The link between lexical semantic features and children's comprehension of English verbal *be*-passives

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Abstract

Children seem to be relatively delayed in their comprehension of the verbal *be*-passive in English, compared to their acquisition of other constructions of object-movement such as *wh*-questions and unaccusatives. Prior work has found that children's performance on these passives can be affected by the verb's lexical semantics. Through a meta-analysis of experimental studies assessing English-speaking children's age of acquisition for the verbal *be*-passive, we identify a developmental trajectory composed of five classes, where each class has a distinct lexical semantic profile. A Truth-Value Judgment (**TVJ**) Task assessing English children's comprehension of verbal *be*-passives supports this developmental trajectory. Together, the meta-analysis and TVJ study underscore the importance of lexical semantics for understanding the development of the English verbal *be*-passive.

keywords: passives, lexical semantics, meta-analysis, Truth-Value Judgment Task, English

1   Introduction

English-speaking children seem to be relatively delayed in their understanding of long verbal *be*-passives (i.e. passives containing a *by*-phrase like (1)-(2)), compared to other constructions of object-movement (e.g. *wh*-questions, unaccusatives). For instance, children over age seven fail to demonstrate understanding of certain verbs in this passive form (Bever, 1970; de Villiers & de Villiers, 1973; Horgan, 1978; Maratsos, Fox, Becker, & Chalkley, 1985, a.o).

(1)   Matthew was hugged by Diana.

(2)   Matthew was loved by Diana.

Several studies have noted that English children's (un-)successful performance is impacted by the lexical semantics of the verb (Maratsos et al., 1985; Messenger, Branigan, McLean, & Sorace, 2012; Liter, Huelskamp, Weerakoon, & Munn, 2015; Nguyen, 2015). For example, Maratsos et al. (1985) observed that younger children perform better on passives with ACTIONAL (i.e. observable) verbs like *hug* (1) compared to non-ACTIONAL verbs like *love* (2). We will refer to this lexical-feature-based difference in children's performance on passives as a *lexical asymmetry* in children's development of the English verbal passive. Our aim here is to better understand the link between lexical semantic features and the acquisition of the long verbal *be*-passive in English (which we refer to simply as the "verbal passive" henceforth), focusing on the observed lexical asymmetry.[1]

Current theories of the acquisition of the English verbal passive often appeal to the +/-ACTIONAL distinction (i.e. the sometimes-called "Maratsos Effect") (Gehrke & Grillo, 2009; Grillo, 2008;

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[1] We note that we chose to focus on long verbal *be*-passives because short passives (e.g., *It was carried*) with actional verbs (like *carry*) are ambiguous between adjectival and verbal passives. This ambiguity has led some prior work, such as Borer and Wexler (1987), to suggest that young children's early success with actional passives is due to interpreting those passive structures as adjectival rather than verbal *be*-passives. That is, young children would be using different syntactic structures to successfully interpret these actional passives compared with other passives. By focusing on long verbal *be*-passives, we can therefore focus on what is generally agreed to be a single underlying passive structure.

Liter et al., 2015; Nguyen, 2015; Snyder & Hyams, 2015), but typically don't go beyond this lexical feature. We first review lexical semantic features previously proposed in the experimental literature, and conduct a meta-analysis of experimental studies investigating the age of acquisition for the English verbal passive. Our meta-analysis reveals a striking correlation between the lexical semantic profile of verbs, encompassing seven different lexical semantic features, and their observed age of acquisition in the verbal passive form. We then describe a Truth-Value Judgment (**TVJ**) Task assessing English four-year-old children's comprehension of verbal passives for different verbs not previously assessed at age four. The lexical semantic correlation we observed from the meta-analysis is supported by our TVJ behavioral study. We discuss the implications of our results for development of the verbal passive in English and also other languages.

2 Lexical semantic features

Several experimental studies (Maratsos et al., 1985; Pinker, Lebeaux, & Frost, 1987; Messenger et al., 2012; Liter et al., 2015; Nguyen, 2015) have collectively described seven potentially relevant lexical semantic features that can affect children's performance on the verbal passive (Table 1): ACTIONAL, STATIVE, VOLITIONAL, AFFECTED, and the thematic-role relations object-experiencer (OBJ-EXP), subject-experiencer (SUBJ-EXP), and agent-patient (AGT-PAT). We note that these tend to be descriptive features proposed by experimenters to explain specific experimental results rather than theoretically-motivated features that were intended to be mutually exclusive. So, there has not yet been a formal account of how well these descriptive features capture the lexical asymmetry observed in children's development of the verbal passive. Moreover, it's not clear whether (or how much) these features overlap semantically. Here, we will treat these features as independent from each other, as there is no theoretical account yet that synthesizes them any other way. We also note that the "signal" of these lexical semantic features is taken from the previous literature, and may be morphosyntactic (e.g., a context the verb can appear in) rather than semantic.

The first feature is ACTIONAL, which was defined by Maratsos et al. (1985) as a verb that is *not* a mental, psych, or perception verb. A signal we use to identify an ACTIONAL verb is whether the event described by the verb is observable (Maratsos et al., 1985). So, *eat* would be +ACTIONAL because eating can be directly observed (e.g., *The penguin is eating a fish* – we can observe the penguin eating the fish). In contrast, a psych verb like *love* would be -ACTIONAL because the internal state caused by loving cannot be directly observed (e.g., *Lisa loves penguins* – we cannot observe Lisa's internal state of pure love because that psychological state is internal to Lisa).

The next features, STATIVE and VOLITIONAL, were proposed by Liter et al. (2015).[2] Stativity is defined as a verb being acceptable in the simple present tense in an "out of the blue" context (Liter et al., 2015).[3] For example, *Diana loves Matthew* sounds acceptable without any special

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Table 1: Descriptive lexical semantic features derived from prior experimental studies on the verbal passive, including signals of that feature and example verbs with (+) and without (-) that feature.

Studies	Feature	Signal	+	-
Maratsos et al. (1985) Nguyen (2015)	ACTIONAL	Observable	*eat*	*scare*
Liter et al. (2015)	STATIVE	Simple present tense in "out of the blue" context	*scare*	*eat*
Liter et al. (2015)	VOLITIONAL	"deliberately *VERB*"	*annoy*	*see*
Pinker et al. (1987)	AFFECTED	X affects Y	*annoy*	*like*
Messenger et al. (2012)	OBJ-EXP	-ACTIONAL where object is Experiencer	*frighten*	*chase*
Messenger et al. (2012)	SUBJ-EXP	-ACTIONAL where subject is Experiencer	*like*	*annoy*
Messenger et al. (2012)	AGT-PAT	+ACTIONAL where θ-roles = Agent, Patient	*eat*	*whisper*

context (*love*=+STATIVE). This contrasts with *Diana carries Matthew*, which sounds odd out of the blue unless we are narrating an event in real time (*carry*=-STATIVE). Secondly, Liter et al. (2015) define a verb as VOLITIONAL if it is acceptable when following the adverb *deliberately*. For example, *Matthew deliberately annoyed Diana* sounds acceptable, and describes an event where Matthew made a concerted effort to annoy Diana (*annoy*=+VOLITIONAL). In contrast, *Matthew deliberately saw Diana* sounds somewhat odd in its default interpretation, as it describes an event where Matthew has preternatural control over his visual perception and can choose whether to consciously perceive Diana (*see*=-VOLITIONAL).

The AFFECTED feature was proposed and defined by Pinker et al. (1987), and applies to verbs where the subject affects the object. For example, in *Matthew annoyed Diana*, Diana is affected by Matthew – she is, in fact, annoyed by him (*annoy*=+AFFECTED). This contrasts with *Matthew liked Diana*, where Diana isn't impacted by Matthew liking her, even though Matthew is impacted himself (*like*=-AFFECTED).

The final three features, OBJ-EXP (Object-Experiencer), SUBJ-EXP (Subject-Experiencer), and AGT-PAT (Agent-Patient), were proposed and defined by Messenger et al. (2012), and focus on the thematic status of the object (as either an Experiencer or a Patient).[4] When verbs are -ACTIONAL, they often involve Experiencers. A verb is +OBJ-EXP when the Experiencer is the object (e.g., *Matthew frightens Diana* – Diana is the Experiencer of the fright). A verb is +SUBJ-EXP when the Experiencer is the subject (e.g., *Diana likes Matthew* – Diana is the Experiencer of the liking). When verbs are +ACTIONAL and the thematic roles are Agent and Patient, the verb is AGT-PAT. For example, *The penguin eats the fish* describes an event where the penguin is the agent and

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from Liter et al. (2015).

[4]Messenger et al. (2012) used the terms "theme-experiencer" and "experiencer-theme" to refer to OBJ-EXP and SUBJ-EXP, respectively.

the fish is the patient (*eat*=+AGT-PAT). This contrasts with *whisper* (e.g., *Diana whispered the secret*), which is +ACTIONAL but does not obviously involve Agent and Patient roles; therefore, it is -AGT-PAT.

We demonstrate the lexical semantic annotation of verbs according to these signals in Table 2. *Find* is an observable action (ACTIONAL=1, STATIVE=0) that is not deliberate (VOLITIONAL=0). In a transitive use, the direct object is unaffected (AFFECTED=0) and a Patient (OBJ-EXP=0, SUBJ-EXP=0, AGT-PAT=1). *Carry* is also an observable action (ACTIONAL=1, STATIVE=0), but can be deliberate (VOLITIONAL=1). In a transitive use, the direct object is affected (AFFECTED=1) and a Patient (OBJ-EXP=0, SUBJ-EXP=0, AGT-PAT=1). *Love* is a stative psych verb (ACTIONAL=0, STATIVE=1) that is not deliberate (VOLITIONAL=0). In a transitive use, the direct object is unaffected (AFFECTED=0) and the subject is the Experiencer (OBJ-EXP=0, SUBJ-EXP=1, AGT-PAT=0).

Table 2: Example annotation of lexical semantic features in the verbs *find, carry*, and *love*.

	find	*carry*	*love*
ACTIONAL	*find* ≠ mental, psych, or perception verb. **1**	*carry* ≠ mental, psych, or perception verb. **1**	*love* = psych verb. **0**
STATIVE	*Alex finds Emma. **0**	*Alex carries Emma. **0**	Alex loves Emma. **1**
VOLITIONAL	*Alex deliberately finds Emma. **0**	Alex deliberately carries Emma. **1**	*Alex deliberately loves Emma. **0**
AFFECTED	Alex finds Emma – Emma is unaffected. **0**	Alex carries Emma – Emma is affected. **1**	Alex loves Emma – Emma is unaffected. **0**
OBJ-EXP SUBJ-EXP AGT-PAT	Alex finds Emma. Alex = Agent. Emma = Patient. **0** **0** **1**	Alex carries Emma Alex = Agent. Emma = Patient. **0** **0** **1**	Alex loves Emma Alex = Experiencer. Alex = Subject. **0** **1** **0**

3   Experimental meta-analysis

To attempt to estimate a lower bound for when children have knowledge of the verbal passive in English, we synthesized the results of 12 experimental studies. Importantly, experimental studies are less likely than spontaneous production studies to underestimate children's grammatical knowledge. So, we focused on experimental studies that have reported performance on English-speaking children's performance on verbal passives across multiple verbs in order to identify an

"age of acquisition" (**AoA**) for verbal passive knowledge of individual verbs. Our synthesis summarizes (i) the verbs used as stimuli (Table 3), and (ii) children's performance on verbal passives for those verbs at different ages.[5] [6] This provided the empirical data about the AoA of the verbal passive for each verb. We determined a verb's AoA by identifying the youngest age when children begin performing significantly above chance in any of the studies; thus, if multiple studies reported successful performance on a particular verb, we chose the youngest age group tested. For the studies that only reported performance on groups of verbs, an AoA was assigned for each verb that belonged in a group. The specific AoA we chose for a verb was based on the age groups that were targeted by the studies in our meta-analysis. For example, we determined the AoA for *hate, like, love,* and *remember* to be five years old because Maratsos et al. (1985) targeted "5-year-old" children (with a mean age of 5;04) and found significantly above-chance performance. Likewise, AoAs with two age groups (e.g., between three and four years old in Table 4) are a consequence of studies collapsing across those two age groups. An AoA could not be determined for a verb if there were no studies in which (i) that verb was tested and (ii) children showed successful performance on that verb. Of the 50 unique verbs tested in these 12 studies, 30 had an AoA by this definition, as shown in Table 4 (and there were no studies that reported conflicting results for these 30 verbs). We subsequently annotated these 30 verbs for their lexical semantic features according to the signals defined in Table 1.

3.1   The lexical semantic profile hypothesis

When verbs were sorted based on observed AoA (i.e., the age of significantly above-chance performance from the meta-analysis), we found that there was a striking relationship between the combination of lexical semantic feature values of a verb (which we call its "lexical semantic profile") and that verb's observed AoA (see Table 5). In particular, we observed that each of the 30 verbs in Table 4 can be categorized into 5 unique lexical semantic profiles, with verbs in the same lexical semantic profile having exactly the same feature values. Profile 1 verbs like *carry*, *chase*, and *fix* are +ACTIONAL, +VOLITIONAL, +AFFECTED, and +AGT-PAT. Profile 2 verbs like *annoy* differ from Profile 1 verbs by being +STATIVE (instead of +ACTIONAL) and +OBJ-EXP (instead of +AGT-PAT). Profile 3 verbs like *find* are like Profile 1 verbs in being +ACTIONAL and +AGT-PAT, but differ in being -VOLITIONAL and -AFFECTED. Profile 4 verbs like *forget* are like Profile 3 verbs in being -STATIVE, -VOLITIONAL, and -AFFECTED, but differ in also being -ACTIONAL and +SUBJ-EXP. Profile 5 verbs like *hate* are like Profile 4 verbs in being +SUBJ-EXP, but are additionally +STATIVE.

Taken together, along with the results for all 30 verbs shown in Table 6, these profiles suggest a natural developmental trajectory for the lexical semantic cues that influence children's ability to interpret long verbal passives. We note that the ages associated with the predicted developmental trajectory are derived from our meta-analysis of English-speaking children's performance; for our

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[5]Refer to [insert url here]/Appendix [to-be-created] for more specific details of the meta-analysis.

[6]These studies either reported successful performance on these verbs in the active or did not report any difficulty in comprehending the meanings of these verbs. We take this to mean that unsuccessful performance in these studies results from children's difficulty with these verbs in the verbal passive rather than difficulty with the task or the meanings of the verbs themselves.

Table 3: Studies, methodology, and verbs used in the experimental meta-analysis.

Studies	Methodology	Verbs tested
de Villiers and de Villiers (1973)	Act-Out	kiss, push, hit, bite, bump, touch
Maratsos and Abramovitch (1975)	Act-Out	kick, kiss, push, hit, bite, bump, tickle, touch
Maratsos et al. (1985)	Picture-Selection	hold, kick, kiss, push, shake, wash, find, forget, hate, like, love, remember, hear, know, miss, see, smell, watch
Gordon and Chafetz (1990)	Truth-Value Judgment	carry, drop, eat, hold, hug, kick, kiss, shake, wash, forget, hate, like, remember, believe, hear, know, see, watch
Fox and Grodzinsky (1998)	Truth-Value Judgment	chase, hear, see, touch
Hirsch and Wexler (2006b)	Picture-Selection	push, kiss, kick, hold, remember, love, hate, see
O'Brien, Grolla, and Lillo-Martin (2006)	Truth-Value Judgment	hug, chase, like, see
Crain, Thornton, and Murasugi (2009)	Elicitation	eat, kiss, push, hit, bite, crash, kill, knock, lick, pick up, punch, scratch, shoot
Messenger et al. (2012)	Picture-Selection	carry, hit, frighten, pat, pull, scare, shock, squash, surprise, upset, hate, love, remember, annoy, bite, hear, ignore, see
Orfitelli (2012)	Picture-Selection	carry, kick, kiss, push, love, remember, hear, see
Nguyen (2015)	Truth-Value Judgment	hug, chase, like, see
Liter et al. (2015)	Truth-Value Judgment	wash, find, fix, forget, paint, spot, hate, love, know

purposes, these ages serve simply to indicate the relative order that profiles should emerge in. The predicted developmental trajectory corresponding to English children's ages is shown in Table 7.

We can interpret these lexical profiles as corresponding to five classes of verbs; the developmental trajectory that we see involves children comprehending successively larger subsets of these five classes (such that English three-year-olds understand the first profile and five-year-olds understand all five). A LEXICAL SEMANTIC PROFILE HYPOTHESIS would predict that the discrepancies between the lexical semantic profiles for some verbs and the observed AoA (e.g., Profile 1 verb *fix* with an observed AoA of 4-5yrs) are due to vagaries of the age of the children tested experimentally for those verbs. For example, if *fix* were tested with children age three, this hypothesis would predict above-chance performance on *fix*'s verbal passive. This is one of the stimuli we explicitly

Table 4: Age of Acquisition (AoA) of verbs from the experimental meta-analysis, representing an AoA by three years old (3yrs), between three and four years old (3-4yrs), between four and five years old (4-5yrs), and five years old (5yrs).

AoA	Verbs
3yrs	carry, drop, eat, hold, hug, kick, kiss, push, shake, wash
3-4yrs	annoy, chase, frighten, hit, pat, pull, scare, shock, squash, surprise, upset
4-5yrs	find, fix, forget, paint, spot
5yrs	hate, like, love, remember

Table 5: Lexical semantic profiles comprised of the seven lexical semantic features for example verbs with different experimentally observed ages of acquisition (AoA).

	AoA						
	3yrs	**3-4yrs**		**4-5yrs**			**5yrs**
	carry	chase	annoy	fix	find	forget	hate
Profile	**1**	**1**	**2**	**1**	**3**	**4**	**5**
ACTIONAL	1	1	0	1	1	0	0
STATIVE	0	0	1	0	0	0	1
VOLITIONAL	1	1	1	1	0	0	0
AFFECTED	1	1	1	1	0	0	0
OBJ-EXP	0	0	1	0	0	0	0
SUBJ-EXP	0	0	0	0	0	1	1
AGT-PAT	1	1	0	1	1	0	0

test in the TVJ task with younger English children, described in more detail in section 4.

3.2   Limitations of the meta-analysis

The current meta-analysis leaves open several questions. First, while some experimental studies tested three- and five-year-old children as their own age groups, the age overlap in other studies means that four-year-old children were often grouped in with these other ages. Because of this, we do not know exactly how four-year-olds will perform; four-year-olds could pattern with either the three- or five-year-olds or have a distinct performance pattern with respect to these lexical semantic profiles. Second, only one study in our meta-analysis (Messenger et al., 2012) has tested +OBJ-EXP verbs in young children and found that they could successfully interpret these verb types in the verbal passive. However, this study was a picture-selection task where pictorial portrayals of stative verbs like *annoy* may have yielded accidental eventive interpretations – so, these accidental eventive interpretations could have led to young children's successful passive interpretations.

Table 6: Observed age of acquisition (AoA) for the 30 verbs with an AoA available from the meta-analysis, along with their lexical semantic profile (Profile).

AoA	Verb	Profile	AoA	Verb	Profile
3yrs	carry	1	3-4yrs	annoy	2
3yrs	drop	1	3-4yrs	frighten	2
3yrs	eat	1	3-4yrs	scare	2
3yrs	hold	1	3-4yrs	shock	2
3yrs	hug	1	3-4yrs	surprise	2
3yrs	kick	1	3-4yrs	upset	2
3yrs	kiss	1	4-5yrs	fix	1
3yrs	push	1	4-5yrs	paint	1
3yrs	shake	1	4-5yrs	find	3
3yrs	wash	1	4-5yrs	forget	4
3-4yrs	chase	1	4-5yrs	spot	4
3-4yrs	hit	1	5yrs	hate	5
3-4yrs	pat	1	5yrs	like	5
3-4yrs	pull	1	5yrs	love	5
3-4yrs	squash	1	5yrs	remember	5

Table 7: AoA predictions (Predicted AoA) for example verbs in English, based on their lexical semantic profiles (Profile).

Profile	Example verbs	Predicted AoA
1	bump, crash, fix, chase, hug	3yrs
2	flatter, hurt	3-4yrs
3	search, discover	4-5yrs
4	spot, notice, overhear	4-5yrs
5	believe, miss, know, remember	5yrs

Because of this possibility, it's unclear if the age of acquisition of the verbal passive for Profile 2 verbs like *annoy* is in fact by four years old in English. Third, Profile 1 verbs (e.g. *fix*) have multiple observed AoAs (e.g., 3, 3-4, and 4-5) but are predicted to be acquired earlier if tested with younger children. Fourth, the meta-analysis combines the results from different groups of children across multiple age ranges using different experimental stimuli and methods (see Table 3 for the different methods). So, the differences in methodologies could impact the observed AoAs, and thus the observed developmental trajectory. In particular, more demanding tasks like act-out tasks or elicitation tasks could be masking younger children's knowledge of the verbs tested in the verbal passive. More generally, our lexical semantic profile hypothesis would be strengthened if the same group of children performed as this hypothesis predicts across a variety of verbs with different lexical semantic profiles. We address all these limitations in the next section with a behavioral

assessment using a TVJ task. The results from this experiment will therefore increase the empirical foundation provided by the meta-analysis, and include four-year-old English comprehension behavior of a variety of verbs from different profiles.

4   Truth-Value Judgment Task

We aim to assess if English four-year-old children perform as the lexical profile hypothesis predicts when interpreting the verbal passive. More specifically, this hypothesis predicts that if children are acquiring the passive form of verbs based on specific lexical profiles, then four-year-olds should successfully comprehend particular verbs with certain lexical profiles earlier than verbs with different lexical profiles. For instance, on the basis of the meta-analysis results connecting age to the comprehension of particular profiles, we would expect four-year-olds to successfully comprehend the passive of Profile 1 verbs like *fix*, and possibly Profile 2, 3, and 4 verbs like *surprise*, *find*, and *forget*. We would expect them not to comprehend the passive of Profile 5 verbs like *love*.

4.1   Subjects

We tested 23 children (3;11-5;01, mean age=4;07) recruited from *[removed for blind review]*. To be included in the data analysis, the child had to correctly answer at least four out of the five active control items (i.e., scoring at least 80% correct), and not exhibit a bias towards a particular answer (i.e., giving the same answer to 90% or more of the test items). Given this inclusion criterion, four children were excluded from the final data analysis.[7] We report results on the data collected from the remaining 19 children, who happened to have the same age range and mean age as the larger group (3;11-5;01, mean age=4;07).[8]

Experimental sessions were limited to 20 minutes per child (the average length of the current study) across all recruitment sites. With respect to particular recruitment sites, multiple testing visits with the same child were available at some locations (e.g. local daycares); other recruitment sites such as the *[removed for blind review]* Science Center only permitted a single testing session. If multiple testing visits were available to a child, that child received a training session (as described in the next section) prior to the testing session; this training session familiarized her with the task methodology, including opportunities for corrective feedback. Otherwise, the child was given verbal instructions for the procedure before proceeding to the test items, without any opportunity for corrective feedback. 11 of the 19 children who passed the control criterion received a training session.[9]

As adult controls, ten undergraduate students were recruited from *[removed for blind review]*. All participants were native speakers of US English.

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[7]Three children were excluded because they exhibited a yes-/no-bias, and one child was excluded for answering only one of the five active controls correctly.

[8]Of these 19 children, four children answered four of the five active controls correctly while the remaining 15 children answered all five active controls correctly.

[9]We note that there was no statistical difference in performance between children who received training and those who did not – see section 4.4 for more discussion.

4.2 Procedure

A modified version of the Truth-Value Judgment (**TVJ**) Task (Crain & McKee, 1985; Crain & Thornton, 1998, 2000) was used to investigate the predictions of the lexical semantic profile hypothesis. The TVJ task was carried out by a single experimenter using a laptop computer. Stories were narrated by the experimenter using animated clipart displayed in Microsoft PowerPoint. Participants were told that a puppet would also watch the stories with them and, at the end of each story, describe something that had happened in the story. Participants were then asked to determine whether the puppet's statement was "right" or "silly". The procedure was the same for the training session, but corrective feedback was provided after every item.

For each participant, follow-up justifications were elicited for the first two to three items in order to ascertain the reason for providing "right" or "silly" responses. If participants seemed willing, follow-up justifications were elicited for the rest of the experimental items. Positive feedback was given to participants after every response in order to avoid accidental cues to incorrect answers. All subjects were tested individually.

4.3 Materials

Ten verbs were chosen for testing, two from each of the five lexical profiles identified in the meta-analysis (see Table 8); the stories used in this experiment were created from these 10 verbs (see Appendix A).

Wash (Profile 1) and *love* (Profile 5) were chosen because they are frequently attested to be successfully understood in the verbal passive by both younger children (*wash*) and older children (*love*)respectively (Gordon & Chafetz, 1990; Hirsch & Wexler, 2006b; Liter et al., 2015; Orfitelli, 2012). These verbs serve as benchmarks for aligning the experimental results found here with the other studies in our meta-analysis. *Fix* (Profile 1) was chosen because the lexical semantic profile hypothesis predicts an earlier AoA than the age found by Liter et al. (2015). In particular, Profile 1 verbs are predicted to have an AoA by three in English, so four-year-olds are predicted to understand *fix* in the verbal passive. *Surprise* (Profile 2), *frighten* (Profile 2), *find* (Profile 3), *spot* (Profile 4), and *forget* (Profile 4) were chosen because they have only been tested in one prior study (Messenger et al. (2012) for *surprise* and *frighten*, Liter et al. (2015) for *find*, *spot*, and *forget*); so, it is unclear how the same group of children will perform on all these verbs. *Discover* (Profile 3) and *believe* (Profile 5) have never been tested before in children.

For each of the 10 verbs, three stories were created: two passive stories, and one active story for control. This yielded 30 stories total. Within each verb, the stories were similar to each other, but differed depending on whether participants were told a passive sentence or an active sentence that either matched or didn't match the story as the test utterance. Test sentences were presented to participants through pre-recorded audio clips spoken by a male native speaker of English. See Appendix A for the 30 stories used and *[url to be inserted here]* for the accompanying Powerpoint presentations.

Sample stories are shown below for the verbs *frighten* (passive test sentence, mismatch for story) and *love* (passive test sentence, match for story)[10] :

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[10] We note that the test stories did not include plausible dissent in order to keep them uniform to each other and

Table 8: Lexical profiles of the 10 verbs tested and the two lists that these verbs were split into, along with their predicted age of acquisition (Predicted AoA) in English, according to the lexical semantic profile hypothesis.

	List A:	wash	surprise	discover	spot	love
	List B:	fix	frighten	find	forget	believe
Profile		**1**	**2**	**3**	**4**	**5**
ACTIONAL		1	0	1	0	0
STATIVE		0	1	0	0	1
VOLITIONAL		1	1	0	0	0
AFFECTED		1	1	0	0	0
OBJ-EXP		0	1	0	0	0
SUBJ-EXP		0	0	0	1	1
AGT-PAT		1	0	1	0	0
Predicted AoA		**3yrs**	**3-4yrs**	**4-5yrs**	**4-5yrs**	**5yrs**

Sample Story 1 - *frighten*, Profile 2, Mismatch
<u>Narrator</u>: Owen and Jackie are at a costume party. Ladybugs frighten Owen but Jackie loves ladybugs and that's why she's dressed as one for the party.
<u>Jackie</u>: Owen, do you see my ladybug costume? Do I frighten you?
<u>Owen</u> [*frowning*]: Yes, Jackie, you frighten me. You know that I don't like ladybugs!
<u>Test Sentence</u>: Jackie was frightened by Owen. (False)

Sample Story 2 - *love*, Profile 5, Match
<u>Narrator</u>: Jake and Isabelle are neighbors. They play with each other every day.
<u>Isabelle</u>: Jake, I don't love you because I'm jealous of your new clothes.
<u>Jake</u>: But I love you because you're my only friend, Isabelle!
<u>Test Sentence</u>: Isabelle was loved by Jake. (True)

The stories were also constructed such that any reliance on linear word order for interpretation would always lead to an incorrect response. For example, in the Sample Story 2 above, a child could interpret the passive test sentence *Isabelle was loved by Jake* as "Isabelle loved Jake" by relying on only the linear word order (either due to confusion or lack of structural knowledge of the passive); the child would then provide an incorrect response to the test sentence (False in

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simple enough to allow for multiple test stories within a single session. This may have made all the stories less felicitous, and so potentially caused four-year-olds not to correctly comprehend the passive for a particular verb when they might have comprehended it in a setup with plausible dissent. However, because all stories were alike in this regard, we expect this to have a global effect, potentially lowering correct comprehension rates across all profiles. So, the qualitative pattern we report below likely would remain the same, though perhaps the profile on the borderline (Profile 4) might have moved into being accepted by four-year-olds in a more felicitous setup. We leave this for future work.

Sample Story 2). Consistently relying on a linear-word-order strategy like that would result in the child systematically providing incorrect responses. Furthermore, for the verbs that fell under Profiles 2 and 5 and so were +STATIVE, we wanted to avoid accidental eventive interpretations and so kept movement of the characters onscreen to a minimum within the test materials; participants thus had to rely on the dialogue of the stories in order to fully comprehend the contexts.

The 10 verbs and their corresponding stories were split into two lists as shown in Table 8. Adult participants were presented with both lists and thus saw all 30 stories. Child participants were presented with one of the two lists. So, each child participant was tested on a total of 15 stories: three stories (two passives and one active) for each of the five verbs in the list. Children who were tested in a single session, and so did not receive a training session, were presented with List A verbs; children who did receive a training session were presented with List B verbs. The materials for the training session were drawn from the active control items from List A since these children would always be presented with List B verbs during the experimental session.

4.4   Results and discussion

The performance of child participants who received a training session did not statistically differ from those who did not receive a training session ($t(11.24) = -0.01, p = 0.9$, independent-samples t-test) and thus the data will be collapsed across the two groups for further analysis. Figures 1 and 2 show the percentage of correct responses by adults and four-year-old children, respectively.[11] Table 9 shows the results of participants' comprehension as compared to chance performance (single-sample *t*-tests) for each verb profile for the adults and the four-year-olds.

Figure 1:   Percentage of correct responses by verb profile for adult controls. (Error bars indicate standard error.)
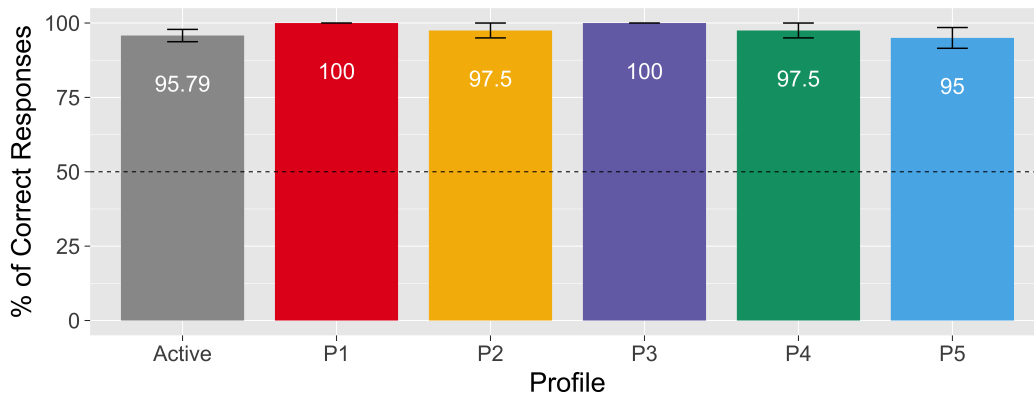
For the adult participants, all 10 subjects performed effectively at ceiling and were significantly above chance across all five lexical profiles. We take this as evidence that our test materials elicited the correct answers from adults. Moreover, we interpret this to mean that our baseline for adult-like

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[11]For discussion on the potential differences in children's performance between the two verbs in each profile, see Appendix B.

Figure 2: Percentage of correct responses by verb profile for four-year-olds. (Error bars indicate standard error.)
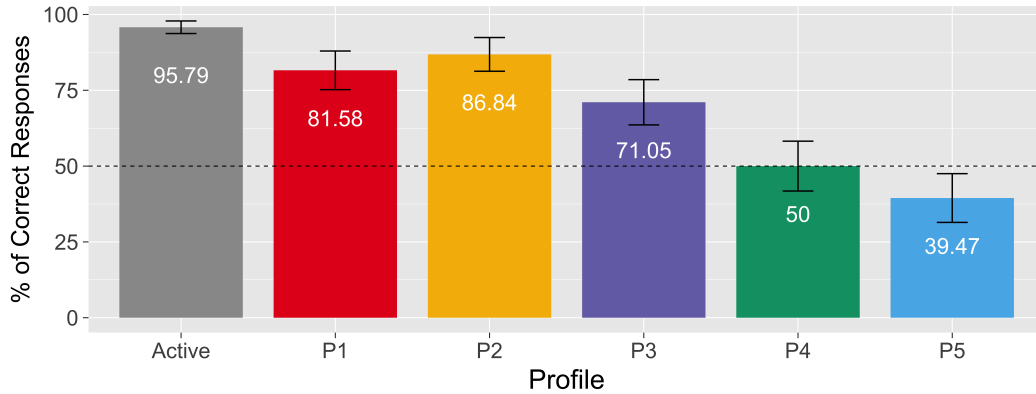

Table 9: Accuracy rates for adults and four-year-olds by verb profile, compared to chance (50%).

	adults					four-year-olds			
Profile	**Percentage Correct**	*t*	*df*	*p*	**Profile**	**Percentage Correct**	*t*	*df*	*p*
1	100.00%	inf	9	<.001	1	81.58%	4.610	18	<.001
2	97.50%	19	9	<.001	2	86.84%	7.098	18	<.001
3	100.00%	inf	9	<.001	3	71.05%	3.023	18	0.003
4	97.50%	19	9	<.001	4	50.00%	0.000	18	0.500
5	95.00%	13.5	9	<.001	5	39.47%	-1.287	18	0.107

knowledge is successful and, importantly, that there is equally good performance across all lexical profiles. So, our materials can be used to determine if a participant comprehends the verbal passive of verbs from all five profiles.

Turning to the four-year-olds, children were effectively at ceiling for the active control items, with 15 out of 19 children answering 100% of the items correctly (and the remaining 4 children answering 80% correctly); we interpret this to mean that children were paying attention to the experiment and knew the target verbs well enough to comprehend them in the active form.[12] For the passive items, four-year-olds performed significantly above chance for Profiles 1, 2, and 3, but were no different from chance for Profiles 4 and 5 (Table 9).

We conducted three additional analyses, based on our meta-analysis. First, our meta-analysis found that Profile 1 had an AoA of three years old while Profile 5 had an AoA of five years old; so, we conducted a planned comparison between Profiles 1 and 5 on our sample of four-year-olds. The

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[12]An anonymous reviewer notes that it is possible that some of the included children who answered only four out of the five active controls correctly (4 of the 19) were guessing on the control items. This is because, at an individual level, 80% correct cannot be statistically distinguished from chance performance at the p<0.05 level (using a binomial distribution). But, because this would only account for four children in our sample, we are reasonably confident that the results we find are valid.

lexical semantic profile hypothesis would predict that four-year-olds should perform differently on verbs from these two profiles. We found that this was indeed true: four-year-olds performed better on Profile 1 than Profile 5 (W= 107, P= 0.0013, Wilcoxon Signed-Rank Test). We interpret this to mean that four-year-olds' performance does differ between these two profiles: in particular, four-year-olds were more successful on Profile 1 verbs than Profile 5 verbs. Furthermore, children's unsuccessful performance on Profile 5 suggests that Profile 5 verbs have an AoA later than four years of age in English.

Second, we were interested in how children would perform on Profile 2 verbs when the material controlled for accidental eventive readings of the verbs *surprise* and *frighten*. In particular, was the AoA for Profile 2 verbs four years old in English? We compared the four-year-olds' performance on Profile 2 to Profile 1 and Profile 5. We found that children performed no differently on Profile 2 than on Profile 1 (W= -7, P= Not Significant, Wilcoxon Signed-Rank Test); moreover, four-year-olds were significantly better on Profile 2 than on Profile 5 (W= 91, P= 0.0008, Wilcoxon Signed-Rank Test). We take this to mean that four-year-olds were equally successful with passives of Profile 1 and Profile 2 verbs and that the AoA for Profile 2 is, at the latest, four years old in English.[13]

Third, it was unclear from our meta-analysis if four-year-olds had a comprehension pattern similar to either three- or five-year-olds, or instead had their own separate comprehension pattern. Recall from Table 6 that three-year-olds have been observed to comprehend Profiles 1 and 2, while five-year-olds have been observed to comprehend Profiles 1, 2, 3, 4, and 5. To assess whether four-year-old children exhibit a pattern different from that of both three-year-olds and five-year-olds, we compared the three profiles on which these four-year-olds performed significantly above chance (Profiles 1-3) to the two profiles on which they did not (Profiles 4-5). We found that four-year-olds' performance was asymmetric: they were reliably better on verbs from Profiles 1-3 than on verbs from Profiles 4-5 (W= 161, P= 0.0005, Wilcoxon Signed-Rank Test). This suggests that four-year-old children are exhibiting a pattern that is distinct from the patterns observed previously for three- and five-year-olds. In particular, four-year-olds comprehend Profiles 1, 2, and 3, while three-year-olds haven't been observed to comprehend Profile 3 and five-year-olds have been observed to additionally comprehend Profiles 4 and 5.

Taken together, our results support the lexical semantic profile hypothesis for English: four-year-old children can successfully understand the verbal passive for verbs in "earlier" profiles (Profiles 1, 2, and 3) but not the verbs in "later" profiles (Profile 4 and 5). In addition, four-year-olds seem to pattern differently than both the three- and five-year-olds in the meta-analysis, comprehending one more profile (Profile 3) than the three-year-olds, and two fewer than the five-year-olds (Profiles 4 and 5). One possible explanation for why the four-year-olds were not successful on Profile 4 verbs, as suggested by our meta-analysis, could be that performance was driven by the

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[13]An anonymous reviewer pointed out that some of the Profile 2 verbs such as *surprise* and *frighten* have been argued by Hirsch and Hartman (2006) to fall under Belletti and Rizzi's (1988) "Preoccupare" class of psych verbs. If this is the case, then it is the active sentences of these verbs, rather than the passive, that should be difficult for young children to comprehend. Because children were effectively at ceiling for all active control items, including active sentences with *surprise* and *frighten*, we suspect that any predicted difficulty of verbs that fall under this "Preoccupare" class would appear in children younger than the ones we tested (cf. Borga and Snyder (2018) for evidence of French-speaking children's difficulty with active Object-Experiencers sentences until four years of age).

five-year-olds in those studies. Another possibility (discussed more in footnote 10) is that the lack of plausible dissent artificially depressed four-year-old performance on Profile 4 verbs (see also Appendix B for discussion of other factors that could have negatively impacted performance on Profile 4 verbs); this would make four-year-old performance appear at chance when it in fact would not be in a more felicitous setup. We note that if four-year-olds do in fact comprehend Profile 4 verbs correctly in the passive, our qualitative results do not change. The four-year-olds would still pattern differently from the three- and five-year-olds, and the lexical semantic hypothesis is still supported as children of different ages seem to be able to comprehend progressively more lexical semantic profiles in the passive. More generally, the distinction found in the lexical asymmetry patterns across the three different age groups supports our hypothesis that English-speaking children's performance on verbal passive is linked to the lexical semantic profile of the verbs.

Our results further suggest that four-year-old English children have structural knowledge of the passive and are not strictly relying on linear word order. More specifically, if they were relying on linear word order, they would interpret passive sentences as active sentences (i.e., interpreting *Jake was loved by Isabelle* as "Jake loved Isabelle"). In our TVJ task, they would then perform significantly below chance (e.g., giving the opposite response every time). Instead, four-year-olds performed above chance for verbs from Profiles 1-3, and no different from chance for verbs from Profiles 4 and 5. So, our results support four-year-olds having structural knowledge of the passive form.

With respect to prior studies, our results align with Messenger et al. (2012), who found comparable performance between AGT-PAT verbs (Profiles 1 & 3) and OBJ-EXP verbs (Profile 2) in three- and four-year-old children. Our results also align with those of Maratsos et al. (1985), who found that four-year-olds fail to comprehend non-ACTIONAL verbs like *love* and *remember*, both of which are Profile 5 verbs. We too found that four-year-olds did not understand the verbal passive of *love*. However, we did find success with non-ACTIONAL verbs from Profile 2: *surprise* and *frighten*. Taken together, the lexical semantic profile hypothesis can replace prior explanations meant to account for the results of Messenger et al. (2012) and Maratsos et al. (1985).

5   General Discussion

We have provided a synthesis of prior experimental work on the development of the verbal passive in English. This meta-analysis revealed a correlation between the lexical semantic profile of a verb and its age of acquisition for the verbal passive; from this, we posited a lexical semantic profile hypothesis, where the lexical semantic features of a verb collectively predict its age of acquisition in English, and more generally the relative order of its acquisition compared to other verbs. A Truth-Value Judgment task with four-year-olds supported this hypothesis, with the four-year-olds successfully understanding the verbal passive of verbs with profiles predicted to have an earlier age of acquisition in English. Our experimental results also increased the empirical coverage of the meta-analysis to include more data about how four-year-olds understand the verbal passive. Future work can further expand the empirical foundation by additionally testing three- and five-year-old children on the same materials as for the four-year-olds we tested. Future work can also specifically evaluate the predictions of the lexical semantic profile hypothesis by testing children

on more verbs for each profile.

We again note (as in footnote 1) that we focused our investigation on the long verbal *be*-passive in English, given the uncertainty about whether the underlying syntactic structure was the same for short passives and long verbal *be*-passives. If the syntactic structures do in fact differ (as suggested by Borer and Wexler (1987)), then the lexical semantic profile hypothesis developed here for long verbal *be*-passives does not make predictions about children's development. In contrast, if this syntactic structure is in fact the same (as suggested by theoretical work (Chomsky, 1957; Fox & Grodzinsky, 1998; Collins, 2005) and acquisition work (Horgan, 1978; Gordon & Chafetz, 1990; Hirsch & Wexler, 2006b, 2006a; O'Brien et al., 2006; Messenger, Branigan, & McLean, 2011)), we would predict the same developmental trajectory with both forms of the verbal passive.

More broadly, we have also provided a collection of empirical data on the verbal passive that must be accounted for when formalizing a theory of children's acquisition, particularly with respect to the lexical semantic distinctions that seem to matter. Current theoretical approaches – including the adjectival strategy (Borer & Wexler, 1987), the resultative hypothesis (Hirsch & Wexler, 2006b), the semantic coercion/smuggling hypothesis (Grillo, 2008; Snyder & Hyams, 2015) – often assume a binary distinction alone (e.g. whether a verb is +/-ACTIONAL). Because our data highlight the impact of several lexical semantic distinctions, proponents of these theoretical accounts can use our data to refine their theories.

We note also that while we focused on English, it is possible that the lexical semantic profile hypothesis applies cross-linguistically. That is, for languages that have reported a lexical asymmetry – children succeeding at passives for some verbs earlier than other verbs – the lexical semantic profile hypothesis would predict a developmental trajectory similar to what we have seen with English-speaking children. Specifically, certain lexical semantic profiles would be understood in the verbal passive earlier than other profiles. So, for instance, even for languages where children seem to comprehend passives quite early (e.g., Sesotho: Demuth, Moloi, & Machobane, 2010 – though see Crawford (2012)), the lexical semantic profile hypothesis predicts that children comprehend verbs from certain lexical semantic profiles earlier than verbs from other lexical semantic profiles. More generally, while the developmental trajectory of the verbal passive for English-speaking children corresponds to specific ages in English, the lexical semantic profile hypothesis is concerned with the relative ordering of the profiles with respect to acquisition, and so is not tied to any specific age when applied cross-linguistically. Additionally, we note that the predicted relative ordering of the profiles in a given language would be influenced by the lexical semantic profiles that are in fact passivizable in that language. For instance, if a language does not allow profiles 3, 4, and 5 to passivize, then the lexical semantic profile hypothesis would only predict the ordering of profiles 1 and 2 (in particular, that profile 1 should be understood in the verbal passive before profile 2). Future experimental work may be able to assess if there is in fact a lexical asymmetry even in those languages where children appear to comprehend the passive much earlier than in English and whether this lexical asymmetry follows the same developmental trajectory that we see with English-speaking children.

From a knowledge representation standpoint, we again note that the seven lexical semantic features included in the lexical semantic profiles investigated here were proposed as a description of the relevant verb properties. However, it is unclear if they are truly separate or if instead there

is overlap that would be better represented with a smaller number of features (e.g., ACTIONAL and AGT-PAT might be better represented by a single feature, because they had the same value for all five profiles we identified). Future theoretical work can investigate other lexical semantic feature representations that are also compatible with the empirical data collected so far.

6   Concluding remarks

Our findings underscore the role of lexical semantic features – and in fact, collections of these features into profiles – for children's observed age of acquisition of the long verbal *be*-passive in English. Using both a meta-analysis and a Truth Value Judgment Task, we identified the developmental trajectory of children's comprehension of this passive, linking it to lexical semantic profiles that apply to multiple verbs. More generally, our data provide a consolidated empirical foundation that must be accounted for when formalizing a theory of children's acquisition of the verbal passive, and highlight the importance of considering lexical semantics when investigating the development of syntactic knowledge.

Acknowledgements

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A   Materials used in the Truth-Value Judgment Task

BELIEVE - Active
Uncle is babysitting his nephew, Luke.
Luke runs into the living room and says to Uncle.
Luke: I saw a unicorn today. It was really big and shiny. Do you believe me?
Uncle: Of course I believe you. I saw one too! Do you believe me?
Luke: No! I was the only one that saw the unicorn.

BELIEVE - Passive
Auntie is babysitting her nephew, Wyatt.
Auntie: Wyatt, I ate all of my vegetables today. Do you believe me?
Wyatt: Of course, I believe you! You love vegetables. I also ate all of my vegetables today.
Auntie: But I didn't pack any vegetables in your lunch today! I don't believe you.

BELIEVE - Passive
Joel and Jane are best friends.
Jane: My parents are taking me to Disney World for my birthday. Do you believe me?
Joel: I definitely believe you. Your parents are so nice. My parents forgot about my birthday.
Jane: I don't believe you. I heard that your parents are throwing you a birthday party this year!

DISCOVER - Active
This is a story about a lion and Edward the explorer.
The lion is roaming the safari. Then, Edward the explorer arrives.
Edward: What's this? Look, I've discovered a lion in the safari.

DISCOVER - Passive
The thief is hiding behind a tree with his stolen diamond ring.
Thief: Ha! I'm safe behind this tree with my ring. No one will be able to discover me in this park. I'll take this time to sleep.
Maria is walking around the park.
Maria: Hmm... Is anyone here? Who's this? I've discovered the diamond thief!

DISCOVER - Passive
This is a story about Michael and a pirate. The pirate is hiding away on an island with her treasure chest.

Pirate: Arg! I'm safe on this island with my treasure. I do not see anyone so no one will discover me and my treasure!

Michael is sailing the ocean when he came upon an island.

Michael: Ah! A deserted island. Is anyone here? Oh look, I've discovered a pirate!

FIND - Active

The thief is hiding behind the tree with the diamond ring.

Thief: I will hide behind this tree. No one is around to find me. I'll sleep for a little bit.

Lincoln is walking around the park.

Lincoln: I wonder if there is anything behind this tree. Look, I found someone!

Thief: Aak! You found me!

FIND - Passive

This is a story about Jason and the farmer. The farmer is looking for his tools.

Farmer: hmmm, I wondering if my tools are behind this big doghouse! I can't see anything so no one will be able to find me behind here.

Jason was walking around the backyard.

Jason: hmmm.... That's a really big dog house. I'll just walk around it to get to the other side of the backyard. Oh look, it's the farmer! I found the farmer.

FIND - Passive

This is a story about June and Lincoln. June is looking for her diamond ring.

June: I wonder where this ring could be. I'll look behind this big bench here. It's hard for people to see me when I'm behind this bench. I'm sure no one will find me here while I'm looking for this ring!

Lincoln is enjoying a lovely day at the park.

Lincoln: What a great walk! I'll sit down on this bench and rest a bit. Oh, who's this? Looks like I found my friend, June!

FIX - Active

The Grey Robot and the Green Robot are working in the office today. The Grey Robot and the Green Robot accidentally bumped into the cabinets and some of their screws fell onto the floor.

Grey Robot : I only have a pen. Pens won't fix this problem.

Green Robot : That's okay, I have a very good screwdriver. I will fix you, Grey Robot!

FIX - Passive

The Round Robot and the Square Robot are hanging out in the laboratory one day.

Suddenly, both their arms fell off their body!

Round Robot: I only have a paintbrush. Paintbrushes can't fix Robots.

Square Robot: Don't worry, I have a wrench. I can fix your arm!

FIX - Passive

The Blue Robot and the Yellow Robot are together in the laboratory mixing chemicals. There was a big explosion. Looks there are wires everywhere.
Yellow Robot: I only have scissors. Scissors will not fix our wires.
Blue Robot: I have superglue! I will fix you!

FORGET - Active
Mommy and Audrey are at the mall. Audrey is staring at the toys when Mommy walks off.
Audrey: Mommy! Where are you going? Did you forget me?
Mommy: Oh gosh, it's true. I'm sorry. I forgot you in the store.

FORGET - Passive
Lucas and Mary are at the playground. Mary is playing by herself.
Lucas: Hey, I did not forget you! We were playing together last week!
Mary: No, I forgot who I was playing with last week.

FORGET - Passive
Chase and Chloe are at school. Chase is playing by himself.
Chloe: Hey, I did not forget you! I played at your house last week.
Chase: You did? I forgot who was at my house last week.

FRIGHTEN - Active
Cole and Aurora are going to a party. Pirates frighten Aurora but Cole loves pirates.
Cole: Your costume is awesome, Aurora. Look, I'm dressed as a pirates. Do I frighten you?
Aurora: Yes, you frighten me! Pirates don't look very nice.

FRIGHTEN - Passive
Andrew and Caroline are at a Halloween party. Mummies frighten Caroline but Andrew loves mummies.
Andrew: Look, Caroline, I'm dressed as a mummy. Do I frighten you?
Caroline: Yes, you frighten me! I can barely see you coming for me!

FRIGHTEN - Passive
Owen and Jackie are at a costume party. Ladybugs frighten Owen but Jackie loves ladybugs.
Jackie: Owen, I love your witch costume! Do you see my ladybug costume? Does it frighten you?
Owen: Yes, Jackie, you frighten me. You know that I don't like ladybugs!

LOVE - Active
The boy is playing around with his cat. The boy loves it when the cat plays with him.
Boy: oh my goodness, you are so cute, kitty. I love you! Do you love me?
Cat: *hisses* no, I do not love you!

LOVE - Passive

Uncle is babysitting his nephew, Alexander. Uncle and Alexander are talking in the living room.
Uncle: You are the cutest kid I know. I love you very much. Do you love your uncle, Alexander?
Alexander: No! I only love mommy and daddy.

LOVE - Passive
Jake and Isabelle are neighbors. They play with each other every day.
Isabelle: Jake, I don't love you because I'm jealous of your new clothes.
Jake: But I love you because you're my only friend, Isabelle!

SURPRISE - Active
Cole and Amelia are best friends. It's Amelia's birthday and Cole wants to do something for her.
Cole: Amelia, I want to surprise you! Happy birthday!
Amelia: Yay! I was not expecting this at all. I am so happy!

SURPRISE - Passive
Clara and Owen are at a baseball field. Owen bought something very special for Clara.
Owen: Look, Clara! I want to surprise you. New baseball mitts!
Clara: Thanks, Owen! You really surprised me! I have nothing to surprise you with today.

SURPRISE - Passive
Mommy and Caroline are shopping at the toy store. Mommy bought Caroline something very special.
Mommy: Caroline, I want to surprise you! Look, a new bike!
Caroline: Wow! So cool! But I can't surprise you, Mommy, you have everything!

SPOT - Active
The boy is playing around with his pet monkey. When the boy wasn't looking, the monkey climbed up one of the trees.
Boy: ah, I spot you hiding in the tree, Monkey! You silly monkey.

SPOT - Passive
Auntie is babysitting her niece, Audrey. Audrey goes behind the curtain.
Audrey: I'm hiding from Auntie behind this big curtain. I can't see anything but I bet Auntie will not spot me.
Auntie: Oh, there are little shoes poking out from the bottom of the curtain. I spot you, Audrey!

SPOT - Passive
Uncle is babysitting his niece, Chloe. Chloe goes behind the brooms.
Chloe: I'm hiding from Uncle behind these brooms. I can't see anything but I bet Uncle will not spot me.
Uncle: Oh, there are pigtails poking out from the brooms. I spot you, Chloe!

WASH - Active
Harvey is playing with his dog in the backyard.
Look how dirty they're getting!
Harvey: You're so dirty, dog. I need to wash you before we go back into the house.

WASH - Passive
Ava and Andrew are in the kitchen. Look! Ava is spilling juice everywhere.
Ava: Aww! There's juice on my dress. I have nothing to wash this off with!
Andrew: I have a wet towel. Let me wash you, Ava.

WASH - Passive
Benji and Anna are in the bathroom. Benji and Anna are dirty from playing outside.
Anna: I can't find anything to wash you with, Benji.
Benji: I found a sponge! I don't mind being dirty; I will wash you first, Anna.

B   Truth-Value Judgment Task Performance by Verb

Figure 3: Percentage of correct responses by verb for four-year-olds. (Error bars indicate standard error.)
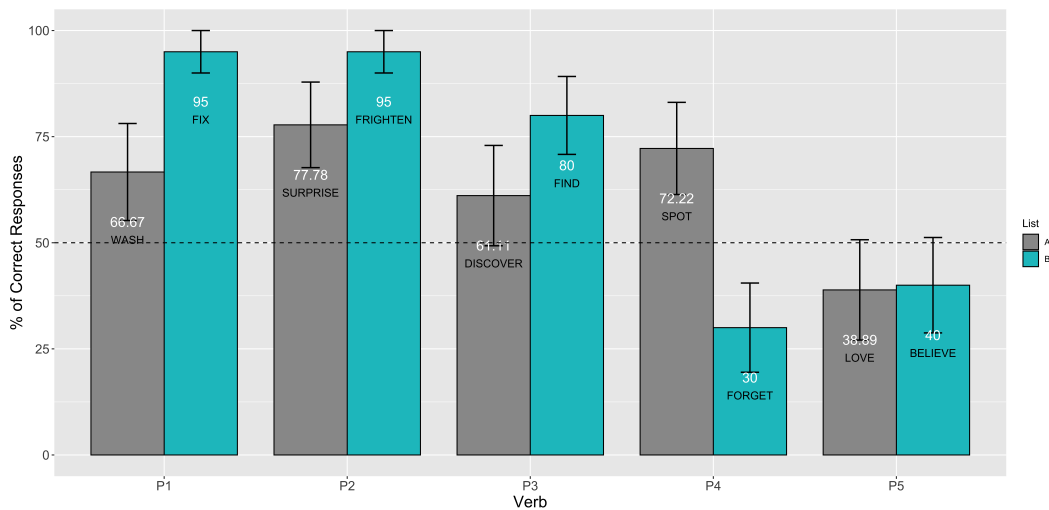
In general, for each profile, children perform similarly across List A and List B verbs. While there are some notable differences – particularly with Profile 1 (*fix* vs *wash*) and Profile 4 verbs (*forget* vs *spot*) – these differences may be driven by small sample sizes. In particular, this experiment was a between-subjects design with a sample size of 19 children (11 children for List A and 8 children for List B). So, lower performance for verbs like *wash* and *forget* may be driven by only having judgments from 11 and 8 children, respectively.

In addition, the much lower performance of *forget* (apart from the low sample size of 8 children) could also be due to the experimental test items for that verb – see Appendix A. In particular, the *forget* test items may have been pragmatically ill-formed. Consider this example test item for the passive use of *forget*:

> *Chase and Chloe are at school. Chase is playing by himself.*
> Chloe: Hey, I did not forget you! I played at your house last week.
> Chase: You did? I forgot who was at my house last week.

In this scenario, it could be that children think *remember* is more pragmatically appropriate as a lead-in than *forget* (i.e., Chloe would say, "Hey, I remember you! I played at your house last week."). However, to ensure the materials across all stories for all verbs were uniform, the target verb (here: *forget*) had to be used in the story leading up to the test sentence. We note that this potentially pragmatically-odd test item was not an issue for adult participants – adults performed near ceiling for *forget*.

More generally, future studies could more thoroughly investigate children's performance on the passive of Profile 4 verbs by (i) testing more children, (ii) creating better test items for *forget*, and (iii) testing more verbs that fall under Profile 4. Additionally, as noted in footnote 10, because test materials could not be constructed to include plausible dissent, we may expect overall comprehension rates to improve across all verbs if tested in a more felicitous setup.

More generally, we want to reiterate (as in the General Discussion) that if four-year-olds do in fact comprehend Profile 4 verbs correctly in the passive, our qualitative results do not change. The four-year-olds would still pattern differently from the three- and five-year-olds, and the lexical semantic hypothesis is still supported as children of different ages seem able to comprehend progressively more lexical semantic profiles in the passive as they get older.