted-upon entity of one part of a causal chain and the “cause” of another part’ (p. 79). Similarly, Fillmore (1968) describes the Instrumental as a property of nominal phrases, where ‘the inanimate force or object [is] causally involved in the action or state identified by the verb’ (p. 24).

These characterizations are empirically limited, however. In some cases, the role of the instrument is difficult to analyze in terms of direct causal relations, defined as in Lewis (1973) or Dowty (1979), for example (see Marantz 1984; Schlesinger 1995; Koenig et al. 2008; Rissman 2013b). Examples of causally intermediate/direct instruments are shown in (7), with more indirect instruments shown in (8), where although some broad notion of causation may be involved, the instruments are not causal intermediaries in any of the senses above:

(7) a. Lily cut the bread with a knife.
   b. Marla dented the table with a hammer.
   c. Booth shot Lincoln with a gun.
As described in Rissman (2013b), these two types of instruments can be distinguished based on the felicity of a causal paraphrase, which approximately tracks how direct the causal chain is. For example, it is felicitous to say of (7a) that Lily caused the knife to come into contact with the bread, which caused the bread to become cut. By contrast, Max acting on the key in (8a) may cause the room to become unlocked, but this does not cause Max to enter the room. That is, acting on the key may be necessary for Max to enter the room, but not causally sufficient. The magnifying glass in (8c) is not even causally necessary: presumably Lucy can examine the portrait via the naked eye, but the magnifying glass allows her to examine with more precision.

Variation such as in (7–8), given the diagnostic of causal paraphrases, indicates that Instruments are not simply causal intermediaries. Schlesinger (1995) proposes that there are multiple Instrumental subroles, including intermediary, enabling and ancillary, which correspond to (2a–c). In several analyses, the existence of different types of instruments follows from differences in the meaning of the lexical verb (Marantz 1984; Ono 1992; Schutze 1995; Koenig et al. 2008). In Koenig et al. (2008), causally intermediate instruments are linked to specific classes of verbs. Verbs such as stab, cut and slice, for example on this view have the semantic substructure in (9):

\[
\text{ACT}(s_1, A, I) \land \text{cause}(s_1, s_2) \land \text{CONTACT}(s_2, I, P) \land \text{cause}(s_2, s_3) \land \text{INCISED}(s_3, P)
\]

\(s_1\) is a subsituation where the agent acts on the instrument, which causes the subsituation \(s_2\) where the instrument makes contact with the patient. \(s_2\) in turn causes \(s_3\), where the patient becomes incised. As another example, poke, dent and prod encode a substructure in which an agent causes the instrument to come into contact with the patient, which causes the patient to become compressed. Within this framework, (7a–b) contain causally intermediate instruments by virtue of cut and dent encoding a chain of three causally linked subsituations.

For the instruments in (8), Koenig et al. represent these sentences as involving a causally indirect relation between subsituations. Sentences with enter and eat have the substructures in (10a) and (10b):

\[
\begin{align*}
\text{a.} & \quad \text{precondition}(s_1, s_3) \land \text{ACT}(s_1, A, I) \land \text{CHANGE-OF-STATE}(s_3, P) \\
\text{b.} & \quad \text{help}(s_1, s_3) \land \text{ACT}(s_1, A, I) \land \text{EATEN}(s_3, P)
\end{align*}
\]

Applying (10a) to the sentence Max entered the room with a key, Max acts on the key, which is a precondition for the room being entered. Applying (10b) to Chloe ate the ice cream with a spoon, Chloe’s acting on the spoon helps bring about the situation where the ice cream becomes eaten. The definition of help proposed by Koenig et al. is paraphrased in (11):

\[
\text{An eventuality } e_1 \text{ helps the occurrence of token } e_2 \text{ of the event category } C \text{ iff there is an ordering of tokens of } C \text{ along a pragmatically defined scale and } e_1 \text{ causes the token } e_2 \text{ of } C \text{ to be higher on that ordering then it would otherwise have been}
\]

Koenig et al. analyze eat as part of a large class of verbs that includes drink, hunt and play. The general formula for this class can involve any dynamic relation between agent and instrument and any property of the patient. For ease of exposition, we have filled in the particular relations ACT and EATEN for the verb eat.
In other words, acting on the spoon causes the event of eating ice cream to have a higher rank with respect to some scale, for example cleanliness, tastiness and efficiency. The relations precondition and help account for the intuition that the key and the spoon in (8a–b) play causally indirect rather than intermediate roles. Crucially, these relations are associated with particular verbs or classes of verbs.

The so-called instrument–subject alternation (Fillmore 1968) has been cited as evidence that this dependence of the instrument on the verb is reflected syntactically (Marantz 1984; Ono 1992; Schutze 1995; Koenig et al. 2008). An instrument from examples like (7–8) appearing in subject position in comparable sentences is possible for the intermediary instruments but not the indirect instruments:

(12) a. The knife cut the bread.
    b. The hammer dented the table.
    c. *The key entered the room.
    d. *The magnifying glass examined the portrait.

These data have been taken as evidence that the semantic distinction between intermediary and indirect instruments is relevant to syntactic argument realization. In analyses that emphasize verbal contributions to instrumental meaning, the compositional role of with and use is either negligible or left unspecified. Marantz (1984), for example, argues that an NP receives the instrumental role not from with but from the verb. Schutze (1995) suggests that with is semantically vacuous, and in Koenig & Davis (2006), the phrases poke and poke with have the same lexical semantic representation.

2.2 Limitations of previous analyses

The studies described above demonstrate that the lexical verb plays an important role in constraining instrumental interpretation. Nonetheless, a variety of evidence indicates that with and use are contentful elements, and understanding their semantic contribution is crucial for understanding the Instrumental role more generally (see Wechsler 1994, for discussion of other semantically contentful prepositional phrases (PPs)). As a first piece of evidence, we observe that a single verb may be compatible with a range of different instrument types. Adopting the Koenig et al. analysis in (9), slice encodes one object making an incision in another object; for the purposes of this paper, we consider the incision-making

Contrasts such as in (i–ii) call into question the generality of this interpretation:

(i) a. The stick hit the fence.
    b. *The stick beat the rugs.
(ii) a. The Derringer pistol killed Lincoln.
    b. *The Derringer pistol murdered Lincoln.

That is, the instruments in the (a) and (b) variants play comparable roles in their respective events, but only the (a) variants are felicitous, as beat and murder require an intentional agent. We do not discuss instrument-subject data as in (12) further in this paper, but adopt the position that ‘instrument subjects’ are in fact non-prototypical Agents, and that multiple constraints influence when an inanimate NP can appear in subject position (Schlesinger 1989; DeLancey 1991; Dowty 1991; Alexiadou & Schäfer 2006; Grimm 2007). In a sentence such as (iia), it is highly likely that the pistol is manipulated by some additional, unnamed animate individual. It is unclear, however, whether labeling these two participants with the roles Instrument and Agent, respectively, helps explain the data in (12) and (i–ii).
object to be an argument of *slice*. The particular instrument in a sentence can fill this argument role (13a), but non-argument instruments are also possible (13b–d):

(13)  
  a. Chloe used a knife to slice the turkey.  
  b. Chloe used a stepladder to slice the turkey. (if Chloe is short)  
  c. Chloe used only her left hand to slice the turkey. (implicit knife)  
  d. Chloe used the two hours before lunch to slice the turkey.

The data in (13) indicate that the verb constrains instrumental interpretation but does not determine it absolutely, indicating a non-vacuous role for *use*. For *with*, Koenig *et al.* (2008) note that multiple instrumental subroles can appear with a single verb, as in *Mark bakes pizza with a wood oven with yeast*. Nonetheless, such variability is beyond the scope of their study.

*With* and *use* also contrast with respect to particular semantic features. The example in (3) suggests that *use* but not *with* requires that its agent act intentionally. Additional evidence for this intentionality contrast is shown in (14–15). Each of the *use* sentences in (14) is infelicitous, unlike its *with* counterpart in (15):

(14)  
  a. #While he was sleeping, Jim used his sleeping bag to mop the floor.  
  b. #The bus used its tire to crush the tricycle.  
  c. #Sue tripped and used her elbow to break the vase.

(15)  
  a. While he was sleeping, Jim mopped the floor with his sleeping bag.  
  b. The bus crushed the tricycle with its tire.  
  c. Sue tripped and broke the vase with her elbow.

The contexts for these sentences all involve an agent who does not intend to accomplish the event specified in the main clause: Jim moves back and forth in his sleeping bag and ends up mopping the floor, the bus is a non-anthropomorphized vehicle that cannot have intentions toward crushing the tricycle, Sue accidentally trips and her elbow knocks the vase over.

The range of possible instruments is also more restricted for *with* than for *use*, as shown in (5). Returning to the examples in (13), a hand manipulating an implicit knife is a possible instrument of slicing for both *use* and *with*. Nonetheless, the *with*-counterparts of (13b) and (13d) are both unacceptable:

(16)  
  a. Chloe sliced the turkey with only her left hand.  
  b. #Chloe sliced the turkey with a stepladder.  
  c. #Chloe sliced the turkey with the two hours before lunch.

We are not aware of any prior discussion of this type of contrast, where a *with*-instrument appears to be required to be more directly involved in the realization of an event. That is,

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4 These data also demonstrate the role of the instrumental noun in constraining instrumental interpretation. It is unlikely that a human hand could fill the role of the bladed object for a slicing event, particularly if the object being sliced is a turkey. For this reason, the hand in (13c) is interpreted as a hand that manipulates an implicit bladed object. This kind of pragmatic influence on instrumental interpretation is assumed to apply in all the examples considered in this paper, and is not specific to *use* or *with*.

5 Thank you to an anonymous SALT reviewer for pointing out this example.
the stepladder is what Chloe stands on to get closer to the turkey but is not involved in the slicing itself.

A final limitation of analyses that focus predominantly on verbal contributions to instrumental meaning is that in some cases, a verb’s meaning alone does not license an instrumental interpretation. In Koenig et al. (2008), for instance, sentences with the verb eat include the instrumental relation help. The sentence John ate the ice cream with a spoon, for example, would be represented by the formula in (17):

\[ \text{help}(s_1, s_3) \land \text{ACT}(s_1, \text{John, spoon}) \land \text{EATEN}(s_3, \text{ice cream}) \]

In Koenig et al.’s analysis of the meaning of eat, the instrument is semantically optional, that is the lexical entry of eat does not itself encode an instrumental role. The formula in (17) must therefore be generated compositionally, via an interaction between eat and either with or use. How does this interaction yield the relation help? When with and use interact with slice, why does the help relation not arise? A computational mechanism that yields an ordering of event tokens, applying to eat but not to slice, remains to be specified.

The data in section 2.2 indicate that use and with make a truth-conditional contribution to the meanings of instrumental sentences. In this paper, we propose analyses of use and with, focusing on the intentionality contrast in (3, 14–15) and the event structure contrast in (5, 16). Specifically, we argue that use-sentences involve quantification over worlds compatible with the agent’s intentions, whereas with imposes a constraint on the position of the instrument in the force-dynamic structure of the event (see Talmy 1988).

## 3 Use

The modal, intentional analysis of use proposed here allows a use-instrument to play a variety of causal roles in an event, including a ‘helping’ role (Koenig et al. 2008). In contrast with previous analyses, we argue that this modal content is present in the truth conditions of all use-sentences, regardless of the lexical verb. The analysis develops in three main steps. First, in section 3.1, we discuss the event structure of instrumental sentences, suggesting that use-instruments are represented as part of a subevent in which the agent ‘acts on’ the instrument. Second, in section 3.2, we describe the event structure of use-sentences in terms of a compositional framework, based on the argument structure of use. Third, in sections 3.3–3.4, we develop the most complex part of the account: the treatment of intentionality for use reports. Section 3.3 sets the empirical stage, and section 3.4 develops the formal analysis in a possible world semantics. This section also explores a technical problem concerning negation, suggesting that the intentional requirement is presupposed.

### 3.1 Instrumental subevent

Following a long line of literature starting with Davidson (1967), we assume that a sentence like Booth shot Lincoln reports a shooting eventuality, with Booth as the Agent and Lincoln as the Patient. What then is the event structure of Booth used a Derringer pistol to shoot Lincoln, or Booth shot Lincoln with a Derringer? We assume a neo-Davidsonian semantics that includes events as an ontological type (Davidson 1967; Parsons 1990; Higginbotham 2000; Pietroski 2005; a.o.). For both with and use, instrumental participants are introduced into the event structure of the sentence through a subevent relation. This expresses what we take to be the common denominator among the various instrumental relations from previous literature discussed in section 2.1: that the agent acts on the
instrument as part of some larger event. For the sentence Booth used a Derringer pistol to shoot Lincoln, for example, the subevent relation (notated with ⊂) is illustrated in (18):

(18) Given a shooting event $e$ s.t. Agent$(e) = Booth$:

\[
\exists e': e' \subset e \text{ and } ACTED-ON(e', \text{pistol}) \text{ and Agent}(e) = Agent(e') = Booth
\]

This subevent $e'$ is parallel to the subsituation $\text{ACT}(s_1, A, I)$ that Koenig et al. (2008) use in their event representation formulae.

(18) indicates that $e'$ is an event where the pistol is acted upon by Booth. Following the neo-Davidsonian approach, we assume Agent as a predicate of event participants (and do not address here issues of whether ‘Agent’ ought to be decomposed). The other participant of the subevent $e'$ is acted upon by the agent, and the range of individuals that can be acted upon, and how they can be acted upon, is quite broad. Keep in mind that although this acted-on participant is Patient-like in $e'$, $e'$ is embedded within the superordinate event $e$, for example Booth acting on Lincoln, leading to the intuition that the Instrumental role is distinct from the Patient role. An instrument need not be a physical object, for either use and with:

(19) a. I used a series of high-pitched tones to prime the subjects.
    b. I primed the subjects with a series of high-pitched tones.
    c. I used my charming personality to seduce him.
    d. I seduced him with my charming personality.

As these examples show, the relation of ‘acting upon’ extends outside of the physical domain, to include an agent willfully leveraging their own personality, for example.

As described in Nilsen (1973), an abstract notion of CONTROL is relevant here; the agent must have control over the instrument. The following examples from Nilsen (1973) and Schlesinger (1989) demonstrate the limits of this notion of control:

(20) a. The apparatus bored holes in the metal with its laser beam.
    b. *The wind broke the window with the tree branch.
    c. *The hammer dented the metal with the nail. (Where an implicit individual is hammering a nail into the metal)

Although the apparatus in (20a) is inanimate and without intention, it controls its own laser beam in the sense that the functioning of the laser beam is determined by the functioning of the apparatus as a whole. The wind and the hammer in (20b–c) can cause the branch and the nail, respectively, to move, but they do not operate on them in the same sense. In (20c), it is the implicit agentive individual who exerts control in the event, not the hammer. This notion of control is encoded in the two properties that predicate of the subevent $e'$ in (18): Agent and ACTED-ON.$^6$ We leave further research to explicate this notion more fully.

We assume that events have a rich part/whole structure, as described in Thomson (1977) and Link (1987) among others. A particular event of cleaning the house, for example, can have multiple subevents, such as cleaning the kitchen and vacuuming the living room. A particular vacuuming event is in turn composed of (sub)events, for example pressing the power button and air being sucked through the hose. The sentence Booth killed Lincoln with a Derringer pistol indicates a killing event whose agent is Booth, as well as a subevent $e'$ in which the pistol is acted upon by Booth. The property and details of $e'$ are

$^6$ As (20a) shows, we assume a fairly broad notion of Agent in which Agents can be both non-intentional and non-sentient (see Dowty 1991).
determined pragmatically. That is, in this example, \( e' \) is likely an event of Booth pulling the trigger of the pistol but could also be an event of Booth hitting Lincoln over the head with the pistol, depending on the context.

We consider next how this part–whole structure for instrumental use-events is derived compositionally.

3.2 Argument structure of use

We propose that use takes two arguments: the instrumental DP, and the infinitival clause, or ‘use-infinitival’. In previous work, the use-infinitival has been analyzed as a type of infinitival adjunct, specifically a purpose clause (Faraci 1974; Bach 1982; Jones 1985; Huettner 1989). We demonstrate first that the use-infinitival is not a purpose clause and then argue that the use-infinitival is an argument of use.

Examples of purpose clauses are shown in (21), from Huettner (1989):

\[ (21) \]
- a. We called in John’s physician [to diagnose the problem].
- b. I built that shelf [to hold my cookbooks].

Purpose clauses are forward-looking, expressing possibilities or intentions that need not be fulfilled (Huettner 1989). In (21a), for example, the physician may not have actually diagnosed the problem. In positive use-sentences, by contrast, the event in the infinitival clause is entailed to have occurred:

\[ (22) \]
- a. #I used chopsticks to eat the noodles, but I decided to not actually eat them.
- b. #Nancy used the prize money to buy a car, but she never ended up buying the car.
- c. #I used my fist to break the window, but I just couldn’t get the window to break.

One cannot use chopsticks to eat noodles without actually eating noodles. Purpose clauses, by contrast, are easily denied:

\[ (21) \] In the literature cited in this section, purpose clauses such as in (21) are distinguished from rationale clauses, such as in Mary submitted the recipe [to win the prize money]. The standard diagnostics of a rationale clause are (1) that the matrix subject controls the gap in the infinitival and (2) that in order may be inserted without changing the sentence’s meaning (Jones 1985). Thus Mary submitted the recipe [in order to win the prize money] is a near paraphrase of the original, but not I built that shelf [in order to hold my cookbooks], from (21b). By this diagnostic, use-infinitivals are not rationale clauses: I used a knife to cut the bread is not synonymous with I used a knife in order to cut the bread.

\[ (22) \] We have the intuition that sentences as in (22) are slightly better when the agent is in some stage of performing an action but does not entirely succeed:

\[ (i) \]
- ?Mario used a chef’s knife to carve the turkey, but the knife was too dull and wouldn’t carve.
- ?The girl used a fork to eat the soup, which is why she failed to eat much soup.

The improved status of (i–ii) may indicate vagueness as to the set of actions that are sufficient for the realization of an event as e.g. an event of carving or eating. These data may also support the hypothesis that events are interpreted as non-completed by default (Copley & Harley 2014).

\[ (21) \] Use-sentences may also have readings where the infinitival clause is a rationale clause. In Timmy used a fork to get a cookie, a possible reading is that Timmy used his fork in some unspecified action, such as eating dinner, in order to get a cookie (see Lakoff 1968; Huettner 1989). For this reading, the infinitival is a rationale clause, as shown by the paraphrase Timmy used a fork in order to get a cookie.
The felicity of (23a–b) suggests that *use*-infinitivals and purpose clauses stand in different relationships to the matrix verb.

*Use*-infinitivals also have different control properties than purpose causes. In purpose clauses, the matrix theme controls the obligatory gap, whether the gap is in subject or object position:

(24) a. We called in [John’s physician] *e to diagnose the problem*.
    b. I brought a book, *e to read *e to the children*.

For *use*-infinitivals, by contrast, the gap is always controlled by the matrix subject:

(25) Chloe, used chopsticks *e/*k to eat her noodles*.

The data in (22–25) indicate that *use*-infinitivals are not purpose clauses.

The *use*-infinitival does not, however, appear to fit into any other category of infinitival adjunct (see Faraci 1974; Bach 1982; Jones 1985, 1991; Huettner 1989; Whelpton 2003), and we argue that the infinitival is in fact an argument of *use*. One difference between *use*-infinitivals and infinitival adjuncts is that *use* does not stand on its own semantically. Unlike the verbs in (21), *use* is necessarily interpreted in relation to some larger event. That is, when an infinitival clause is absent, its presence is understood:

(26) a. I would have used the cuff of my coat or a bleach wipe.
    b. I objected to them using enhanced interrogation techniques.
    c. He used the same weapon that the Christmas Day bomber used.

These sentences have elliptical interpretations: using the coat cuff, for example, is understood to be part of an event such as cleaning or wiping.

Given syntactic diagnostics of argumenthood, *use*-infinitivals pattern like arguments with respect to *do so* replacement (Lakoff & Ross, 1966):11

(27) a. John used a hammer on Monday and Bill did so on Tuesday.
    b. John built a bookshelf to hold his cookbooks and Bill did so to hold his paper-weight collection.
    c. *John used a hammer to open walnuts and Bill did so to open pecans.

As described in Jackendoff (1977), *do so* targets the verb and its complements. Excluding adjunct phrases such as *on Tuesday or to hold bis cookbooks* is possible, as in (27a–b), but not

10 In a few instances, *use* may be able to stand on its own semantically:

i. Angie used a can of clam sauce in the casserole.
ii. Ronnie started using drugs when he was 16.

Lakoff (1968) analyzes (i) as involving a separate ‘use-up’ sense of *use*, although it is possible that the predicate *in the casserole* is supplying the larger event description indirectly. We propose that using drugs is a separate sense of *use*. Using drugs is essentially synonymous with *doing drugs*, indicating that no additional event context is required.

11 Thanks to an anonymous reviewer for pointing out these data.
a *use*-infinitival as in (27c). Given that *use* implies the presence of an additional event and given the syntactic evidence in (27), we propose that the infinitival clause is an argument of *use*.

In our analysis, we assume a type-driven, Montague-style compositional semantics and the lambda calculus notation developed in Heim & Kratzer (1998). We analyze *use* as having type \( \langle e \langle \langle s \langle \langle \langle v \langle \langle t \rangle \rangle \rangle \rangle \rangle \rangle \rangle \rangle \), where \( v \) is the type of events. The two arguments of *use* are the instrumental DP (type \( e \)) and the infinitival clause (type \( \langle s \langle \langle v \langle \langle t \rangle \rangle \rangle \rangle \rangle \)). Figure 1 shows a compositional parse tree for the sentence *Chloe used the ladder to paint the ceiling*. Following Kratzer (1996), we assume that Voice introduces the subject.\(^{12}\) The events \( e \) and \( e' \) share the same agent, which is ultimately contributed by Voice.

3.3 *Use* and intentionality

With this understanding of the event representation of *use*-sentences in place, we next explore in more detail the nature of the intentionality requirement shown in (3, 14–15).\(^{13}\)

\(^{12}\) The analysis could be formulated without Voice, for example in a Davidsonian fashion; this is an assumption of convenience and for presentational clarity.

\(^{13}\) Despite this intentionality requirement, *use* can sometimes be modified by the adverb *accidentally*, which *a priori* might be unexpected. However, the behavior of *accidentally* in general and in this case is more complicated than might be predicted:

(i) a. Mark accidentally used a dirty fork to poke the potatoes.
   b. Anita accidentally used tap water to fill her neti pot.
   c. Jamila accidentally used her hand to block a ball and was red-carded.

(iia–b) suggest that Mark and Anita acted on the fork/water intentionally, but that they learned after the fact that the instrument had some undesirable properties; for example, Mark didn’t know the fork was dirty, Anita thought she was using distilled water, or even that she did not know that tap water is dangerous in neti pots. These data indicate that *accidentally* does not simply negate the presence of intention in an event, and interacts with intention-denoting elements or their sub-constituents in a complex way. We suggest that (ic), pointed out by an anonymous reviewer, is an instance of the agent acting intentionally at least in the moment to use some instrument to fulfill the intended goal, but where the particular instrument acted upon is undesirable in the larger situation. One possible explanation for these facts is that *accidentally* is focus-sensitive, which allows these cases to be treated similarly to our proposal for the interaction of *use* and negation, in section 3.5.1.
In the context described in (3), Nancy is passively holding a pair of scissors but trips and thus cuts her dress with the scissors. This action is doubly unintentional: Nancy does not mean to cut her dress (i.e. the occurrence of the target event is unintentional), and Nancy does not mean to act on the scissors (i.e. the occurrence of the instrumental event is unintentional). In this context, the description Nancy used the scissors to cut her dress is infelicitous.

*Use*-sentences may still be infelicitous, however, even if some aspects of the event are intentional. In the context for (28), John is a worker at a museum who is attempting to clean a painting with a small brush. Unfortunately, he presses too hard and smudges the painting, thus destroying it. In this context, a *use*-description is significantly degraded relative to a *with*-description:

(28) a. John destroyed the painting with a small brush.
    b. #John used a small brush to destroy the painting.

In the *use*-sentence, the agent must intend for the target event to occur, even when the instrumental event is independently intentional. As another example, imagine that a nurse catheterizes a patient with a latex catheter, but unbeknownst to her the patient is allergic to latex and dies. (29) is sharply infelicitous:

(29) #The nurse used a latex catheter to kill the patient.

*Use* requires intentionality with respect to the target event.

The data in (30) show that the converse is also true: the agent must intend to act on the instrument, even if the occurrence of the target event is intended. The intended context is that Sam is kneeling on the floor to polish it with a rag, but the rag is too rough and actually scratches the floor. But, as Sam works his way across the floor, his pants end up polishing the floor. In this scenario, a *use*-description is degraded relative to a *with*-description:

(30) a. Sam polished the floor with his pants.
    b. #Sam used his pants to polish the floor.

Although Sam intended to polish the floor (the target event), he did not intend the instrumental event, i.e. to act on his pants in a controlled way.

In *use*-sentences, the agent must also intend for the instrumental event to occur as part of the target event. For the sentences in (30), imagine an altered context in which Sam intends to polish the floor and act on his pants, but the pants are meant for a different purpose: as Sam works his way across the floor, he wants to polish the floor with the rag but make squeaky sounds with his pants. As before, the rag ends up scratching the floor and the pants end up polishing the floor. (30b) is still infelicitous, given this context. That is, the relation \( e_{\text{instrumental}} \subset e_{\text{target}} \) must also be intended. In the analysis that follows, we

---

14 Fifty-six English-speaking adults on Amazon Mechanical Turk judged these and three other sets of contrasting sentences on a seven-point Likert scale. The *use*-sentences were judged to be significantly worse \( (\chi^2(1) = 26.3, P < .001) \).

15 In the same study described in footnote 14, the *use*-sentences were judged to be significantly worse \( (\chi^2(1) = 9.8, P < .01) \).
model the agent’s intentions in terms of possible worlds, that is we state the agent’s intentions in terms of worlds where these intentions are achieved.\textsuperscript{16}

3.4 A modal analysis of \textit{use}

This analysis draws on the modal semantics framework developed in Kratzer (1981, 1991). In this framework, modals quantify over sets of worlds that are delimited by two types of conversational backgrounds, where a conversational background is a function from worlds to sets of propositions. The first type, the modal base, determines the set of accessible worlds. The second type, the ordering source, determines a ranking over these accessible worlds. This theory captures a variety of modal readings through varying conversational backgrounds: the modal base may pick out worlds consistent with the circumstances or worlds consistent with our knowledge, for example, and worlds may be ordered with respect to the laws, our desires, or our goals. Finally, modals differ as to their force: \textit{must} has universal force, whereas \textit{might} has existential force.

We propose in (31) a denotation of \textit{use} that combines the discussion of the instrumental subevent in section 3.1, argument structure in section 3.2 and intentionality in section 3.3.\textsuperscript{17} (31) is a singly relative modal analysis: an intentional modal base restricts the set of accessible worlds (Inman 1993). Descriptively, the target event and instrumental event both occur in the actual world. Given all the worlds compatible with the agent’s intentions, the target

\textsuperscript{16} Intentionality for \textit{use} can seemingly be avoided if parts of its arguments are interpreted \textit{de re}, a possibility for any intensional predicate. If Chloe has three types of spices in unmarked bottles and randomly chooses the oregano, we can felicitously say Chloe \textit{used the oregano to season the soup}. That is, the description \textit{the oregano} may be interpreted \textit{de re}. This issue is part of a wider phenomenon of \textit{de re} interpretations of nominals (Kamp 1971; Montague 1973; Ladusaw 1977; Cresswell 1990; Ogihara 1989, 1996; Stowell 1993; Percus 2000; Keshet 2011; a.o.). The intentionality requirement for \textit{use} can be stated conditionally: to the degree to which the agent is aware of the identity of the referent, they must have intended to act on that referent in the described way. In addition, there are certain DPs that must be interpreted \textit{de dicto} relative to \textit{use}. For example, in \textit{Sam used any spice he could find to season the soup}, Sam has to have intended to use all these spices (and would have used other spices if he had found them). We leave exploration of these cases for the future.

\textsuperscript{17} \textit{Use}-sentences potentially weakly presuppose the occurrence of the event specified in the infinitival clause. For example, the sentence \textit{Brutus didn’t use a knife to kill Caesar} implies that Brutus did kill Caesar, but used something other than a knife. As with other sentences containing weak presupposition triggers, however, (see Abusch 2010; Abrúsán 2011; Romoli 2015) the presupposition may be defeated:

\begin{itemize}
  \item a. Brutus didn’t use that knife to kill Caesar, he just threatened him.
  \item b. If Brutus used that knife to kill Caesar, why don’t we see any blood?
\end{itemize}

These contexts do not imply that Brutus killed Caesar. This issue is independent from our central claim regarding the intentional semantics of \textit{use}, but we provide a first-pass presuppositional analysis in (ii), using the Heim and Kratzer (1998) notation for presuppositions via partial functions, with the presupposition underlined:

\begin{enumerate}
  \item i
    \begin{itemize}
      \item a. Brutus didn’t use that knife to kill Caesar, he just threatened him.
      \item b. If Brutus used that knife to kill Caesar, why don’t we see any blood?
    \end{itemize}
  \end{enumerate}
and instrumental events, as well as the subevent relation between them, occur in each of these worlds:

\[
\begin{align*}
(31) \quad & [\text{use}]^{c, w} = \lambda x \in D_c. \lambda P_{\text{use}<x<\text{vt}>}. \lambda e' \in D_e. \text{ACTED-ON}(e', x, w) \\
& \quad \land \exists e: e' \subseteq w e \land P(w)(e) \land \text{Ag}(e) = \text{Ag}(e') \land \\
& \quad \forall w' \in \{\text{worlds compatible with Ag(e)'s intentions in } w\}: \text{ACTED-ON}(e', x, w') \land P(w')(e) \land e' \subset w' e
\end{align*}
\]

Applying (31) to Chloe used a ladder to paint the ceiling, \( e \) is an event of painting the ceiling and \( e' \) is an event of Chloe acting on the ladder. \( e \) and \( e' \) both occur in the evaluation world and \( e' \) is a subevent of \( e \) in the evaluation world. In each world \( w' \) compatible with Chloe’s intentions in the evaluation world, Chloe acts on the ladder in \( w' \), Chloe paints the ceiling in \( w' \) and \( e' \) is a subevent of \( e \) in \( w' \):

\[
(32) \quad [\text{to paint the ceiling}]^{c, w} = \lambda w \in D_c. \lambda e \in D_e. \text{painting}(w, e) \land \text{Pat}(e, \text{n.n is a ceiling})
\]

\[
(33) \quad [\text{Chloe used a ladder to paint the ceiling}]^{c, w} = \\
\quad \exists e' \in D_e \text{ s.t. } \text{Ag}(e', \text{Chloe}) \land \exists y: y \text{ is a ladder} \land \text{ACTED-ON}(e', y, w) \land \\
\quad \exists e: e' \subseteq w e \land \text{painting}(w, e) \land \text{Pat}(e, \text{n.n is a ceiling}) \land \text{Ag}(e') = \text{Ag}(e) \land \\
\quad \forall w' \in \{\text{worlds compatible with Chloe’s intentions in } w\}: \text{ACTED-ON}(e', y, w') \land \\
\quad \text{painting}(w', e) \land e' \subset w' e
\]

The modal configuration in (31) explains the contrasts in (34–35), where high-and low-attached modifiers yield different interpretations:

\[
(34) \quad \begin{align*}
& \text{a. Mark used special goggles at night to spy on his neighbors.} \\
& \text{b. Mark used special goggles to spy on his neighbors at night.}
\end{align*}
\]

\[
(35) \quad \begin{align*}
& \text{a. Reba used chopsticks gracefully to eat the noodles.} \\
& \text{b. Reba used chopsticks to eat the noodles gracefully.}
\end{align*}
\]

(34a) conveys that Mark’s intention was to spy on his neighbors, and it happened to be at night that he used goggles. By contrast, (34b) conveys that Mark’s intention was to spy on his neighbors specifically at night, and the goggles were helpful toward this end. The analysis in (31) accounts for this contrast through its asymmetrical treatment of the instrumental event and the infinitival clause. When the modifier is attached within the infinitival clause, the modifier is part of the property \( P \) and is embedded under the modal. The high-attached modifier, by contrast, modifies \( e' \). Thus for (34a), the goggles are acted upon at night, but the property of occurring at night does not constrain the agent’s intention-compatible worlds.

Following Inman (1993), we assume an intentional modal base that picks out worlds compatible with the agent’s intentions. This intentional conversational background has several crucial properties: first, intentions are constrained by the agent’s desires as well as the agent’s foresight (Nichols & Ulatowski 2007; Egré 2014). Imagine, for example, that Kalima is in an archery contest, and her desire is to hit the bull’s-eye and win the contest. When she aims at the target, her hand slips and the arrow goes wild, but a sudden gust of wind guides the arrow to the bull’s-eye and she wins the contest. It is strange to say of this scenario that Kalima intentionally hit the target, or that she intentionally won the contest, because Kalima did not foresee the chain of events that led to the final outcome.
We also assume that the relevant kind of intentionality involved in this modal base is tied to the realization of particular events, rather than generalities. Consider a scenario in which John’s job is to clean a particular painting, but a wealthy rival artist has offered him $10 million to destroy the painting sometime the following week. John accepts the deal, and so in a general sense, one of John’s intentions is to destroy the painting. On Monday, he intends to clean the painting as usual and he does so. If the modal base includes all of John’s general intentions, as in (37), (36) should be an infelicitous description of this Monday cleaning event, counter to our intuitions:

(36) John used a small brush to clean the painting.

(37) \{worlds compatible with John’s intentions in w\}:

\(w_1:\) in \(w_1\) I clean the painting, keep my job and don’t get $10M

\(w_2:\) in \(w_2\) I destroy the painting, lose my job and get $10M

\(w_3:\) in \(w_3\) I destroy the painting, lose my job, get $10M and get tickets to Hamilton

Given the set in (37), it would not be true of (36) that John cleans the painting in all of these worlds. (36) is true because the propositions in the modal base only include intentions vis-à-vis the realization of the particular event \(e\). That is, John’s intentions are to destroy the painting in a particular event at a particular time, and those intentions are not associated with the cleaning event.

This intentional conversational background is similar to the teleological (i.e. goal-based) conversational background found more frequently in modal analyses, but the two appear to constrain the domain of possible worlds in different ways. von Fintel & Iatridou (2004), von Fintel & Iatridou (2008) and Rubinstein (2012), for example, use a teleological ordering source in their analysis of the weak necessity modal \(\text{ought}\):

(38) John ought to clean the painting.

(38) could be true or false depending on the contextual specification of John’s goals (or those of the speaker). If John’s goal of becoming rich has the most weight, then (38) is false; if John’s goal of keeping his job is paramount, then (38) is true. The intentions relevant to the truth or falsity of \(\text{use}\)-sentences, by contrast, are less flexible. The truth of the \(\text{use}\)-sentence in (36) is evaluated relative to John’s intentions for that particular event, and his more general intentions do not restrict the domain of possible worlds, even those intentions that are directly relevant to the outcome of the event.\(^{18}\) While we leave this event relativity relatively unformalized as part of the general description of the modal base, one idea (following Hacquard 2006, a.o.) would be to explicitly relativize the modal base to an event as well as the evaluation world.

For wholly unintentional events such as Nancy tripping and cutting her dress, the intentional modal base is empty. Following Kratzer (1995), we assume that natural language predicates prohibit vacuous quantification and that \(\text{use}\)-sentences presuppose a non-empty
set of accessible worlds. For this reason, in the wholly unintentional context, sentences such as *Nancy used the scissors to cut her dress* are infelicitous due to presupposition failure, rather than being vacuously true.

In summary, we propose a modal semantics for *use* in which the target event and instrumental event (and subevent relation between them) occur in the evaluation world, but in which these events also occur in worlds compatible with the agent’s intentions. This proposal accounts for a variety of truth-conditional and felicity behaviors of *use* reports, including infelicity in the face of accidental actions and scope effects of operators with respect to the infinitival.

### 3.5 Use: additional considerations

#### 3.5.1 Negation

As with many intensional verbs that are veridical, interactions with negation are more complex than they might initially seem (Hacquard 2006, 2010). As described above, the sentence *Nancy used the scissors to cut her dress* is infelicitous in a context in which she is holding scissors and trips, because there is no world compatible with her intentions where she acts on the scissors as part of a dress-cutting event. Crucially, however, a negated *use*-sentence is also infelicitous as a description of the event in this unintentional context:

(39) #Nancy didn’t use the scissors to cut the dress.

That is, a negative *use*-sentence appears to be incompatible with a context in which both the target and the instrumental events occur in the evaluation world, but the agent’s involvement in these events is not intentional. By contrast, negative *use*-sentences are quite natural if either the target or instrumental event does not occur in the actual world, especially with a contrastive continuation:

(40) a. Nancy didn’t use the scissors to cut the dress (...she used a razor blade).

b. Nancy didn’t use the scissors to cut the dress (...but she did poke several holes in the dress).

A similar contrastive continuation is not possible in an unintentional context: #Nancy didn’t use the scissors to cut the dress, she did so by accident.

To account for these data, we propose for *use* that negation cannot target the intentional component, but can target the overall existence of an instrumental subevent, the choice of instrument, and the choice of target event. The situation resembles that of both implicative verbs (Karttunen 1971; see White 2014, for a recent discussion of implicatives v. negation) and more generally modal verbs with so-called ‘actuality entailments’ (see Bhatt 1999; Hacquard 2006, 2010; Homer 2010; Alxatib 2016 a.o.). In general, across this wide class of verbs, negation does not target the intensional/modal component of the verb. We do not aim to present a general solution for actuality entailments but base our proposal off the standard treatment of implicative predicates: we suggest that the requirement that there are intentions of the agent toward the event is a presupposition of *use*, rather than a simple at-issue conjunct.20

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19 Thanks to an anonymous reviewer for pointing out this issue.

20 An alternative possibility, which we will not pursue in this paper, is to develop a proposal for the interaction of negation based on Hacquard’s Event Identification Across Worlds principle
The simplest case of this follows already: the universal quantifier presupposes that there are worlds where Nancy has intentions, and so in wholly unintentional contexts such as Nancy tripping and cutting her dress, the pattern of infelicity follows from a prohibition on vacuous quantification (see section 3.4). For partially unintentional contexts, for example John destroying the painting when he meant to clean it, or Sam polishing the floor with his pants when he meant to polish it with a brush, the situation is more complicated:

(41) a. #John didn’t use a brush to destroy the painting.
    b. #Sam didn’t use his pants to polish the floor.

When the intention in the scenario doesn’t align with the intention suggested by the sentence, we also find infelicity. We take this to suggest that the entire conjunct characterizing the intentionality requirement is a presupposition of use. Why then are sentences like (40a) appropriate when Nancy does not intend to act on the scissors?

We will not work out a detailed solution for this here, but we suggest that negation in these examples is focus-sensitive, building specifically on Herburger’s (2000) account for the interaction of negation with focus in a neo-Davidsonian context. In particular, we take examples like (40a) to involve a ‘bound’ reading, where negation specifically targets the focused direct object (also indicated by the contrastive continuation). On Herburger’s analysis, this leads to a semantics for a sentence like (40a) that can be paraphrased with a pseudocleft: what Nancy didn’t use to cut the dress was her scissors. That is, the sentence takes as given that Nancy didn’t use some particular thing to cut the dress and asserts at-issue that that thing was her scissors. The prediction then is that the intentionality presupposition will be much weaker than what might be expected on ordinary propositional negation—(40a) will presuppose just that Nancy intended to use something to cut the dress. We leave a full exploration of the interaction of negation and focus with modal inferences and presuppositionality for the future.21

3.5.2 Event structure revisited The modal analysis above allows a use-instrument to play a range of causal roles in an event: instruments can be causal intermediaries, as in Brutus used a knife to stab Caesar, or causally necessary but not sufficient, as in Max used a key to enter the room, or neither necessary nor sufficient, as in Mark used a spoon to eat the cereal. Use-instruments may in fact occupy a role outside the regular causal chain of an event, as in John used his desk to chop the lettuce, where the desk is at best a causal enabler.

Use does, however, place some constraints on the relationship between the instrument and the structure of the event as a whole. Suppose that Harold is a professional painter whose capricious boss demands that he wear red socks while painting or he will be fired.22 Even if Harold intends to keep his job, and in all worlds compatible with this intention he acts on red socks and paints the ceiling, (42) is infelicitous:

(42) #Harold used his red socks to paint the ceiling.

(Hacquard 2006, 2009), which handles the interaction with negation less directly. We are grateful for the feedback of several reviewers on this issue.

21 In fn. 17 we noted the possibility that use could be a soft trigger for the presupposition that the infinitival complement is true of some event. The presupposition described in this section, in contrast, is not a soft trigger.

22 Thanks to Alexander Williams (p.c.) for pointing out this example.
What seems to underlie the infelicity of (42) is that wearing socks is not meaningfully related to an event of painting. That is, although a space–time chunk of Harold wearing socks can be part of a space–time chunk of Harold painting the ceiling, the former event is not relevant to the forward progress of the latter event.

Analyses of *ought* that involve necessity also face this issue. Nissenbaum (2005) points out that (43) is infelicitous in a scenario in which I want to go to Harlem, and I could take either the A-train or the city bus, but Pedro Martinez happens to be riding the A-train and one of my goals is to kiss him:

(43) To go to Harlem, you ought to kiss Pedro Martinez.

Just as wearing red socks is not relevant to painting, kissing Pedro Martinez is not relevant to going to Harlem. von Fintel & Iatridou suggest that the proposition under the modal must be an essential part of a way of achieving the designated goal. That is, there must be some set of propositions \( P \) such that \( P \) alone does not lead to the designated goal but the addition of the prejacent does lead to the designated goal.

Although not the focus of this paper, ruling out sentences such as (42) is an important part of the broader project of understanding instrumental meaning. We sketch here two types of solutions to this problem. In the first, there is some single notion of an instrument contributing to the forward progress of an event that is encoded in the semantics of *use*, a notion that has so far been difficult to formalize. Koenig *et al.* (2008), for example, articulate more fine-grained types of relations between the instrumental event and the target event, such as precondition and part-cause. Note that the ‘essential part of a way of achieving’ criterion suggested by von Fintel & Iatridou is too restrictive: in Mary *used* a magnifying glass to examine the portrait, for example, Mary does not need to act on the magnifying glass to examine the portrait, it just helps her do so with more precision. Thus, the unified notion of contributing to the forward progress of an event would have to include causally unnecessary instruments.

A second type of solution would be that the relationship between the instrumental event and the target event is constrained inferentially based on verb meaning and world knowledge, not by the semantics of *use*. That is, given that *use* requires that the agent act on the instrument, and that this instrumental event be part of a target event which shares the same agent, there is a strong bias to interpret these two events as meaningfully related. Ruling out (42) through general inferential processes about event representation could explain why so many different types of relations between instrumental event and target event are permitted for *use*-sentences. We leave future research to provide a solution to this important issue.

### 3.6 Summary of the analysis of *use*

In this analysis, *use* encodes both extensional and intensional elements: it specifies the occurrence of target and instrumental events in the evaluation world but also quantifies over worlds compatible with the agent’s intentions. Returning to the issues raised in sections 1 & 2, our analysis of *use* establishes connections between instrumentality and facets of meaning not typically considered in relation to thematic roles, such as actuality entailments in modal contexts. The surface syntactic dissimilarity between *with* and *use*, where *with* is a preposition and *use* is a periphrastic verb taking an infinitival complement, is not often discussed in analyses of instruments. In our analysis, this syntactic difference is linked
to the intentionality contrast: like many other types of infinitival constructions (see Bhatt 1999; Meier 2003; von Fintel & Iatridou 2007; Hackl & Nissenbaum 2011), use-sentences encode modal content. Use appears to be part of a family of verbs that encode both extensional and intensional components, such as try, happen to and manage (Grano 2011; Inman 1993; Baglini & Francez 2016). Characterizing the meaning of use solely in terms of a primitive predicate such as INSTRUMENT(x) would miss these connections.

4 WITH

With does not systematically require an intentional agent, in contrast to use. This finding raises the question of why with- and use-instrumental sentences are sometimes seemingly synonymous, when the agent can in principle intentionally participate, as in (44):

(44) a. Carla lifted the logs with a pulley.
    b. Carla used a pulley to lift the logs.

The default interpretation of (44a), according to our intuitions, is that Carla acted on the pulley intentionally. If with does not require intentional participation, and therefore cannot have a modal semantics of the sort we have attributed to use, how does this interpretation arise?

In section 4.1, we propose that the instrumental with-PP is a syntactic adjunct. In section 4.2, we suggest that the default intentional reading of with-sentences as in (44a) arises through general inferential processes. In section 4.3, we return to the contrast in (5) and argue that with encodes a constraint on the participant structure of an event whereby the instrument must be embedded within the agent’s force. Thus, in the right context and given the right subject, the overall meaning of a with-sentence can end up quite close to that of the comparable use sentence, though via a different route.

4.1 Argument structure

Following Koenig et al. (2008), we assume that verbs such as slice, hit and poke semantically require an instrument: that is, poking specifies the presence of an agent, a patient and instrument (see also Rissman et al. 2015). In syntactic terms, however, the with-phrase patterns as an adjunct (Sedivy & Spivey-Knowlton 1994; Goldberg 2002; Rissman 2010). With-instruments are syntactically optional and behave like adjuncts with respect to syntactic diagnostics such as pro-form placement, pseudo-clefting and word order (see Jackendoff 1977; Pollard & Sag 1987; Radford 1988; Cowper 1992; Schutze 1995, for review). These diagnostics do not distinguish between verbs for which the instrument is semantically optional v. obligatory (see also Rissman et al. 2015):

(45) a. What John did last night was drink a martini.
    b. *What John did on the table was put his keys.
    c. What Sarah did with the stick was poke the fire.
    d. What Sarah did with the chopsticks was eat the sushi.

Several uses of with will not be considered in this paper: (1) comitative uses that can be paraphrased by a conjoined subject: I walked to the store with Mary ~ Mary and I walked to the store. (2) Attributive uses, that modify NPs: I want the shoes with blue shoelaces. (3) Manner uses that may be paraphrased with an –ly adverb: I stirred the fondue with care ~ I stirred the fondue carefully. See McKercher (2002) for discussion.
Pseudo-clefting is possible for adjunct but not argument phrases, as shown in (45a–b) (Klima 1962; Vestergaard 1977). As shown in (45c–d), clefting of an instrumental with-phrase is possible for both obligatory-instrument verbs (e.g. poke) and optional-instrument verbs (e.g. eat), indicating that the with-PP is an adjunct.

For sentences with a verb that lexically specifies an instrument, such as slice or poke, the with-adjunct is aligned with the verbal argument pragmatically. In John sliced the turkey with a knife, for example, a strong inference is that the knife fills the bladed-object role specified by slice. As described in section 2, however, a with-instrument need not fill this role, as in John sliced the turkey with only his left hand.

One additional preliminary constraint on with-sentences is that with-instruments require a dynamic, agentive subject; this, for example, rules out the inchoative constructions in (46a–b) and the stative sentences in (46c–d) (Gruber 1965; Fillmore 1968; Lakoff 1968):24

   b. *The door opened with a key.
   c. *John had $500 with his paycheck.
   d. *Albert knew the answer with a sliderule.

Following Dowty (1979), we analyze the subject of a stative verb as non-agentive.

The requirement for an agentive subject appears to be presupposed. That is, in a context where John breaks the vase with a hammer, (46a) is an infelicitous description, but so is the negative sentence in (47a):

(47) a. *The vase didn’t break with a hammer.
   b. *The door didn’t open with a key.
   c. *Albert didn’t know the answer with a sliderule.
   d. *John didn’t have $500 with his paycheck.

We analyze with’s requirement for a dynamic agent as a presupposition, given that it projects out of negation.25

Version 1 of the denotation of with is proposed in (48), corresponding to the parse tree in Figure 2. With has type $\langle e \langle \langle \langle vt \rangle \langle vt \rangle \rangle \rangle$. With takes the instrumental DP (type e) as an argument and heads a PP modifier. The instrumental subevent e’ is introduced via existential quantification. In section 4.3, we return to this definition and revise it to include some further constraints on the event structure of with-marked events.

(48) $[\text{with}]^e$ (version 1) = $\lambda x \in D_e. \lambda P_{(vt)}$. $\lambda e: e \in D_e \land \exists y [Ag(e, y)]$. $\exists e': e' \subset e \land P(e) \land Ag(e') = Ag(e) \land ACTED-ON(e', x)$

24 Recall from section 3.1 that this dynamic, agentive subject need not be animate, given the felicity of (20a), the apparatus bored holes in the metal with its laser beam. The dynamic agentive subject may be implicit, as in the passive voice, for example this door was opened with a key, and middle voice, for example this door opens with a key.

25 Use-sentences with stative verbs are also infelicitous: *John used a sliderule to know the answer. The analysis in (31) rules these out because there is no set of worlds compatible with the agent’s intentions. The requirement that use-sentences include a dynamic agent appears to be part of at-issue content: we judge that the sentence the vase didn’t use a hammer to break is actually a true description of the situation in which John breaks the vase with a hammer.
4.2 Intentionality inference
The semantics of with in (48) does not include any reference to the agent’s intentions. The crucial question then is why use- and with-sentences can appear to be synonymous in an intentional context, as in (44). We argue that this apparent synonymy follows from general inferences about agentive participants, based on evidence across a range of discussions of intentionality. As a demonstration of the kind of inferential mechanism we have in mind, consider the non-instrumental sentences in (49):

(49) a. Jim broke the vase.
    b. Martha opened the door.

The predicates break and open are compatible with both intentional and unintentional contexts. Nonetheless, the sentences in (49) imply by default that the agent acted intentionally, according to our intuitions.

Evidence for an intentionality bias comes from both the psycholinguistics literature and the theoretical linguistics literature. Kako (2006) reports that when participants read sentences with nonsense nouns (e.g. the dax wrote the rom), they were highly likely to judge that the dax chose to be involved in the action (Kako’s paraphrase of volition). This result held given nonsense verbs as well as nonsense nouns (e.g. the dax meeked the rom), indicating a strong default tendency to interpret the subject as acting intentionally.

Given data like (49) across multiple languages (including languages where there is explicit marking of ‘involitivity’), Holisky (1987) and Inman (1993) propose a general inferential mechanism whereby human agents are assumed to act intentionally, in the absence of evidence to the contrary. We suggest that this bias toward intentional inference often leads with-sentences such as (44a) to be interpreted intentionally by default (though of course context or lexical items can bias the other direction). That is, in with-sentences, lexical and pragmatic factors lead to the inference that the action was intentional, as in (50), or unintentional, in (51). Crucially, however, use-sentences always lead to the
inference that the agent is acting intentionally, even when the nominals bias a *with*-sentence toward an unintentional interpretation (52):

(50) a. Martha hit the target with her sharpest arrow. (≥ > intentional)
    b. Suzanne poked the potatoes with a fork. (≥ > intentional)

(51) a. Martha hit the lamppost with her car. (≥ > unintentional)
    b. Suzanne poked the man with her elbow. (≥ > unintentional)

(52) a. Martha used her car to hit the lamppost. (≥ > intentional)
    b. Suzanne used her elbow to poke the man. (≥ > intentional)

The instruments in (51–52) play the same causative roles in their respective events. The example in (52a) is particularly striking because the available reading is quite improbable. Inferences about intentionality cannot be manipulated pragmatically for *use*-sentences the way they can for *with*-sentences, suggesting that the apparent synonymy of *use-* and *with*-sentences arises through pragmatic enrichment.

4.3 *With* and event structure

In this final section on *with*, we address the infelicity of the *with*-sentences in (16), repeated here as (53):

(53) a. #Chloe sliced the turkey with a stepladder.
    b. #Chloe sliced the turkey with the two hours before lunch.

The *use*-variants of these sentences are acceptable, suggesting that *with*-instruments are relatively more constrained. Nonetheless, *with*-instruments may still play multiple roles for the same verb:

(54) a. John sliced the turkey with a knife
    b. Amazingly, John sliced the turkey with only his left hand.

(55) a. Martha wiped down the table with a cloth.
    b. Do you wipe with your left or your right?

In the dominant readings of (54b) and (55b), the instrument is filling the role of the agent’s hand, which is manipulating some external object, such as a knife. To account for the observation that *with*-instruments are partially but not wholly constrained by the verb, we propose that *with* encodes a constraint on event part–whole structure: *with*-instruments must be embedded within the agentive force of the event.

4.3.1 Agentive force and event structure

Agentive events center around the agent exerting force on a patient. For events in the physical domain, this force involves a set of motions and changes initiated by the agent which narrow the physical gap between the agent and the patient such that the patient can be acted upon and potentially altered (see Talmy 1988; Langacker 1991; Wolff 2007; Gärdenfors & Warglien 2012). In the sentence *John stepped on a bug*, for example, this force involves John moving his foot in the direction of the bug until he makes contact with it. Events can be augmented in a variety of ways: we can say, for example, *John stepped on a bug at the top of a mountain*, or *John stepped on a bug wearing a 10 gallon hat*. While
the mountain and the hat are participants in these respective stepping events, they are not represented as part of the force of John acting on the bug.

This distinction between the force-dynamic core of an event and other peripheral participants appears to be a fundamental one, observed in infancy. Gordon (2004), for example, found that when 10-month-olds habituated to a video of a girl hugging a boy while holding a toy, they did not dishabituate when the toy was removed. That is, the presence or absence of someone holding a toy did not lead the infants to perceive the hugging events as being substantially different, presumably because the toy is external to the force-dynamic core of a hugging event.

Although numerous theories have described event part–whole structure in formal terms (Bach 1986; Link 1987; Krifka 1989, 1992; Piñón 2008), we are not aware of any formal account of this distinction between the force-dynamic core and other aspects of the event, and such an account is beyond the scope of this paper. We propose here simply that instrumental *with* is sensitive to this distinction: *with* requires that the instrument be part of the force-dynamic core, a subpart of the event we label as FORCE(e), which we will not attempt to characterize formally. We appeal to FORCE(e), given the difficulty of characterizing *with*-instruments in terms of direct causal relations, as discussed in sections 2.1 and 3.5.2; see also Rissman (2013b). In Lucy examined the portrait *with a magnifying glass*, for example, the event of Lucy acting on the magnifying glass is neither causally necessary nor causally sufficient for Lucy to examine the portrait.

4.3.2 Agentive force and *with*

(56–59) demonstrate a contrast between instruments in the force-dynamic core and instruments in the periphery:26

(56) (where Nigel is chopping lettuce on top of his desk)
   a. Nigel used his desk to chop the lettuce.
   b. #Nigel chopped the lettuce with his desk.

(57) (where Chloe is wearing scuba gear in order to breathe underwater)
   a. Chloe used scuba gear to clean the floor of the tank.
   b. #Chloe cleaned the floor of the tank with scuba gear.

(58) (where Chloe is standing on the ladder in order to reach the ceiling)
   a. Chloe used a ladder to paint the ceiling.
   b. #Chloe painted the ceiling with a ladder.

(59) (where Max is writing a letter during the hour before lunch)
   a. Max used the hour before lunch to write a letter.
   b. #Max wrote a letter with the hour before lunch.

In (57), for example, Chloe needs her scuba gear to access the floor of the tank, but the scuba gear is not involved in the cleaning *itself*: it is a peripheral participant. In other

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26 Thirty-six adult English speakers on Amazon Mechanical Turk rated sentences such as in (57–60) on a seven-point scale. Participants rated the *with*-variants as significantly less natural than the *use*-variants, \( t(126) = 8.9, p < .001 \).
words, the scuba gear helps Chloe breathe but is not part of the subevent in which she actually exerts force on the tank. Similarly, the location in (56) and time span in (59) specify background properties of the chopping and writing events, which are not part of the force-dynamic core of these events. In Chloe cleaned the floor of the tank with a sponge, however, the sponge is intermediate between Chloe’s initiated action and the tank receiving her action and so is felicitous as a with-instrument.

As a first step toward incorporating force dynamics into the analysis, the final version of the denotation of with is shown in (60). We intend the predicate FORCE to pick out a subevent of its argument that forms the ‘force–dynamic core’ of the event:

\[
[\text{with}]^\text{c} \quad (\text{version } 2) = \lambda x \in D_c. \lambda P <_{\text{vt}} >. \lambda e: e \in D_e \land \exists y[\text{Ag}(e, y)].
\]

\[
P(e) \land \exists e': e' \subset \text{FORCE}(e) \land \text{ACTED-ON}(e', x) \land \text{Ag}(e') = \text{Ag}(e)
\]

This denotation is fairly underspecified: the agent must act on the instrument, and this instrumental subevent must be part of the force-dynamic core of the event. Following the dynamicity requirement discussed in section 4.1, with-events must have a part that can be picked out by FORCE. This denotation accounts for the observation that with-instruments need not play a fixed role for any particular verb. For events where the with-instrument is a hand that is manipulating an implicit tool, the hand is still part of the force directed by the agent on the patient and so is acceptable as a with-instrument. Given this constraint, with-instruments can be thought of as playing an intermediary role, as described by Croft (1991) and Langacker (1991). The data in (56–59) indicate that this feature is localized to with, rather than being a general property of instruments.

Further research is needed to understand the distinction between force-dynamic participants in an event and more peripheral participants, including whether this distinction is categorical. The use/with data in (56–59) appear to reflect this distinction and are therefore a source of evidence about what types of participant relationships are relevant to this distinction. For example, the use/with data suggest that the core/peripheral distinction cannot be reduced to the distinction between semantically obligatory and semantically optional participants of the verb. That is, with-instruments may be part of the core of an event even when they do not fill a verbally specified role, as in Chloe cleaned the floor of the tank with a sponge (see Koenig et al. 2008).

4.4 Summary: with

We propose that with, like use, introduces an instrumental subevent \( e' \) in which the agent acts on the instrument. By default, the subject of a with-sentence is inferred to act intentionally, leading to pairs of use/with sentences with similar meanings. We also propose that with requires that its instrument be part of the force-dynamic core of an event, accounting for the observation that with is more limited than use in the range of participants it allows as an instrument. The predicate FORCE allows for some flexibility, however, accounting for the observation that instrumental role is not strictly determined by the verb.

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27 We intend the predicate FORCE to include agentive relations that are not easily expressed in terms of actual physical force between participants, for example psychological changes (I seduced him with my charming personality) and mediated action (I blew up the bomb with a remote control). As with the predicate ACTED-ON, explicating the content of FORCE is part of a broader project of understanding the nature of agency.
5 The instrumental role

A key issue for theories of event representation concerns how event participants are categorized based on their semantic properties. One barrier to understanding this categorization is that analyses of thematic roles are not typically situated within a compositional, truth-conditional semantic framework. One of our primary aims in this paper has been to connect instrumental meaning to semantic domains not typically considered in conjunction with thematic roles, such as modal semantics.

As a result of this approach, we find no single generalization that captures what an instrument is, other than being part of what we have labeled an instrumental event: a subevent where the agent acts on the participant termed the instrument. That is, an instrument is an entity that is manipulated, either concretely or abstractly, by an agent as part of a larger event, where that agent is also the agent of the larger event. Given the generality of this condition, the analysis of use and with proposed here is more consistent with a theory in which event participant categories are represented in terms of a cluster of event and participant properties, rather than in terms of necessary and sufficient conditions.

Researchers from diverse theoretical backgrounds have advocated such a view of thematic roles (see Croft 1991; Langacker 1991; Dowty 1991; Grimm 2007, Reisinger et al. 2015). For example, Dowty (1991) proposes that abstract properties such as causation, sentience and undergoing a change of state determine whether the arguments of a verb are proto-Agents or proto-Patients and that these proto-properties determine linking to subject and object grammatical functions. We demonstrated in this paper two properties relevant to instrumental meaning in English: intentionality, and that an instrument is a direct extension of the force initiated by the agent. Although many event participants that have been pre-theoretically described as instruments share both of these properties, neither property is definitive of Instrumenthood.

Alternative conclusions about the category Instrument are certainly possible: adopting the with/use diagnostic discussed in section 2, it may be that only with-instruments are Instruments, and use-instruments, as in she used scuba gear to clean the floor of the tank, are some other type of role. Independent evidence would be needed to support such an alternative. Cross-linguistic evidence, for example, may be informative with respect to this issue. If the properties encoded by English instrumental use and with, intentionality and force-dynamicity, are encoded consistently by instrumental markers in other languages, this would suggest that these properties constitute a salient way of categorizing of event participants. Alternatively, these properties of with and use may be relatively idiosyncratic, and instrumental markers in other languages may encode a range of other specific properties. A fruitful avenue for future research would be to investigate whether the properties of English instrumental markers are shared across languages, suggesting a conceptually robust Instrumental event category, and common mappings from conceptual to linguistic representations of events.

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