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# The semantics of the transitive causative construction: Evidence from a forced-choice pointing study with adults and children

**Abstract:** Adults and children aged 3;0–3;6 were presented with ungrammatical NVN uses of intransitive-only verbs (e.g., *\*Bob laughed Wendy*) and asked – by means of a forced-choice pointing task – to select either a causal *construction-meaning* interpretation (e.g., ‘Bob *made* Wendy laugh’) or a non-causal *sentence-repair* interpretation (e.g., ‘Bob laughed *at* Wendy’). Both age groups chose casual *construction-meaning* interpretations on at least 82% of trials, regardless of (a) verb frequency and (b) the construction used for grammatical control/filler trials (transitive – e.g., *Bob moved Wendy* – or intransitive – e.g., *Wendy moved*). These findings constitute support for cognitive linguistic approaches under which verb argument structure constructions have meanings in and of themselves and – further – suggest that construction meaning is sufficiently powerful as to overrule verb meaning when the two conflict.

**Keywords:** language acquisition, construction semantics, transitive construction, intransitive construction, pointing, comprehension

DOI 10.1515/cog-2014-0012

Received June 3, 2013; revised February 20, 2014; accepted March 13, 2014.

## 1 Introduction

A central assumption of construction-based theories of grammar (Lakoff 1987; Langacker 1987; Fillmore, Kay and O’Connor 1988; Goldberg 1995; 2006; Croft 2001; Dabrowska 2004; Michaelis 2012) is that grammatical constructions – ordered sequences of abstract *slots* and/or concrete lexical material – have meaning in and of themselves. Thus, constructions contribute meaning above and

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beyond that contributed by the individual lexical items that make up an utterance. For example, consider the sentence *John blicked Sue the teega*. Even without knowing the meaning of *blick* or *teega*, we understand that the sentence denotes an event of transfer. According to construction-based accounts, this is because the construction itself – here, the double-object dative construction [SUBJECT] [VERB] [NP<sub>RECIPIENT</sub>] [NP<sub>THEME</sub>] – is associated with a particular meaning – here, transfer<sup>1</sup> (Pinker 1989; Goldberg 1995). Similarly, to borrow a famous example from Goldberg (1995), we have no trouble interpreting the sentence *John sneezed the napkin off the table*, despite the fact that *sneeze* is not a conventional motion verb, because the meaning of caused-motion is contributed by the [SUBJECT] [VERB] [NP<sub>THEME</sub>] into/onto/off etc. [NP<sub>LOCATION</sub>] caused-motion construction.

Although the claim that constructions make an independent contribution to sentence meaning may seem uncontroversial (particularly to readers of this journal), it is important to bear in mind that this assumption has no place in mainstream linguistic theory; i.e., Chomsky's (1995) minimalist program and its predecessors (e.g., Chomsky 1965, 1981, 1986). These accounts do not posit constructions as units with independent existence, but as “taxonomic artifacts, collections of phenomena explained through the interaction of the principles of UG, with the values of the parameters fixed” (Chomsky 1995: 170) (see Zwicky 1994; Sag 2010; Michaelis 2012, for discussion of the taboo status of constructions within the Chomskyan framework).

This debate between Chomskyan and construction-based approaches to the adult grammar is paralleled by the debate between *parameter-setting* and *constructivist* approaches in the domain of child language acquisition (Ambridge and Lieven 2011). Constructivist approaches (e.g., Tomasello 2003; Dabrowska 2004; Goldberg 2006) conceptualize language acquisition as the process of building a structured inventory of constructions. Children start out with entirely concrete constructions (e.g., *I want it*) and gradually abstract across these stored utterances to yield, at first, partially-abstract constructions (e.g., *I want [THING]*) and, ultimately, fully-abstract constructions (e.g., [SUBJECT] [VERB] [OBJECT]). Under parameter-setting approaches (Christophe, Millotte, Bernal and Lidz 2008; Fodor and Sakas 2004; Guasti 2004; Crain and Thornton 2012), children acquire rules

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<sup>1</sup> Note that the prepositional dative construction [SUBJECT] [VERB] [NP1] to [NP2] is associated with a subtly different meaning; caused-motion to a location (for empirical evidence see Ambridge, Pine, Rowland, Freudenthal and Chang 2014; Allen, Pereira, Botvinick and Goldberg 2012). This subtle difference in construction meaning constitutes a problem for accounts in which one argument structure pattern is derived from another via a transformation that preserves meaning (e.g., Baker 1996; Hale and Keyser 1997; Larson 1988), and support for accounts that treat these patterns as separate constructions.

of phrase structure (e.g., [VP [NP<sub>SUBJECT</sub>] [V'[V][NP<sub>OBJECT</sub>]]]) by setting word-order parameters, including the complement-head (VO/OV), specifier-head (SV/VS) and V2 (+/-) parameters.

The aim of the present study is to test a prediction that arises from the *construction-based*, *constructivist* viewpoint, and that is not shared by Chomskyan or *parameter-setting* accounts. Before setting out this prediction, we should note that it is shared by all approaches which assume that configurational patterns of verbs and their arguments have meanings in and of themselves. That is, the prediction is also shared by theoretical linguistic frameworks such as Head-Driven Phrase Structure Grammar (e.g., Pollard and Sag 1994) and Lexical Functional Grammar (e.g., Bresnan 2001), and by nativist acquisition theories such as that developed by Pinker (1984, 1989).

The prediction is that if presented with ungrammatical sentences where a verb is used in an incompatible argument-structure construction, both adults and children will use the meaning of the construction to arrive at an interpretation, rather than arriving at an interpretation via a “sentence-repair” strategy. Consider, for example, the sentence *\*Bob laughed Wendy* (which is ungrammatical because an intransitive-only verb has been used in a transitive construction). If listeners use a *construction-meaning* interpretation strategy, they will interpret the sentence as ‘Bob *caused* Wendy to laugh’, in line with the prototypical causative meaning of the transitive construction<sup>2</sup>. If listeners use a *sentence-repair* strategy, they will interpret the sentence as, ‘Bob laughed *at* Wendy’, replacing the “missing” preposition. Of course, other types of repair are possible (e.g., ‘Bob laughed *with* Wendy’); an issue that we address using a manipulation check.

This construction-based prediction enjoys support from a number of previous studies. Naigles, Fowler and Helm (1992; see also Naigles, Gleitman and Gleitman 1993) used an act-out method where children were asked to enact transitive NVN sentences<sup>3</sup> with (a) four intransitive-only verbs (*come, go, fall, stay*)

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<sup>2</sup> At least, this is the prototypical meaning of the transitive *causative* construction (Levin 1993). Of course, not all transitive utterances are causal (e.g., *Bob heard Wendy*). There is room for debate as whether there are in fact a number of semantically distinct transitive constructions which share the same word order, or whether there is a single transitive construction. On this latter view, the core meaning of this construction is causal, with non-causal uses peripheral metaphorical extensions. Either way, participants who follow the strategy described here are interpreting the sentence in line with the core meaning of a prototypical transitive construction.

<sup>3</sup> Naigles’ studies also investigated three other constructions (NVNPN, NVPN and NV), which – since the present study focuses solely on the NVN construction – we do not discuss here. For the same reason, we do not discuss children’s enactment of sentences with four transitive-only verbs (*bring, take, push, put*), which are grammatical in all transitive NVN sentences.

and (b) two alternating intransitive / transitive verbs (*move, drop*). Some example stimuli from the study are shown below.

**(a) NVN (transitive) sentences  
with intransitive-only verbs  
(target trials)**

- \*The kangaroo goes the monkey
- \*The tiger comes the lion
- \*The elephant falls the bird.
- \*The lion stays the kangaroo

**(b) NVN (transitive) sentences  
with alternating verbs  
(control/filler trials)**

- The tiger moves the bird
- The elephant drops the lion

All participants showed close to ceiling performance with the grammatical control sentences. As in the present study, the main question of interest was how children would interpret the ungrammatical NVN sentences with intransitive-only verbs (e.g., *\*The kangaroo goes the monkey*). Would they interpret the sentence in line with the semantics of the transitive causative construction (enacting ‘the kangaroo *makes* the monkey go’), a response which the authors termed *frame-compliance*, or by repairing the sentence to be an intransitive with a prepositional phrase (e.g., ‘the kangaroo goes *to[wards]* the monkey’)? This latter response was coded as an instance of *verb-compliance*, though a number of other responses (e.g., making both animals go) were also scored as *verb-compliant* (for this reason, we do not adopt these terms in the present study, and instead contrast *construction-meaning* and *sentence-repair* interpretations).

These authors found that children aged between 2 and 4 years displayed a consistent and high degree ( $\approx 70\%$ ) of *construction-meaning* interpretations (= ‘the kangaroo *makes* the monkey go’), dropping to just under 50% for older children and adults. The causes of this development shift need not concern us here (though see Desai 2007, for a computer model that simulates this effect). The important point for our purposes is that even young children displayed a compelling effect of construction semantics.

Our goal in the present study is not to dispute either the appropriateness of this method, or the pattern of findings, both of which have been supported by a number of follow-up studies (e.g., Naigles and Lehrer 2002; Naigles and Maltempo 2011; Lidz, Gleitman and Gleitman 2003; Gökşun, Küntay and Naigles 2008). Rather, our goal is to test our prediction of interest using a new paradigm: forced-choice pointing. Compared with an act-out task, this paradigm has a number of advantages.

First, act-out tasks can be surprisingly difficult for young children. For example, one study of simple transitives (Akhtar and Tomasello 1997) found that only

4/10 children aged 2;8–2;10 performed at above-chance levels in an act-out task with novel verbs. This may be because children have difficulty keeping the sentence in mind whilst planning the enactment or because, having picked up one character at random (or because they prefer it to the other), they automatically assign it the dominant role of agent, ignoring linguistic cues (Ambridge and Rowland 2013). Forced-choice pointing removes many of these task demands, meaning that the paradigm is suitable for even young two-year-olds (e.g., Noble, Rowland and Pine 2011) (though as a preliminary investigation, the present study focused on children aged 3;0–3;6). Indeed, stimuli used for forced-choice pointing can in principle be used in a preferential-looking paradigm, thus extending the lower age bound below 2;0 (e.g., Naigles 1990; Gertner, Fisher and Eisengart 2006).

Second, perhaps due in part to the task demands associated with act-out paradigms, children sometimes produce potentially ambiguous enactments (Goldberg 2004: 81). For example, when asked to enact ungrammatical sentences such as *\*The kangaroo goes the monkey*, children sometimes, for example, have both animals go, or have the monkey go towards the kangaroo. Although it is possible to mitigate against this problem by using a carefully-designed coding scheme (Naigles et al. 1992; Naigles et al. 1993), the forced-choice pointing task removes it altogether, by having participants make an unambiguous choice between *construction-meaning* and *sentence-repair* interpretations (e.g., the kangaroo *making* the monkey go vs the kangaroo going *towards* the monkey).

Finally, and relatedly, the need to minimize ambiguous enactments, and to include only actions that children can perform easily with toys, places certain restrictions on the verbs that can be included. In contrast, because they use video recordings or cartoon animations, forced-choice pointing tasks can include verbs such as *laugh* for which many theoretically-possible enactments (e.g., Bob making Wendy laugh; Bob laughing at Wendy) would be difficult to perform (and/or to code).

Thus the aim of the present study is to test the claim that syntactic constructions – here, the transitive causative construction – make an independent contribution to sentence meaning, using a forced-choice pointing task. If so, when presented with ungrammatical sentences such as *\*Bob laughed Wendy*, participants should use a *construction-meaning* interpretation strategy (choosing an animation where Bob made Wendy laugh), rather than using a *repair* strategy (choosing an animation where Bob laughed *at* Wendy), or choosing at random. We should note that a number of previous forced-choice preferential-looking (Naigles 1990, 1996; Naigles and Kako 1993; Hirsh-Pasek, Golinkoff and Naigles 1996; Kidd, Bavin and Rhodes 2001; Bavin and Growcott 2000; Yuan and Fisher 2009; Scott and Fisher 2009; Yuan, Fisher and Snedeker 2012;

Arunachalam, Escovar, Hansen and Waxman 2012) and pointing studies (Arunachalam and Waxman 2010) have demonstrated that children use construction semantics to learn the meanings of *novel* verbs, which do not (at the start of the study) have any meanings or associated argument-structure restrictions. This study goes one step further, to ask if construction meaning, here of the transitive-causative construction, is sufficiently powerful to *override* the usual meanings and argument-structure restrictions of familiar intransitive-only verbs such as *laugh*.

To summarise the design of present study, adults and children aged 3;0–3;6 heard ungrammatical NVN “target” sentences containing intransitive-only verbs (e.g., *\*Bob laughed Wendy*) and were asked to choose between a causal *construction-meaning* interpretation (e.g., ‘Bob made Wendy laugh’) and a non-causal sentence-repair animation (e.g., ‘Bob laughed *at* Wendy’). We also included various control conditions designed to verify that children understood the procedure, and to rule out the use of task-specific strategies.

Following Naigles et al. (1992) and Naigles et al. (1993) we decided to also include a verb frequency manipulation. Naigles and colleagues found that children were more likely to produce *frame-compliant* enactments (*construction-meaning* interpretations) of ungrammatical sentences with lower than higher frequency verbs. For example, children were more likely to produce causative enactments of *\*The elephant falls the bird* than *\*The tiger comes the lion*. In other words, the more frequent a verb, the less willing children are to allow its usual meaning to be overridden by construction meaning. This finding is predicted by the entrenchment and pre-emption hypotheses (Braine and Brooks 1995; Golberg 1995), under which each occurrence of a verb (in a particular construction) contributes to a growing inference that non-attested uses are ungrammatical for adult speakers. In order to manipulate verb frequency, we paired each verb (e.g., *laugh*) with (a) lower frequency verb from the same Pinker/Levin semantic verb class (e.g., *giggle*) and (b) a novel verb designed to be semantically consistent with the class (e.g., *stip*).

## 2 Method

### 2.1 Participants

Participants were 42 children (21 female) aged 3;0–3;6 ( $M = 3;3$ ) and 42 undergraduate students (36 female) aged 18–12. Participants were from a predominantly middle-class background, though detailed SES information was not col-

lected. All participants were tested in a dedicated laboratory at the University of Manchester. Two additional participants (one adult and one child) began – but subsequently decided not to complete – the study.

## 2.2 Design and materials

The study used a mixed design with between-subjects groups of age (children/adults) and group. Each group saw exactly the same animations, but with different audio:

- The **transitive-control group** heard ungrammatical transitive test sentences (e.g., *\*Bob is falling/running/laughing Wendy*) and grammatical **transitive control** sentences (e.g., *Bob is rolling/turning/moving Wendy*).
- The **intransitive-control group** heard identical ungrammatical transitive test sentences (e.g., *\*Bob is falling/running/laughing Wendy*) and grammatical **intransitive control** sentences (e.g., *Wendy is rolling/turning/moving*).
- The **nondirective-audio** group saw exactly the same animations as the other two groups, but heard only **nondirective audio** throughout (e.g., *look, rolling/turning/moving!*)

The transitive-control group allows us to check that participants understand the task, and choose the causal over the non-causal animation, when it is unambiguously the correct choice (i.e., for control trials such as *Bob is rolling Wendy*). However, it may be that participants in this group are primed by the grammatical transitive sentences to choose the causal animation for every trial. The intransitive-control group allows us to rule out this possibility as, for control trials such as *Wendy is rolling*, the non-causal animation is unambiguously the correct choice<sup>4</sup>. Note that all of the control trials used alternating verbs (i.e., verbs that can appear grammatically in both the intransitive and transitive construction) in order to ensure that participants had to rely on the syntax of the sentence, rather than argument-structure properties of the verb itself, to choose the matching animation. The non-directive-audio group allows us to control for any general preference that participants (particularly children) might have for either the causal or non-causal scenes.

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<sup>4</sup> At least on the assumption that participants interpret such sentences as inchoative intransitives, e.g., *Wendy is rolling [herself]*, not as unspecified-object intransitives, e.g., *Wendy is rolling [someone]*. Fortunately, this was overwhelmingly the case (92% of trials) (see also Scott and Fisher 2009).

The within-subjects variables were verb-class (*falling/running/laughing* for the test sentences, *rolling/turning/moving* for the control sentences) and frequency (high/low/novel). There were also two counterbalancing factors (phonological novel verb form [between-subjects] and side [within-subjects]). However, since preliminary analyses revealed that these counterbalancing factors were not associated with any main effects or interactions, we do not discuss them further.

Eighteen NVN sentences were generated by allocating to each trial one of three pre-determined N1+N2 character pairs: *Boots+Dora*, *Wendy+Bob*, and *Piglet+Tigger*, ensuring that each pair occurred equally often in each condition (though perfect counterbalancing was not possible given the number of trials). We then created a further 18 trials by switching the order of the nouns within each pair, for a total of 36 sentences per participant. The complete list of sentences and for each group is given in Table 1.

For each sentence, we created two cartoons: one depicting a causal scene (e.g., Boots *making* Dora fall); the other, a non-causal scene (e.g., Boots falling *to/wards* Dora). Thus, in each pair, the causal and non-causal scene included the same two participants. In order to check that the causal and non-causal scenes really did correspond to the *construction-meaning* (causal) and *sentence-repair* (non-causal) interpretations respectively, we conducted a manipulation check. A new group of 10 adults were asked to describe each of the animations with the audio switched off. For the causal animations, participants gave some type of causal description (e.g., *Boots is making/helping Dora fall, Dora is falling because Boots is pushing her*) on 73% of trials (the only problematic verb was *run*, where participants gave non-causal descriptions – e.g., *Piglet and Tigger are running* on 85% of trials). For the non-causal animations, participants used an intransitive sentence including a prepositional phrase beginning with the target preposition (e.g., *Boots is falling to/wards Dora*) on 79% of trials (for laughing verbs, participants usually offered – e.g., *Piglet is laughing with* [rather than *at*] *Tigger* – which, although not the intended meaning, is still non-causal). Thus, overall, participants clearly interpreted the causal and non-causal animations as intended.

A second manipulation check further demonstrates the plausibility of the *sentence-repair* interpretations. A new group of 10 adults were played the full set of audio sentences (except the non-directive “look, VERBing”) type with no animations and asked (a) to identify sentences containing grammatical errors and (b) – for such sentences – to suggest what the speaker “meant to say”. Note that this is a very unconstrained task, as – in the absence of any visual cues to the speaker’s intended meaning – all kinds of repairs are, in principle, perfectly possible. For example *Boots is falling Dora* was repaired to *Boots is falling down*, *Boots is following Dora*, *Boots is falling with Dora*, and so on. Nevertheless, despite the highly unconstrained nature of the task, participants gave the exact target sen-



Table 1: Sentences heard by each group

Freq.	Test sentences		
	Transitive-control group	Intransitive-control group	Nondirective-audio group
High		*Boots is falling Dora	look, falling!
Low		*Wendy is tumbling Bob	look, tumbling!
Novel		*Piglet is stipping Tigger	look, stipping!
High		*Piglet is running Tigger	look, running!
Low		*Boots is hopping Dora	look, hopping!
Novel		*Wendy is fleeping Bob	look, fleeping!
High		*Wendy is laughing Bob	look, laughing!
Low		*Piglet is giggling Tigger	look, giggling!
Novel		*Boots is tarking Dora	look, tarking!
		Plus a further 9 reversed sentences e.g., <i>*Dora is falling Boots, *Bob is tumbling Wendy, etc.</i>	Plus a further 9 identical trials
Freq.	Control sentences		
	Transitive-control group	Intransitive-control group	Nondirective-audio group
High	Boots is rolling Dora	Dora is rolling	look, rolling!
Low	Wendy is bouncing Bob	Bob is bouncing	look, bouncing!
Novel	Piglet is plimming Tigger	Tigger is plimming	look, plimming!
High	Piglet is turning Tigger	Tigger is turning	look, turning!
Low	Boots is spinning Dora	Dora is spinning	look, spinning!
Novel	Wendy is glitting Bob	Bob is glitting	look, glitting!
High	Wendy is moving Bob	Bob is moving	look, moving!
Low	Piglet is sliding Tigger	Tigger is sliding	look, sliding!
Novel	Boots is bligging Dora	Dora is bligging	look, bligging!
	Plus a further 9 reversed sentences e.g., <i>Dora is rolling Boots, Bob is bouncing Wendy, etc.</i>	Plus a further 9 reversed sentences e.g., <i>Boots is rolling, Wendy is bouncing, etc.</i>	Plus a further 9 identical trials

tence repair for a mean of 30% of all trials. Together, these manipulation checks demonstrate that when given a sentence such as *\*Boots is falling Dora*, participants (a) interpret the videos as consistent with the intended *construction-meaning* and *sentence-repair* interpretations (e.g., *Boots is making Dora fall / Boots is falling to[wards] Dora*) and (b) consider the latter to be a possible sentence repair.

For each trial, participants heard an audio recording of the relevant sentence, whilst one video played on the left-hand side of the screen, and the other on the right-hand side. For each individual participant, trials were fully counter-balanced with regard to whether the causal scene was on the left-versus right hand side of the screen both (a) overall, (b) within verb type (target, control) and

(c) – as far as possible – within verb class and verb frequency (full counterbalancing was not possible, given the number of trials).

## 2.3 Procedure

The study used a forced-choice pointing procedure based on the preferential-looking study of Naigles (1990) and the pointing study of Noble et al. (2011). Animations (plus accompanying audio sentences) were presented using a laptop computer. Participants were first shown videos illustrating the meanings of the novel verbs (introduced in gerund form). For example, for the novel falling verb ('falling head over heels') participants heard "this is called stippling" (Counterbalance Group A) or "this is called plimming" (Counterbalance Group B), and viewed a video in which a character not used in the test trials – a frog – performed this action alone. Details of the videos can be found in Appendix A. The appropriate video was re-shown before each trial including a novel verb, in order to remind children of its meaning. Next, participants were asked to name all of the characters, which the vast majority of participants were easily able to do. For any character that the participant was unable to identify, she was given the name and re-tested until she was able to do so<sup>5</sup>. Participants did not complete any further warm-up before proceeding to the main part of the study.

Trials ( $N = 36$  per participant), each consisting of audio paired with two animations, were presented in random order. The procedure for each trial was as follows. Participants heard "Hey watch. Look here. See this!" whilst, first, the left-hand animation played. Next the right-hand animation played whilst the participant heard "Oh look. Look over here. Watch this!". Participants then watched both the left- and right-hand animations play simultaneously and heard four sentences, either directive (e.g., *Look, Wendy is gonna fall Bob. Wendy is falling Bob, see? Wendy fell Bob. Point to where Wendy is falling Bob*) or nondirective (e.g., *Look, falling. Look, falling, see? Look, falling. Point to falling*), depending on the condition. If a participant produced an ambiguous point or did not respond, the video was replayed and she was asked to point again or – if necessary – to place a sticker on the computer screen to indicate her choice. This procedure ensured that every participant made an unambiguous choice for every trial, with no missing data.

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<sup>5</sup> Note that, in any case, the referent of each name is easily inferable from the video: Bob and Wendy are clearly male and female, Boots wears large distinctive boots, Piglet is a pig and Tigger a tiger.

**Table 2:** Mean proportion of points to the causative action

Age	Condition	Mean causative points	SE
Control Trials			
3;0–3;6	(a) Transitive-control	0.80	0.04
	(b) Intransitive-control	0.13	0.04
	(c) Nondirective-audio	0.56	0.04
Adults	(a) Transitive-control	0.90	0.04
	(b) Intransitive-control	0.02	0.04
	(c) Nondirective-audio	0.28	0.04
Test Trials			
3;0–3;6	<b>(a) Transitive-control</b>	<b>0.82</b>	<b>0.05</b>
	<b>(b) Intransitive-control</b>	<b>0.82</b>	<b>0.05</b>
	(c) Nondirective-audio	0.51	0.05
Adults	<b>(a) Transitive-control</b>	<b>0.89</b>	<b>0.05</b>
	<b>(b) Intransitive-control</b>	<b>0.93</b>	<b>0.05</b>
	(c) Nondirective-audio	0.22	0.05

### 3 Results

The dependent variable was simply whether the participant pointed to the causal animation (scored as 1) or the non-causal animation (scored as 0) for each trial (there were no missing data). Table 2 shows the mean proportion of points to the causal scene for each condition.

#### 3.1 Analysis of control trials

The first analysis was a preliminary analysis, designed to check that participants pointed to the intended screen for the control trials with unambiguous audio significantly more often than (a) participants in the nondirective audio group and (b) than would be expected by chance (i.e., 50%).

A mixed ANOVA with independent variables of age (children/adults)  $\times$  group (transitive-control, intransitive-control, nondirective audio)  $\times$  verb class (*rolling/turning/moving*)  $\times$  frequency (high/low/novel) yielded a significant main effect of group ( $F_{2,78} = 187.64$ ,  $p < 0.001$ ,  $PE_2 = 0.83$ ). None of the within-subjects variables were associated with any main effects or interactions. The main effect of group reflected the fact that – collapsing across age – participants made more causal points for grammatical transitive sentences ( $M = 0.85$ ,  $SE = 0.03$ ) than grammatical intransitive sentences ( $M = 0.08$ ,  $SE = 0.03$ ), with both significantly different

from the nondirective audio group ( $M = 0.42$ ,  $SE = 0.03$ ), and from each other. Thus, as we intended, participants in the transitive-control group overwhelmingly (85%) chose the causal animation for sentences such as *Boots is rolling Dora*, whilst those in the intransitive-control group overwhelmingly (92%) chose the non-causal animation for sentences such as *Dora is rolling*<sup>6</sup>. Both of these proportions were significantly different to chance responding (50%) by binomial test ( $p < 0.001$  in both cases). Participants in the nondirective audio group chose the non-causal scene significantly less often (42%) than would be expected by chance ( $p < 0.001$ ), though it must be stressed that there is no “correct” choice here.

### 3.2 Analysis of test trials

The main analysis followed the same format as the preliminary analysis, looking only at the test trials. Again, none of the within-subjects variables were associated with any main effects or interactions. However the analysis revealed a significant main effect of group ( $F_{2,78} = 83.35$ ,  $p < 0.001$ ,  $PE2 = 0.68$ ), such that participants in both the transitive-control group ( $M = 0.85$  causative points,  $SE = 0.03$ ) and intransitive control group ( $M = 0.87$ ,  $SE = 0.03$ ) chose the causal scene significantly more often than participants in the nondirective audio group ( $M = 0.37$ ,  $SE = 0.03$ ;  $p < 0.001$  in both cases)<sup>7</sup>. Importantly, the proportion of causal choices was almost identical for the transitive-control and intransitive-control groups ( $p = 0.66$ , n.s.). Both the transitive-control and intransitive-control groups se-

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<sup>6</sup> Although a significant age by group interaction was also observed ( $F_{2,78} = 11.31$ ,  $p < 0.001$ ,  $PE2 = 0.23$ ), this was caused solely by an age difference in the nondirective audio group, with children choosing the causative scene ( $M = 0.56$ ,  $SE = 0.04$ ) more often than adults ( $M = 0.28$ ,  $SE = 0.04$ ), with no other comparisons significant. This finding is of little importance, since there is no “correct” response here. Importantly, all between-group differences remained significant for both children and adults when analyzed separately. A significant main effect of age ( $F_{2,78} = 8.22$ ,  $p = 0.005$ ,  $PE2 = 0.09$ ) was also observed, with children ( $M = 0.50$ ,  $SE = 0.02$ ) making significantly more causative points than adults ( $M = 0.40$ ,  $SE = 0.02$ ) overall. However, this difference is not important, given that it is driven solely by the nondirective audio group (as revealed by analysis of the age  $\times$  group interaction).

<sup>7</sup> Although a significant age by group interaction was again observed ( $F_{2,78} = 11.81$ ,  $p < 0.001$ ,  $PE2 = 0.23$ ), this was again caused solely by an age difference in the nondirective audio group, with children choosing the causative scene ( $M = 0.51$ ,  $SE = 0.04$ ) more often than adults ( $M = 0.22$ ,  $SE = 0.04$ ,  $p < 0.01$ ), with no other comparisons significant. Again, this result is not meaningful as there is no “correct” response here. Importantly, the pattern of results reported in the main text held for each age group when analyzed separately. No main effect of age was observed, indicating that adults and children did not differ in the overall proportion of causative points.

lected the casual scene (85% and 87% respectively) significantly more often than would be expected by chance, with the nondirective audio group selecting this scene significantly less often (37%) than would be expected by chance (though there is no “correct” choice here).

In summary, when asked to interpret an ungrammatical NVN sentence such as *\*Boots is falling Dora*, *\*Piglet is running Tigger* or *\*Wendy is laughing Bob*, both adults and children aged 3;0–3;6 overwhelmingly select a causal construction-meaning interpretation (e.g., Bob *making* Dora fall, Piglet *making* Tigger run or Wendy *making* Bob laugh), over a non-casual sentence-repair interpretation (e.g., Boots falling *to[wards]* Dora, Piglet running *to[wards]* Tigger, or Wendy laughing *at* Bob). This pattern holds regardless of age (3-year-olds vs adults), verb frequency (high, low or novel) and the type of sentence (intransitive vs transitive) used in grammatical control trials with alternating verbs.

## 4 Discussion

In the present study, 3-year-olds and adults were asked to choose between *construction-meaning* and *sentence-repair* interpretations of ungrammatical NVN sentences containing intransitive only verbs (e.g., *\*Wendy is falling / tumbling / running / hopping / laughing / giggling Bob*; plus novel equivalents). Both age groups overwhelmingly (i.e., on at least 82% of trials) chose the *construction-meaning* interpretation.

This finding clearly constitutes strong evidence in support of theories of the adult grammar and child language acquisition which assume an independent role for construction-meaning. Indeed, since all the verbs used in the test trials were intransitive only, participants not only overwhelming *used* construction meaning to guide their sentence interpretations, but allowed it to *override* their knowledge of the meanings and typical usage of these verbs.

A possible objection is that participants were not making a meaningful choice of the *construction-meaning* interpretations, because the *sentence-repair* interpretations against which they were pitted were not plausible alternatives. This objection was addressed by means of two manipulation checks which demonstrated that participants frequently offered such descriptions themselves, both when asked to describe the non-causal videos without audio and – conversely – to suggest possible sentence repairs without videos. But even if some participants did not consider the *sentence-repair* interpretations to be particularly plausible alternatives, the fact remains that they did not point at random, or object that neither sentence matched the picture. Instead, they consistently and overwhelmingly chose the *construction-meaning* interpretations. Indeed, given that the verbs

for the target trials were intransitive-only and have meanings entirely consistent with the non-causal animations, it is hard to see how participants could have chosen the casual animations for *any* trials – let alone the vast majority trials – without using construction meaning.

A second possible objection is that these findings are unreliable because they conflict with well-established findings from previous act-out and judgment studies. With regard to act-out studies, we would suggest that the findings are not as divergent as they may at first appear. Indeed, the youngest children studied by Naigles et al. (1992; 1993) showed rates of construction-meaning interpretations (“frame-compliance”) broadly similar to those observed in the present study (70% as compared with 82% here). The findings for adults appear initially to be more divergent: In the act-out task, adults showed rates of construction-meaning interpretations (“frame compliance”) of just under 50%, as compared with 89–93% here. However, it is important to bear in mind that, in Naigles’ study, the 50% or so of responses that were *not* frame-compliant included not only *sentence-repair* interpretations – the distractor in the present study – but other verb compliant responses, such as making one or both characters perform the action independently.

Thus, if one were to reanalyze Naigles’ adult data excluding all but construction-meaning and sentence-repair enactments, the proportion of the former would certainly rise (simply because the denominator would shrink), possibly even close to the rates observed in the present study. In other words, it could be the case that Naigles’ developmental decrease of frame-compliant interpretations represents an increase in the type of verb-compliant responses that were not offered as foils in the present study. Of course, this discussion is necessarily speculative, and there are many other important differences between the studies (e.g., Naigles et al. included ungrammatical intransitive uses of transitive verbs, as well as various three-argument constructions). However, for our purposes, the similarities between the two studies are more important than their differences. The most important finding is one that is shared by both studies: any non-trivial rate of frame-compliance constitutes evidence that participants have some representation of construction meaning.

An unexpected finding observed in the present study was the null effect for frequency. Does this mean that our findings are inconsistent with those observed in previous grammaticality-judgment studies (e.g., Ambridge et al. 2008; Ambridge et al. 2009; Ambridge et al. 2011), in which children are less accepting of intransitive-to-transitive overgeneralizations with higher frequency verbs (e.g., *\*The man fell/tumbled/laughed/giggled Bart*) (see Brooks and Tomasello 1999, for similar findings in production)? We suggest that the findings of judgment and comprehension studies are not contradictory but orthogonal; the two types of

studies provide answers to different questions (Ambridge and Rowland 2013; Lewis and Philips in press). Judgment (and production) tasks investigate participants' knowledge of the extent to which particular sentences are grammatical. Comprehension tasks investigate participants' interpretations of particular sentences, *whether those sentences are grammatical or ungrammatical*. There is clearly some relationship between grammatical acceptability and comprehensibility, as most people rate incomprehensible sentences as ungrammatical (Frazier 1985; Gibson and Thomas 1999)<sup>8</sup>. Importantly, however, the reverse is not true; ungrammatical sentences are often perfectly comprehensible. For example, the intended meaning of a sentence such as *\*The funny joke giggled Bart* is very clear, even though most speakers regard it as highly unacceptable. Indeed, the findings of the present study suggest that, in many cases, speakers find it easier – or otherwise preferable – to interpret an *ungrammatical* sentence (e.g., *\*Wendy laughed Bob*) than to repair it in order to yield a grammatical sentence (e.g., *Wendy laughed at Bob*).

What does this pattern of findings mean for accounts of the adult grammar and its acquisition by children? As we argued in the introduction, construction-meaning effects are problematic for Chomskyan accounts of the adult grammar that explicitly deny the independent existence of constructions, and for acquisition accounts that adopt this framework (e.g., parameter-setting). The present findings are, of course, consistent with nativist or early-abstraction accounts that do posit a role for construction meaning (e.g., Gertner, Fisher and Eisengart 2006), including syntactic bootstrapping (Gleitman 1990; Naigles 1990; Naigles et al. 1992; Naigles et al. 1993; Lidz, Gleitman and Gleitman 2003). However, our findings do not address the question of whether these construction-meaning mappings are learned entirely on the basis of the input (e.g., Tomasello 2003) or have at least some innate basis (as under most formulations of the syntactic bootstrapping hypothesis).

In summary, although there remain a number of interesting questions with regard to the relationship between different comprehension, judgment and production tasks, the findings of the present study – like those of Naigles et al. (1992) and Naigles et al. (1993) – suggest a clear conclusion: Participants use construction semantics to interpret ungrammatical sentences, even with this requires overriding their knowledge regarding the usual meanings and argument-structure restrictions of particular verbs. Thus a role for construction semantics

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<sup>8</sup> Indeed, incomprehensible sentences that are, in principle, grammatical are sometimes rated as more unacceptable than bona-fide ungrammatical sentences (Christiansen and Macdonald 2009).

will necessarily be incorporated in any successful model of both adults' grammatical knowledge and children's language acquisition.

**Acknowledgments:** We thank the children, parents, teachers and students who participated in this study. This research was funded by Leverhulme Trust Grant RPG-158 to the first author.

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