1

Productivity and constraints in the acquisition of the passive*

STEVEN PINKER

Massachusetts Institute of Technology

DAVID S. LEBEAUX

University of Arizona

LOREN ANN FROST

Cornell University

Abstract

The acquisition of the passive in English poses a learnability problem. Most transitive verbs have passive forms (e.g., kick/was kicked by), tempting the child to form a productive rule of passivization deriving passive participles from active forms. However, some verbs cannot be passivized (e.g. cost/*was cost by). Given that children do not receive negative evidence telling them which strings are ungrammatical, what prevents them from overgeneralizing a productive passive rule to the exceptional verbs (or if they do incorrectly passivize such verbs, how do they recover)? One possible solution is that children are conservative: they only generate passives for those verbs that they have heard in passive sentences in the input. We show that this proposal is incorrect:

in children's spontaneous speech, they utter passive participles that they could not have heard in parental input, and in four experiments in which 3–8-year-olds were taught novel verbs in active sentences, they freely uttered passivized versions of them when describing new events. An alternative solution is that children at some point come to possess a semantic constraint distinguishing passivizable from nonpassivizable verbs. In two of the experiments, we show that children do not have an absolute constraint forbidding them to passivize nonactional verbs of perception or spatial relationships, although they passivize them somewhat more reluctantly than they do actional verbs. In two other experiments, we show that children's tendency to passivize depends on the mapping between thematic roles and grammatical functions specified by the verb: they selectively resist passivizing made-up verbs whose subjects are patients and whose objects are agents; and they are more likely to passivize spatial relation verbs with location subjects than with theme subjects. These trends are consistent with Jackendoff's "Thematic Hierarchy Condition" on the adult passive. However, we argue that the constraint on passive that adults obey, and that children approach, is somewhat different: passivizable verbs must have object arguments that are patients, either literally for action verbs, or in an extended abstract sense that individual languages can define for particular classes of nonactional verbs.

When children learn to speak, they generalize from a finite sample of adult speech to an infinitely large language. How they succeed is the most important problem in language acquisition research. It is a particularly difficult problem because children have no systematic access to *negative evidence*: information about which strings of words are not grammatical sentences in the language. Children are neither corrected nor miscomprehended more often when they speak ungrammatically (Brown & Hanlon, 1970; Hirsh-Pasek, Treiman, & Schneiderman, 1984), and anecdotal evidence suggests that they pay no attention when they are corrected (Braine, 1971; McNeill, 1966). The absence of negative evidence makes acquisition difficult for the following reason: if the child hypothesizes a rule system generating a language that is a superset of the target language, the input, strictly speaking, can never tell the child he or she is wrong (Gold, 1967; Osherson, Stob, & Weinstein, 1985; Pinker, 1979).

The no-negative-evidence problem arises in concrete terms in cases where the child is faced with inputs that tempt him or her to form some overinclusive generalization, such as a productive rule that has exceptions for some lexical items. In a seminal paper, C.L. Baker (1979) has outlined several intriguing examples where this learnability problem arises in the acquisition of certain

lexicosyntactic alternations in English that have traditionally been attributed to grammatical transformations (Chomsky, 1965). Baker pointed out that alternations like dativization (*John gave a painting to the museum / gave the museum a painting* and raising *It is likely that John will win / John is likely to win*) apply to many different verbs, apparently justifying a rule that could apply productively to any structure of the required form, regardless of the verb it contained; for example, a rule that converted a *V NP₁ to NP₂* phrase into a *V NP₂ NP₁* phrase. The problem is that these alternations do not extend to all predicates; sometimes they exclude a predicate that is a near-synonym of one that does alternate (cf., *John donated a painting to the museum / *donated the museum a painting; It is probable that John will win / *John is probable to win*). One must explain either how the child unlearns the overgeneralized forms created by the productive rule, or how the child avoids making the generalization in the first place.

In this paper we examine the passive construction, which involves most transitive verbs in English (e.g., 1) but not all of them (e.g., 2).

(1) a. John owns three bicycles.
         Many people misunderstand the argument.
         Dr. Caron weighed the patient.

     b. Three bicycles are owned by John.
         The argument is misunderstood by many people.
         The patient was weighed by Dr. Caron.

(2) a. John has three bicycles.
         The argument escapes many people.
         Tiny weighs 210 pounds.
         The coming decade will see many changes.
         This bottle contains a deadly poison.
         Tom resembles Gene.

     b. *Three bicycles are had by John.
         *Many people are escaped by the argument.
         *210 pounds are weighed by Tiny.
         *Many changes will be seen by the coming decade.
         *A deadly poison is contained by this bottle.
         *Gene is resembled by Tom.

Given these facts, one could imagine three types of learning strategies. The child could coin a general productive rule allowing him or her to create passive participles for transitive verbs, such as those in (1b) on the basis of having heard their active counterparts (1a) in the parental input. Let us call

this hypothesis *unconstrained productivity*. The problem for this type of hypothesis, Baker argues, is that it leaves us with the problem of explaining how the child avoids applying such a rule to exceptional verbs such as those in (2a), which would result in the production of ungrammatical (and, because of the no-negative-evidence problem, unexpungeable) forms such as those in (2b). Or, to put it another way, we would have to explain how the exceptions have managed to survive in the language.

The alternative that Baker proposed for the dative is that children are *conservative* learners: in the case of the passive, they would have to hear a verb passivized in the input before they add the passive participle form to their lexicons. In this account, children would be incapable of creating a rule that added nonwitnessed passive participles to their lexicons; they would just store lists of active and passive forms. They would not *overgeneralize* because they would not *generalize* to begin with: ungrammatical passives would never appear in parents' speech, and so the child would never learn those participles. Of course, active verb forms and their participles do not form unrelated lists, but on this account the relatedness of corresponding active and passive forms would be captured in a lexical redundancy rule (see Jackendoff, 1975). Such a rule might save space in memory by minimizing redundancy; it could hasten the learning of passive forms heard in the input; or it could dictate what a passive form must look like if one exists for a particular verb. But it would not sanction the addition of new passive participles to the lexicon unless the form was heard in the input. Fodor (1985) has also articulated and defended a version of this position.

A third possibility is that despite initial appearances, there are no productive rules with arbitrary lexical exceptions. Rather, productive rules apply to subtle but well-defined classes of verbs defined by phonological and semantic constraints. Possessing representations of these constraints, speakers productively apply passivization to verbs that obey the constraints while avoiding the verbs that disobey them. Mazurkewich and White (1984) argue that a version of this hypothesis, which we will call *constrained productivity*, can explain how the dative alternation is applied correctly in the absence of negative evidence. Verbs are dativizable only if they follow Anglo-Saxon phonological patterns (more precisely, they must constitute a metrical foot; Grimshaw, 1985), and if the indirect object is a prospective possessor of the direct object. The phonological constraint accounts for the contrast between *give* and *donate*; the semantic constraint accounts for the contrast between *She baked a cake for me / She baked me a cake* and *She stirred a cake for me / *She stirred me a cake*. If there is a constraint that divides the passivizable verbs from the nonpassivizable ones, a speaker who possessed that constraint could be productive but could still avoid or recover from overgenerali-

zations. Jackendoff (1972) has in fact proposed a constraint on passivizability, which we will discuss later in some detail.

Despite the many studies of children's comprehension of the passive (e.g., Bever, 1970; Maratsos, 1974; de Villiers & de Villiers, 1973), there is little evidence relevant to how children acquire the correct domain of application of passivization in English in the absence of negative evidence. The only relevant data come from two papers whose authors argue that children are not conservative passivizers. Each paper reports examples of children spontaneously using verbs in the passive that they were most unlikely to have ever heard passivized in parental speech. Wasow (1981) reported his daughter saying *I don't like being falled down on*, and Bowerman (1983) reported her daughters saying *Both are going to be go-ened in!*, referring to two toilets, and *If you don't put them in for a very long time they won't get staled*, referring to crackers in a bread box. In addition, passivization appears to be productive for adults (Wasow, 1981): given a novel transitive active verb (e.g., to *clothesline*, meaning to stop a charging athlete by extending an arm across his neck), adults can surely create their passive versions (e.g., *Kurt was clotheslined by Kevin*). Thus, Wasow points out, even if children are conservative, we would still need an explanation of how they become productive as adults.

These facts, of course, do not settle the conservatism issue: it is unknown how representative of children's language the three reports of children's productive passives are (Fodor, 1985), nor what their precise grammatical status is (e.g., whether they are simply phonetic confusions of legitimate passive forms; whether they are adjectival or verbal passives; see Wasow, 1977, 1980).

There have also been some suggestions as to what children's constraint on passivization might be if indeed they have a rule of passivization. Maratsos, Kuczaj, Fox, and Chalkley (1979) found that 4–5-year-old children were able to understand both the active and passive versions of verbs denoting actions (e.g., *kick, tickle*), but only the active versions of verbs denoting perceptual or cognitive relations (e.g., *see, hear, know, want*). This phenomenon has been replicated by de Villiers, Phinney, and Avery (1982), by Maratsos, Fox, Becker, and Chalkley (1985), and by Gordon and Chafetz (1986). In their first report, Maratsos et al. (1979) suggested that children's passive rule was semantic, not syntactic; it applied not to grammatical subjects and objects, but to arguments bearing the semantic roles *agent* and *patient*. A variant of this account is that children's rule of passivization does apply to subjects and objects, but only to subjects and objects that are agents and patients respectively (Pinker, 1982). This is not the correct constraint for adult English (cf., *A parcel was received by John; Tabs were kept on subversives; John was thought to be arrogant by his colleagues*), but it might be a first approximation,

because it *is* true that all agent-patient verbs passivize but not vice versa.

However, the relevance of these studies to the current question is unclear. Maratsos et al. tested comprehension of existing English verbs whose degree of exposure to children in parental speech was uncontrolled. Passives of all sorts are rare in parental speech (Brown, 1973; Hochberg & Pinker, in preparation; Stromswold, Pinker, & Kaplan, 1985), and passivized perception verbs involving an experiencer as subject and a stimulus as object are even rarer (Maratsos et al., 1985). Thus children's performance in these experiments may simply have reflected conservative learning of the combinations of verb and voice exemplified in parental input. Some evidence that this may be so comes from Gordon and Chafetz (1986), who found a high correlation between the individual verbs that children had difficulty with in a test of comprehension of passive sentences, and the verbs that they had trouble with in a retest one week later.

In any case, successful comprehension is at best an imperfect index of whether a sentence is within a speaker's language: adults, for example, can fail to comprehend legitimate passives (e.g., *The horse raced past the barn fell*) and can easily comprehend passive strings that are clearly outside their language (e.g., **Shampoo is contained by the bottle*).

In the experiments reported in this paper, we test these three hypotheses (conservatism, unconstrained productivity, and constrained productivity) using two different methods. Both methods are addressed to the existence and domain of *productive* passivization in children, not just the ability to master phrases heard in the input, and neither of them relies on comprehension abilities. First, we examine transcripts and reports of spontaneous speech to see if children regularly produce passives that they could not have heard in the input. Second, we expose children to novel verbs in either the active or passive voice, and test the children's ability to produce each verb in the voice in which they heard the verb and, more importantly, in the voice in which the verb had never been heard. Third, in the experiments we vary the semantics of the verb and thus ascertain whether children's tendency to passivize, if it exists, is sensitive to the kinds of constraints that delineate the domain of passivizability in adults.

Study 1

In this study, we examine the prevalence of productive passives in children's spontaneous speech. First, we examine transcripts of the spontaneous speech of four children. Second, we examine published reports of two major types of verb innovation in young children, causativization (Bowerman, 1982a) and

denominal verb formation (Clark, 1982), to see if innovative verbs were ever used in the passive.

Method

Subjects and materials

The primary subjects were four children whose speech transcripts have been converted to computer text files as part of the Child Language Data Exchange System (MacWhinney & Snow, 1985). Three of the children, Adam, Eve, and Sarah, were observed by Brown (1973) and his students. Adam's speech was recorded in 55 2-hour samples taken every 2–4 weeks between the ages of 2;3 and 4;11. Eve's speech was recorded in 20 2-hour samples taken every 2–3 weeks between the ages of and 1;6 and 2;3. Sarah's speech was recorded in 139 1-hour samples taken at intervals ranging from 2–19 days between the ages of and 2;3 and 5;1. The transcripts include limited descriptions of the contexts of the utterances, usually when disambiguation was necessary. The fourth child, Allison, was studied by Bloom (1973). Six 40-minute speech transcripts, recorded at ages of 1;5, 1;7, 1;9, 1;10, 2;4 and 2;10, were examined.

Procedure

The transcripts were read onto a PDP-11/44 computer running the Berkeley UNIX 2.9 operating system. The UNIX utility *grep* was used to extract all lines from the transcripts containing words ending in *ed, en, wn,* and *rn,* and all lines containing the word *by.* The outputted lines included information about which transcript the lines came from and where in the transcript they appeared; this information allowed us to go back to the full transcripts to eliminate all lines that did not contain passivized words (e.g., simple past tenses, words like *bed* and *brown*), and to check the preceding and following contexts. All passives, including ones that could have been adjectival passives, were recorded, and those that were unambiguously productive because their participles were ill-formed in adult English were noted separately.

Examples of innovative verbs were examined in two published articles. Clark (1982), in her examination of denominal verb formation, cites 39 examples of non-intransitive innovative verb forms from the speech of children learning English, 16 examples from children learning French, and 26 examples from children learning German. Bowerman (1982a) cites 146 examples of innovative causative transitive verbs. Additional examples were taken from Bowerman (1983), Wasow (1981), and Roeper (personal communication).

Results

For two of the children, Eve and Allison, the transcripts do not extend to late enough ages for large numbers of passives of any sort to have been recorded. Eve produced only 10 sentences that might have contained passives, none of them productive, and Allison produced two passives, one of them productive. Adam, however, produced 72 utterances that might have contained passives and Sarah produced 32, both starting at age 3;1. For the purpose of estimating the *total* number of passives produced, productive and nonproductive, we defined "passives" in a liberal way, including likely adjectives (e.g., *named, crowded, mixed up*, possible simple past tense forms (e.g., *It's stopped in the sky*), and some of the irregular passives we came across that were not detected by the computer search (e.g., *hurt, left*). Immediate identical repetitions were counted only once. For the purpose of cataloguing *productive* passives, only unambiguous verbal or adjectival passives were included. The productive passives obtained from these children and from the published sources of innovative verbs are listed in Tables 1–3, each table containing a different type of productive error. Parenthesized comments are in the original sources; the bracketed comments are ours.

The first type of error, listed in Table 1, consists of sentences whose verbs have grammatical passive participles in adult English, but in which the child produced a participle with the incorrect morphological form. This is analogous to the errors such as *comed* and *foots* that are often cited as evidence of productivity in the acquisition of past tense and pluralization rules (e.g., Cazden, 1968). The examples in Table 1 indicate that a similar phenomenon occurs in the acquisition of passive participles. It could be argued that in these examples the children conservatively learned an abstract passive lexical entry for each verb upon hearing it in the input, and that their productivity consisted only in overgeneralizing the morphological rule that spells out the surface form of the participle. This could happen if there was a selective pattern of decay within the children's lexicons, such that the participle entry survived but its surface form decayed, requiring that the morphological rule be applied on-line. It seems unlikely to us, however, that this exact conjunction of decay and retention would have occurred in every one of the cited cases. Note that an analogous possibility exists for the classic cases of overgeneralization of plural and past tense forms—in each case the child might hear, for example, *broke* in the input, create a lexical entry for it indicating that it is the past tense form of *break*, forget the phonological representation [brok] while retaining the rest of the entry, and apply a productive rule filling in the phonological form. To our knowledge, no one has raised this as the explanation for all of children's past tense overgeneralizations, since it is far

Table 1.   *Productive passives in spontaneous speech: Incorrect participle forms*

Adam 3;3	It's broked? (i.e. is it broken?)
Adam 3;3	When I get hurts, I put dose one of dose bandage on.
Adam 3;7	I don't want the bird to get eated.
Adam 3;7	He all tieded up, Mommy.
Adam 3;8	It's all tied up. (pronounced "ty-ed")
Adam 3;8	Mommy, what dat snake all winded up like dat?
Adam 3;8	I want to be shooted.
Adam 3;10	How could it go up if its not ... if it's not flyed?
Adam 4;2	[playing with a toy telephone] Oh, look its ropted through here. (Past participle of "rope")
Adam 4;2	Is dat where I was borned?
Adam 4;5	Oh, oh, it's sticked to the floor.
Adam 4;7	It's just sticked together.
Adam 4;7	I think it's not fulled up to de top.
Sarah 3;3	(Sarah throws little monkey to the floor) Ooo, he hahted. (... hurted)
Sarah 4;2	We got all stucked on each other.
Sarah 5;1	His mouth is splitted. [said twice]
Allison	I think I'll gave him this one why these are all bite-ed.
(Wasow, 1981)	I don't like being falled down on!
(Bowerman, 1982a) Mindy 6;4	I couldn't get the balanced keeped. (= I couldn't keep my balance. Telling of difficulties in bike riding)
(Bowerman, 1983) EB 3;8	(Watching one child sit on a potty, another on a toilet) Both are going to be go-ened in!

more plausible that *at least* occasionally, and perhaps always, the entire past tense form was generated in these cases. We argue that similar considerations should apply in the interpretation of the errors in Table 1.

The second and most relevant type of error, examples of which are listed in Table 2, consists of regular or irregular passivizations of words that do not exist as transitive verbs in English, most of them passives of causative or denominal verbs created by the children. Once again, there is no source in the input for learning the passives directly.

The remaining examples are listed in Table 3. Some are from verb-particle combinations that do not allow their prepositions to be stranded by processes such as passivization (see Bresnan, 1982). Some are from verbs that do not easily accept certain particles (e.g., *to smoke up*). Since particles do not combine with verbs in ways that are completely productive and semantically predictable, it has been argued that verb-particle combinations are stored as individual lexical entries (Bresnan, 1972, 1982). Thus if the child produces passivized versions of them that sound ungrammatical to adult ears, Baker's problem arises and so we classify them as productive even if the verb without

Table 2.   *Productive passives in spontaneous speech: Nonexistent transitive verbs*

Adam 4;11	I'm gonna ask Mommy if she has any more grain ... more stuff that she needs grained.*
Sarah 3;8	He get died.
(Clark, 1982) LA 2;0	C'est déconstruit, c'est bulldozé. (It's unbuilt, it's bulldoze-red.)
(Clark, 1982) RN, 2;10	Da wird er glatt und dann wird er ausgeplätzelt (Then it's getting smooth and then it's caked/made into cakes.)
(Clark, 1982) S, 3;2	Is it all needled?
(Clark, 1982) EB, 3;4	It was bandaided.**
(Clark, 1982) HS, 3;6	Der Löffel ist besuppt. (The spoon is souped.)
(Clark, 1982) FS, 3;9	... vollgeascht ... (well-ashed; talking about something covered in ashes)
(Clark, 1982) EG, 3;10	Elles ne sont pas encore grainées. (They (plants) haven't made seeds yet/are not seeded yet.)
(Clark, 1982) CB, 4;2	But I need it watered and soaped. (talking about a rag for washing a car)**
(Clark, 1982) CB, 4;4	How was it shoelaced?**
(Clark, 1982) HS, 4;7	... zugebändst ... (ribboned; talking about having ribbons on that needed tying.)
(Clark, 1982) CB, 5:6	I don't want to be dogeared today. (asking for her hair not to be arranged in "dogears")**
(Clark, 1982) DL, 5;6	Hier ist Gold angestreift. (This is gold-striped.)
(Clark, 1982) EG, 6;8	... pain enoeuffé ... (egged bread; talking about bread with egg on it)
(Clark, 1982) CG, 7;0	... pain enconfiture ... (jammed bread; talking about bread with jam on it)
(Clark, 1982) CG, 7;4	Mon assiette est entartée (My plate is covered with tart.)
(Clark, 1982) MA, 9;3	... une procession eautée ... (A watered procession; describing a procession on the water.)
(Bowerman, 1983) CB, 3;6	If you don't put them in for a very long time they won't get staled.**
(Bowerman, 1982a) CB, 3;6	Until I'm four I don't have to be gone. (= be taken to the dentist.)**
(Bowerman, 1982a) CB, 4;3	Why is the laundry place stayed open all night? (= kept.)**
(Bowerman, 1982a) CB, 5;1	I need to round this circle very much. I need to have this rounded very much. (As rotates knife tip in lump of clay to make a cut-out circle)**
(Bowerman, 1982a) H, 4+	He's gonna die you, David. (Turns to mother) The tiger will come and eat David and then he will be died and I won't have a brother any more.
(Tom Roeper, pers. comm.)	I don't want to get waded.
(Tom Roeper, pers. comm.)	I don't want to get waved over.

*This example is somewhat ambiguous. It could be an incorrect participle of *grind*; indeed, one of the adults conversing with Adam had said *Yes, or else you could ask your mother if there is anything else she wants ground* seven utterances prior to the quoted example. Alternatively, *grained* could be the correct participle of the novel denominal causative verb *to grain*, analogous to the examples from Bowerman and Clark. Since Adam has been referring to the cracker crumbs he has been making as *grain* several times in the conversation, referred to the *grain thing* and the *grain thrower*, and said *it's gonna get grainer*, we have classified it as a passivized denominal.
**The children referred to as 'EB' and 'CB' by Clark are the same children as those referred to by Bowerman.

Table 3.   *Productive passives in spontaneous speech: Other errors*

Nonstrandable preposition

(Wasow, 1981) 4+   I don't like being falled down on!*
(Bowerman, 1983) EB, 3;8   (Watching one child sit on a potty, another on a toilet)
               Both are going to ge go-ened in!*
(Bowerman, personal communication) CB, 3;3 (After putting small items into both a jewelry
               box and a coin purse)
               Both of these things can be put things in.

Unusual particle
Adam 4;0   Now it's all painted up.
Adam 4;4   [Adam is drawing] All colored up.
Adam 4;11   [Adam is crushing crackers in a meat grinder]
            All smoked up.

Incorrect preposition, or obligatory preposition omitted
Adam 4;2   [playing with a toy telephone]
            Oh, look its ropted through here. (Past participle of "rope")*
Adam 4;2   [Another child has put a bowl on Adam's mother's head]
            You look like a crashed lady. (Mother: A crashed lady?)
            Yeah, like a crashed lady.
Sarah 4;2   We got all stucked on each other.*
Sarah 4;7   She's scribbled.
Sarah 4;7   I'm making her picture scribbled.

Improper argument assignment
Sarah 3;5   It was get burned on my thore fingeh. (... finger)

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*These examples are also listed in Table 1.

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its particle has a passive participle which could have been heard in the input. In other cases, the children produced passives whose arguments lack obligatory prepositions or where an incorrect preposition is supplied. For example, the object of *to rope* is something bound by rope, not a rope itself, and the verb does not subcategorize for a path-complement. The site of a crash has been *crashed into*, not *crashed*. *Stick* takes a *to*-object, not an *on*-object, and so on. Like verb-particle combinations, different versions of a verb that take different combinations of oblique objects are probably stored in separate lexical subcategorizations (Bresnan, 1972, 1982), and so these should count as productive passives even if alternative subcategorizations of the same verbs are passivizable. Finally, in one example the child used a pleonastic subject rather than one derived from the underlying object, and assigned the underlying object the role of oblique object.

Discussion

We have uncovered numerous examples of passive sentences produced by children whose verbs differed morphologically or in surface argument structure from correct adult forms or whose verbs do not exist at all in English. Therefore we conclude that the children could not have heard these forms in their parents' speech, and that they are not conservative learners of passive forms.

It is important to stress that productive passivization is not a rare phenomenon. Both of the children from whom we had transcripts at ages following the onset of passivization uttered many productive passives: Of Adam's 72 passives, 18, or 25%, reflected lexical entries that could not have been learned on the basis of the verb's distribution in adult speech, and of Sarah's 32 passives, 7, or 22%, were of this sort. Even Allison's two passives included one that was productive. Note in addition that these estimated proportions are probably conservative. First, the criteria for counting an utterance as a well-formed *non*productive passive were extremely inclusive, encompassing forms that were almost surely pure adjectives, such as *crowded* and *mixed up*. More important, we only counted an utterance as productive if it was ungrammatical in adult English, to be sure that the child could not have actually heard the form. However, any of the children's passive forms could have been productive, including the well-formed ones; it is only to meet the burden of proof that the forms *were* created productively that grammatical passives had to be excluded. Further evidence that productive passivization is not a freak occurrence comes from the prevalence of passives in the published studies of innovative verb formation, neither of which sought examples of passives *per se*. It seems reasonable to predict that productive passivization is a sufficiently robust phenomenon that it will turn up in any reasonably sized sample of children's passives in general or productive verb usages in general.

There are, to be sure, limitations on the conclusions that can be drawn from analyses of spontaneous speech. Since each datum is an event that is unique in terms of the preceding linguistic experience of the child, the linguistic properties of the verb in question, and the physical and discourse context, it is impossible to perform the kinds of analysis that are needed to establish unequivocally that each example is a productive verbal passive participle. For example, some of the examples could have been adjectival passives—though adjectival passives themselves are thought to be derived from verbal passives (see Bresnan, 1978; Levin & Rapaport, 1985; Wasow, 1977, 1980), and in any case raise the same learnability problems as we have been discussing for verbal passives. But there are enough examples of enough different types

that it is highly unlikely that all of them were either heard in the input or not genuine passives.

Experiment 1

The remaining four studies reported in this paper attempt to gather more systematic evidence on the existence and nature of productive passivization in children, by exposing children to novel words with specific semantic and grammatical properties in restricted sentence types. In the first of these experiments, we teach children four novel verbs, two of them presented exclusively in active sentences and two presented exclusively in passive sentences. One of the active sentences contains an action verb, the other a verb denoting a perceptual relation; likewise for the passive sentences. We test children's comprehension, by asking them to act out both active and passive sentences, and production, by asking them to describe events in discourse contexts favoring active or passive sentences. That is, for each verb we test performance both in the taught and non-taught voice.

In testing the hypotheses of conservatism, unconstrained productivity, and constrained productivity described in the Introduction, we will focus on the production data. The comprehension task, which requires a binary response, is less demanding of the child, because in most cases attention to the position of a single noun phrase, to the auxiliary, to the morphology of the verb, and especially the presence of *by* could be sufficient to ensure above-chance performance, regardless of properties of the verb (Stromswold et al., 1985). Furthermore, as mentioned in the Introduction, adults, and presumably children, can comprehend passive constructions that their grammars would deem ill-formed. Since the hypotheses under consideration make predictions about children's grammars, the production task, which gives the child ample means to avoid forms that he or she would find ungrammatical (e.g., by using active sentences), is the more appropriate measure.

The theories sketched in the Introduction make competing predictions about the outcome of the experiment. If children are conservative, they should produce and comprehend the verbs only in the voice in which we teach the verbs. If children have a productive passive rule that applies to all transitive verbs, they should be capable of producing and comprehending all the verbs in both active and passive versions regardless of the voice in which the verb was presented. If children have a productive passive rule that applies only to transitive verbs that denote actions or that have agent and patient arguments, they should produce and comprehend both the taught and non-taught versions of the action verbs, but only the taught versions of the perception verbs.

Method

Subjects

Sixteen 4-year old children participated, all from day care centers affiliated with Harvard University.

Materials

Four verb types were created, each pertaining to an activity for which there is no exact English equivalent. The two action verbs meant "to rub the back of the neck of" and "to jump on top of and then over", respectively. The two perception verbs meant "to see through a binoculars-like instrument" and "to hear through an ear-trumpet-like instrument". Actual verbs were created by combining each of the four meanings with one of the phonetic forms *gump, doak, pell,* and *kale,* in such a way that meanings and forms were counter-balanced across children. The toys used in the testing phase were a dog, a cat, an elephant, and a bear.

Procedure

The children were tested individually in a quiet area in their day care centers. The session was divided into four sections, one for each verb, and each section was divided into a teaching and a testing phase. Each child was taught one active action verb, one active perception verb, one passive action verb, and one passive perception verb. The orders of teaching for different children were constructed by combining four orders of the voice in which the verb would be presented and four orders of verb semantics (i.e., action vs. perception), yielding 16 unique orders in which each combination of voice and verb semantics appeared equally often in all serial positions across the experiment. Each of the phonetic forms, and each verb meaning, also appeared equally often in each serial position, though that was not true of each combination of these factors.

In the teaching phase the experimenter first showed the child the toys to be used in the procedures, told the child the English name of the toys used, and allowed the child to handle the toys. The child was asked to repeat the phonetic form of the verb. Then the experimenter said "This is what [e.g.] 'kale' means" and made the toy animals play out the corresponding act on a small stage while he narrated the action using the novel verb. The narration involved a single sentence form, either active (e.g., "The dog is pelling the

elephant"), or passive (e.g., "The elephant is being pelled by the dog"). Three sentences were given using different pairs of toys; some toys played the role of agent or perceiver in one sentence and patient or stimulus in another. The toys for each teaching instance for a particular child were chosen randomly. For the perceptual verbs, the scenario was acted out by bringing the binoculars-like object up to the eye of the perceiver or the ear-trumpet-like object up to its ear; this was done so that the child would not mistakenly think that the verbs were actional (e.g., to orient oneself in the direction of).

In the testing phase, the production task always preceded the comprehension task because the comprehension task necessarily involved presenting the child with the verb in both voices. Putting the comprehension task first would have vitiated the possibility of testing for productivity in the production test.

The production test was designed to put the child in a discourse context in which the passive was the most felicitous way of describing an event, but not the only way. Turner and Rommetveit (1967) showed that children were sensitive to the following discourse property of the passive: when the object argument of a transitive verb is the discourse topic or prior focus of attention, there is a bias to use the passive voice in describing an event so as to make the topic the subject. Thus the production test went as follows: the child was told "Here's the [e.g.] elephant. Nothing's happening to the elephant. Now something's going to happen to the elephant. I want you to tell me what's happening". At that point, the experimenter would make the toys display the meaning of the newly-taught verb, with the focused toy (in this example, the elephant) playing the role of the patient or the perceived stimulus. If the child said nothing, he or she was prompted with the question "what is happening to the elephant?" Active sentences were elicited in a similar way: the experimenter said to the child "Here's the [e.g.] kitty. The kitty is doing something to the elephant. What is happening?" The experimenter then displayed the toys acting out the meaning of the newly-taught verb using the focused toy as the agent or experiencer. If the child did not respond, he or she was prompted with the question "What is the kitty doing?" or "What is the kitty doing with the elephant"? Actives and passives were each elicited with two animal pairs, thus providing two data points per child per condition. Whether active or passive sentences were elicited first was varied in such a way that (a) for each child, neither voice taught nor semantic type was confounded with testing order, and (b) across children, neither voice taught, semantic type, nor combinations of these two factors were confounded with testing order. The pair of toys used in this task were never the same pair used in teaching the verb in the teaching phase. As in the teaching phase, perceptual

verbs were acted out by moving the instrument, not the animals.[1]

In the comprehension task, the experimenter showed the child two of the toys, reminded the child of their names (in a random order), and then asked the child "Can you make it so the elephant is kaling the doggy" or "Can you make it so the doggy is being kaled by the elephant?" The pair of animals was not the same pair as was used in the teaching phase. The order of active and passive was the same as in the production test. Following the comprehension task, the next verb was taught and tested in the production and comprehension tasks, until all four verbs had been used.

Scoring

In the production task, the child was scored as correct if he or she produced the obligatory constituents and inflections that distinguish active from passive sentences, if the voice corresponded to the one that was elicited, and if the sentence was true of the scenario acted out by the experimenter. To be credited with producing an active sentence, the child had to supply the verb, either in the present or progressive form but not as a passive participle, and if the progressive form was used with a full subject, the copula had to be supplied. In addition, the child had to supply the correct object, and if he or she supplied a subject, it had to be the correct one. Subjectless responses were considered correct if they were grammatical in the context of the question; for example, when the experimenter asked *What is the bear doing?*, the answer *Doaking the dog* was scored as correct. To be credited with producing a passive sentence, the child had to supply the verb in its passive participle

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[1]It could be argued that our training and elicitation techniques could nonetheless induce a bias to interpret perceptual and spatial relationships in a quasi-actional sense. This is because the progressive aspect and the verbs *do* and *happen* which we used in teaching and eliciting the verbs are most felicitous when used with events rather than states, and actions are invariably events whereas perceptual and spatial relations are often stative. For example, in response to the question *What is John doing?* it is somewhat odd to say *He's seeing an elephant* and in response to *What's happening to the elephant* it's odd to say *He is being seen by John*. It could be argued that children, in hearing the perceptual or spatial relations described in locutions appropriate to events, construed them as some sort of action, spuriously elevating the performance of supposedly nonactional verbs. Thus the absolute levels of performance for nonactional verbs in our experiments must be interpreted with caution. Nonetheless, we suggest that this is not a serious problem of interpretation. First, the experimental setting transparently involved the teaching and elicitation of new verbs, and English allows no alternative way of describing an ongoing state; thus there was no special contrastive or diagnostic information implied by the use of the progressive, *do*, or *happen* in that context. Second, nonactional verbs are not ruled out by the use of these devices, as many experiential verbs such as *think about, remember, listen to,* and *decide* are nonstative (see the General Discussion for examples with spatial verbs). Finally, there was always a static accompanying referent event that severely constrained the possible interpretation of the verb; if children managed to construe its meaning as involving an "action" it could only be in the most abstract and metaphorical sense of the term, one that would be consistent with the theory we end up proposing in the General Discussion in any case.

form (e.g., *doaked*), the correct subject, and a form of either *be* or *get*. The *by*-phrase was not required since it is optional in adult English; the subject was required because it cannot be omitted even in the discourse context (i.e., when asked a question like *What's happening to the bear?*, the answer *Getting doaked* is not grammatical). In the comprehension task, a response was scored as correct if the child used both toys mentioned in the sentence correctly.

Overview of the data analysis

Because all the experiments to be reported in this paper involve similar analyses, we will preview here the various tests that will be performed. First, we simply examine whether children were productive by observing the proportion of times they produced passives in conditions in which they had been taught the verb in the active, and vice versa. The equivalent of the null hypothesis in this case is that such responses should *never* occur; no statistical tests of this hypothesis are possible. Second, we perform an Analysis of Variance on the proportion of trials in which we were successful in eliciting a passive sentence from the child. Note that these trials represent only half of our conditions; since we are interested in the process of forming passives, we will not report inferential statistics from conditions in which active sentences were elicited (though we will report the means and error rates). In the analysis of elicited passives, two within-subjects factors are examined: Voice Modeled (i.e., whether the verb was taught in an active or a passive sentence) and Verb Type (e.g., in Experiment 1, action vs. perception verbs). In addition, in Experiments 2–4 Age serves as a between-subjects factor.

To test various versions of the hypothesis of constrained productivity, it is necessary to establish whether children are unwilling, or at least less willing, to passivize certain types of verbs (e.g., nonactional). This cannot be done by examining the main effect of verb semantics in the ANOVA (i.e., to see if children are more likely to utter passives of actional verbs than of perceptual verbs), because such an effect may be a consequence of the greater ease with which they process actional verbs in general, actional verbs being more concrete and salient than nonactional verbs. For the same reason, one cannot simply compare children's production of nonexemplified actional passives with nonexemplified perceptual passives. Rather, a constraint on the child's passive rule would have to manifest itself as some decrement in children's willingness to passivize nonactional verbs when the inherent difficulty of nonactional verbs, and of passivizing a verb productively (as opposed to uttering a previously exemplified participle), are held constant. The relevant

statistical test is the interaction between Verb Type and Voice Modeled in the ANOVA. Since this is a 2 × 2 interaction, it has one degree of freedom, and its magnitude and direction can be summarized in a single number, which we will call the *Relative Passivizability Index* (RPI). The number is calculated as follows: First, examine children's performance with actional verbs; specifically, how much worse they are at producing passives when they were taught the verb in the active than when they were taught the verb in the passive. This difference is an estimate of the children's difficulty in *productively* passivizing action verbs, measured against a baseline of passives of action verbs that they have learned directly fronr the input. Second, perform the same subtraction (productive passive – nonproductive passive) for the nonactional verbs. The difference between these differences yields a value that reflects the extra difficulty of productively passivizing a nonactional verb, with overall effects of voice, semantics, and productivity held constant. The formula for the RPI is listed in (3):

(3)   Relative Passivizability Index =

$$\left(\begin{matrix} \text{nonproductive} \\ \text{nonactional} \\ \text{passive} \end{matrix} - \begin{matrix} \text{productive} \\ \text{nonactional} \\ \text{passive} \end{matrix} \right) - \left(\begin{matrix} \text{nonproductive} \\ \text{actional} \\ \text{passive} \end{matrix} - \begin{matrix} \text{productive} \\ \text{actional} \\ \text{passive} \end{matrix} \right),$$

where

   nonproductive passive   =   proportion of trials in which the child was taught a verb in the passive, and a passive sentence was successfully elicited from him or her,

   productive passive   =   proportion of trials in which the child was taught a verb in the active, and a passive sentence was successfully elicited from him or her.

   (Note that this test does not measure the degree of difficulty of nonactional passive *forms*; it measures the degree of difficulty of *applying the passive rule* to a nonactional form heard only in the active voice. In most contemporary theories·of generative grammar (e.g. Bresnan, 1982; Chomsky, 1981), these two aspects of the passive are distinct: there is a lexical rule that generates a passive participle given an active lexical entry as input, and syntactic rules that generate and constrain the surface structures that the passive participle can appear in. The learnability issues that we discuss in this paper pertain to the lexical rule, and the RPI allows us to focus on this rule by contrasting

rule-generated passive participles with participles provided in the input, holding constant the difficulty of the surface form of passive sentences in general. However, for certain purposes it will also be useful to determine whether children have difficulty learning nonactional or noncanonical passive surface forms directly from the input, compared to the corresponding active forms, ignoring the question of productivity. This can be done by calculating the following measure from the success probabilities in the production tasks, focusing only on nonproductive conditions (i.e., where the voice modeled is the same as the voice elicited): First, subtract the mean for passive sentences of actional verbs from the mean for active sentences of actional verbs. This estimates the decrement in production likelihood for passive sentences compared to active sentences, for actional verbs. Then do the same for the nonactional verbs. Subtract the first difference from the second difference. If the result is positive, it would indicate that children have selective trouble when called on to produce passives of nonactional verbs, holding the difficulty of passives in general, the difficulty of nonactional verbs in general, and degree of exposure to the target form in the input constant. We will call this the Relative Passive Surface Structure Acceptability Index (RPSSAI), and mention its value in the experiments to be described, even though most of the discussion in this paper is devoted to the productivity of the passive participle formation rule and hence focuses on the RPI.)

We are now faced with a statistical problem. The dependent measure in this experiment is restricted to the values 0, .5, and 1, violating the assumption of normality required by the Analysis of Variance. This violation is even more severe in Experiments 2–4, where 0 and 1 are the only possible values. It has been argued that, despite this violation, the Analysis of Variance is the most appropriate test for 1-0 data (Anderson, 1961), but the interpretation of tests of interactions is still problematic. Interpreting the interaction requires assuming that the percentage of children who passivize various verbs is a linear function of the underlying willingness of children to passivize those verbs, and that assumption is dubious. There is no standard test for interactions among two or more factors with categorical data and repeated measures, but an article by Guthrie (1981) recommends one solution, in which the "GSK" method of analyzing factorial experiments with categorical data (see Grizzle, Starmer, & Koch, 1969) is extended to experiments with repeated measures. The procedure allows tests that are conceptually similar to those allowed in an ANOVA, applied to the success probabilities (in our case, proportion of trials in which the elicited form was produced) in each cell defined by the factorial design. This procedure can be done in two ways: it can be applied either to the raw success probabilities, or to success probabilities converted into logit scores via the transformation logit $= \ln[p/(1 - p)]$,

changing the proportion scale, which is bounded at both ends, into an open-ended scale that is more likely to be a linear function of underlying psychological difficulty.

As it turns out, the results of the GSK procedure in these experiments were virtually identical to those of the Analysis of Variance. When the RPI and RPSSAI were calculated on logit scores rather than raw probabilities in the experiments to be reported, their signs remained unchanged in all cases but one (where an RPI went from zero to a small positive value). And of the 24 significance tests performed, there was only one in which the ANOVA, the GSK procedure used with raw proportion scores, and the GSK procedure used with logit-transformed proportion scores disagreed as to significance level (and the disagreement hinged on the fourth decimal place of a p-value close to .01). The agreement between the parametric and the categorical analyses gives us confidence that the passivizability analyses in this paper do not depend on questionable assumptions about the linearity of the dependent variable.

Results and discussion

Results are shown in Tables 4 and 5. The most striking finding is that children were massively productive. Children produced passive verbs that they had only heard previously in the active 59% of the time for actional verbs and 69% of the time for perceptual verbs; 13 of the 16 children produced a productive passive at least once. In this experiment and in the others reported in this paper, productive use of the active forms of verbs heard only in the passive was even higher. Comprehension was virtually perfect, both for productive and nonproductive forms, and both for actional and perceptual verbs.

Though the data show that children are not subject to any constraint that would prevent them from passivizing nonactional verbs altogether, it is of interest to see whether they are *relatively* less willing to passivize nonactional verbs. The RPI was .22, a positive value indicating that children were somewhat less willing to passivize perceptual verbs heard only in active sentences than actional verbs heard only in active sentences (relative to their use of such passives when they had previously heard the verbs in passive sentences). Note that this difference emerged because of the children's superior production of nonproductive perceptual passives (yielding a higher baseline, and contributing to the negative RPSSAI of −.29 observed in this experiment), not their inferior production of productive perceptual passives. However, this difference did not manifest itself statistically: in the Analysis of Variance, the interaction between Voice Modeled and Verb Semantics was not signifi-

Table 4. *Experiment 1, elicited production task: Proportion of successful elicitations*

Taught in active voice		Taught in passive voice	
Elicit active	Elicit passive	Elicit active	Elicit passive
Action verbs			
.94	.59	.84	.62
Perception verbs			
.97	.69	.88	.94

Table 5. *Experiment 1, comprehension task: Proportion correctly acted out*

Taught in active voice		Taught in passive voice	
Act out active	Act out passive	Act out active	Act out passive
Action verbs			
1.00	.94	.94	1.00
Perception verbs			
.94	1.00	1.00	1.00

cant, $F(1,15) = 2.30$, $p = .15$. Similarly, neither of the GSK tests involving this interaction was significant, $p > .25$. No other factor in the ANOVA was significant, though the effect of Verb Type was marginal ($p < .10$). Because of the uniformly high performance on the comprehension task, no statistics were performed.

The results of this experiment suggest the following conclusions. First, 4-year-old children possess a productive rule of passivization which they can apply both in production and comprehension. Hence Baker's conservatism hypothesis does not seem correct as an account of the acquisition of the English exception-laden passive. Second, children do not absolutely restrict productive passivization to actional predicates. This fails to support any suggestion that 4-year-olds' passive rule is couched in terms of semantic or thematic roles such as "agent" and "patient" in contrast to the adult rule with its use of grammatical symbols such as "subject" or "NP". Third, though

children were not completely unwilling to passivize perceptual verbs productively, we did find a slight but nonsignificant difference between action and perception verbs in the likelihood with which children productively passivized them, relative to the likelihood of producing their nonproductive versions.

Tangentially, we note that our data suggest that 4-year-old children are not in general incapable of *comprehending* passive versions of nonactional verbs (productive or not), contrary to the results of Maratsos et al. (1979) and de Villiers et al. (1982). It is, however, consistent with the conclusions of Maratsos et al. (1985), who point out that a variety of experimental factors can influence absolute levels of comprehension for nonactional passives. In our case, we equalized prior input frequency of active and passive versions of all verbs; in addition, we presented children with several model passive sentences narrating the appropriate events, a manipulation that de Villiers (1981, 1984) showed to be effective in improving children's comprehension of passives. Finally, the extra auxiliary *being* that our stimuli contained (as in *The dog is being kaled by the bear*) may have served as an additional surface cue to the passive; Stromswold et al. (1985) found that at certain ages children's comprehension of passive sentences improved with the number of passive surface cues included in a sentence.

Experiment 2

There are several limitations on the conclusions one can draw from the first experiment. For one thing, the unusually high level of performance in the comprehension of passive sentences suggests that the children, who were all drawn from university day care centers, may have been unrepresentatively test-wise or advanced in verbal skills. Furthermore, the children were in a limited age range that precluded looking for developmental trends. Most important, the acts we chose as meanings for "nonactional" verbs (to see through a binoculars-like instrument and to hear using an ear-trumpet-like instrument) may not have been unambiguously nonactional. Though in demonstrating the acts we moved the instrument and not the experiencer, children may still have construed the act as a kind of action, such as orienting the sense organs. To be sure, the studies of Maratsos and others that contrasted passives of actional and nonactional verbs also used experiential verbs (specifically, a mixture of perceptual and cognitive/affective verbs), but conclusions about the interaction between verb semantics and passivization would be more general if the nonactional verbs tested were not perceptual.

In this experiment we replicate the procedure of Experiment 1 with children in two age ranges from a nonacademic community, using verbs denoting

actions and static spatial relations (similar to those denoted by *suspend* and *contain*). Because we anticipated that performance would be poorer in this experiment, we also included a control condition involving an existing actional verb (*kick*) and an existing spatial verb (*cover*). These conditions provide a crude baseline that allows one to separate poor performance attributable to the task itself (e.g., sensitivity to the pragmatic manipulations used in the elicited production task) from poor performance attributable to a lack of the appropriate productive rule.

Method

Subjects

Thirty-two children attending day care centers and elementary schools in Torrington, Connecticut participated. The children were divided into two groups, one composed of children between 3 years and 4 years 6 months (mean age 3;10), the other composed of children between 4;6 and 5;6 (mean age 5;1).

Materials

Materials were similar to those of Experiment 1, except that the phonetic forms used were *floose, gomp, jape*, and *pilk*, the meanings of the two actional verbs were "to back into" and "to slide down the back of", and the meanings of the two nonactional verbs were roughly "to suspend" and "to contain". The actional verbs involved a plastic toy monkey, bear, lion, cow, horse, and giraffe. The "suspend" verb involved an upright rectangular wooden frame with a small hook at the center of the cross beam, and a pencil, pen, plastic knife, plastic fork, and plastic spoon, each with an S-hook attached at each end. Any of these toys could hang from the hook on the frame, and any of the other toys could hang from the first toy. The sentences *The pencil floosed the fork* or *The fork is being floosed by the pencil* meant that the pencil was hanging from the hook on the frame, and the fork was hanging from the pencil. An opaque cloth tacked to the cross beam of the frame allowed the experimenter to hang the objects out of view of the child; when the cloth was lifted, the child would see the arrangement in its final state and so would not misinterpret the verb as referring to the act of arranging the objects. The second spatial verb involved the top halves of plastic cylindrical toothbrush cases in five different colors; these pieces could be partially nested inside one another. The sentence *The red is floosing the white*

or *The white is being floosed by the red* meant that the white case was nested inside the red case (part of the nested object visibly protruded from the nesting one). In addition, there were two control verbs, *kick* and *cover*. The former involved the same toys as were used for the novel action verbs. The latter involved a small note pad, a penny, a wallet, a button, an eraser, and a small roll of tape; to demonstrate instances of covering, one of these objects was placed on top of the other out of sight of the child and the pair was shown in this configuration to him or her.

Procedure

The procedure for teaching and testing novel verbs was identical to that used in Experiment 1 except for the following minor variations. The order in which each voice was tested was constant for each child (i.e., either the active or the passive was tested first), with half the children being tested in each order. In the elicited production test, the child was simply prompted with the question "Can you tell me what the monkey is doing?" (when active sentences were desired) or "Can you tell me what is happening to the giraffe?" (when passives were desired), with no follow-up questions. Comprehension was tested with sentences such as "Can you show me ... the horse is being floosed by the giraffe?". Because of time constraints, children were presented with only one opportunity to produce and comprehend each verb, rather than two as in Experiment 1.

Following the testing of the four novel verbs, the two existing verbs *kick* and *cover* were tested. The child was asked whether he or she knew what one of the words meant, then was tested for production and comprehension in the same manner as for the novel verbs. Order of testing of the two verbs and two voices were counterbalanced. All responses in the elicited production tests were recorded in writing during the session, and then checked against audio tapes.

Results and Discussion

Criteria for scoring elicited productions as correct actives and passives were identical to those used in Experiment 1. In addition, the different types of errors were recorded: Uninterpretable Response; Wrong Toy used as Subject; Different Voice than Elicited; Wrong Subject and Different Voice; Wrong Verb Form (either a different verb altogether, or the correct verb in an incorrectly inflected form).

Control verbs

Table 6 shows the children's performance with the verbs *kick* and *cover*. Performance by the older group is comparable to that of the subjects of Experiment 1; performance of the younger group was significantly lower than that of the older group both in production ($F(1,30) = 7.00, p < .05$) and in comprehension ($F(1,30) = 16.30, p < .001$). Passives were elicited less successfully than actives ($F(1,30) = 30.54, p < .001$), and comprehended less successfully ($F(1,30) = 13.27, p < .001$), though for comprehension, this difference held only for the younger children; for the interaction between Age and Voice, $F(1,30) = 14.16, p < .001$. *Kick* was produced more readily than *cover* by the younger children, but less readily by the older children; for the interaction between Verb and Age, $F(1,30) = 9.50, p < .01$. No such difference obtained in the comprehension test. There was a larger discrepancy between the likelihood of producing the active and passive versions of *kick* than of *cover* (for Verb × Voice, $F(1,30) = 14.16, p < .001$), and this tendency was stronger for the younger than for the older children (for Verb × Voice × Age, $F(1,30) = 6.79, p < .05$). Most errors consisted of producing actives when passives were elicited; in addition, the younger children occasionally used a different verb than that elicited.

The means in Table 6 can be used as an approximate ceiling for the performance we can expect of these children when actives and passives of novel verbs are elicited (it is a high ceiling, because the task was administered after the experiment and performance on it benefited from the exposure the children had to passives in the task itself). Furthermore, we can expect that our procedures should lead to lower levels of performance for passives and in younger children even when productivity is not at issue, but they do not appear to penalize nonactional verbs selectively.

Productivity with actional verbs

Table 7 shows the probabilities with which children uttered sentences containing novel verbs in the voice elicited in the different trials of the production task. Though performance is lower across the board in this experiment than in the preceding one, it is clear that these children were productive, too: one quarter of the children in each age range produced passives of actional verbs that they had previously heard only in the active voice.

Productivity with spatial verbs

Performance on the spatial verbs was poorer across the board than for the actional verbs, and poorer than performance on the control verb *cover*, but

Table 6.   *Experiment 2, control verbs: Production and comprehension*

Age	Response	"Kick" (action)			
		Elicit active		Elicit passive	
3–4.5	Correct	.94		.25	
	Wrong voice		.00		.44
	Wrong subj. & voice		.00		.12
	Wrong vb or form		.06		.06
	Uninterpretable		.00		.12
4.5–5.5	Correct	1.00		.50	
	Wrong voice		.00		.50
Mean correct		.97		.38	
		Act out active		Act out passive	
3–4.5		.94		.56	
4.5–5.5		1.00		1.00	
Mean correct		.97		.78	

Age	Response	"Cover" (spatial)			
		Elicit active		Elicit passive	
3–4.5	Correct	.44		.44	
	Wrong subject		.00		.06
	Wrong voice		.00		.19
	Wrong subj. & voice		.00		.06
	Wrong vb or form		.31		.25
	Uninterpretable		.25		.00
4.5–5.5	Correct	1.00		.62	
	Wrong voice		.00		.38
Mean correct		.72		.54	
		Act out active		Act out passive	
3–4.5		.94		.56	
4.5–5.5		1.00		.94	
Mean correct		.97		.75	

Table 7.   *Experiment 2, Elicited production task, proportion of successful elicitations*

Age	Response	Action verbs			
		Taught in active voice		Taught in passive voice	
		Elicit active	Elicit passive	Elicit active	Elicit passive
3–4	Correct	.69	.25	.38	.38
	Wrong subject	.00	.00	.00	.06
	Wrong voice	.00	.44	.06	.19
	Wrong subj. & voice	.06	.00	.00	.00
	Wrong vb or form	.06	.19	.25	.25
	Uninterpretable	.19	.12	.31	.12
4.5–5.5	Correct	1.00	.25	.88	.50
	Wrong voice	.00	.50	.00	.31
	Wrong subj. & voice	.00	.12	.00	.06
	Wrong vb or form	.00	.06	.12	.12
	Uninterpretable	.00	.06	.00	.00
Mean correct		.85	.25	.62	.44

Age	Response	Spatial verbs			
		Taught in active voice		Taught in passive voice	
		Elicit active	Elicit passive	Elicit active	Elicit passive
3–4.5	Correct	.56	.06	.38	.31
	Wrong voice	.00	.19	.12	.12
	Wrong subj. & voice	.00	.12	.00	.00
	Wrong vb or form	.25	.19	.12	.19
	Uninterpretable	.19	.44	.38	.38
4.5–5.5	Correct	.88	.25	.62	.62
	Wrong subject	.00	.00	.06	.06
	Wrong voice	.00	.56	.19	.12
	Wrong subj. & voice	.00	.00	.00	.06
	Wrong vb or form	.06	.06	.00	.00
	Uninterpretable	.06	.12	.12	.12
Mean correct		.72	.16	.51	.47

many children were still productive. One child from the younger group, and four (25%) from the older group uttered passives heard only in the active. We are unable to say that all children are productive passivizers of spatial verbs, but given the overall poor performance with the spatial verbs, and given that no more than half the children produce passives in this procedure even when the verbs are highly familiar, the minority of children who used passivized forms productively is large enough to cast severe doubt once more on the hypothesis that nonactional verbs cannot be productively passivized.

Errors for the older children generally consisted of using the active voice when the passive was elicited, especially in conditions where the active had been modeled. Younger children made errors of this sort, and also made errors consisting of using the wrong verb (often a novel word taught in a previous condition) or giving unintelligible or uninterpretable responses. Rarely did an error consist of describing the opposite of what occurred but in the correct voice, or of using active word order with passive morphemes or vice versa (wrong subject and voice).

Comparing actional and spatial verbs

There was a small tendency for children in both age ranges to be less willing to passivize spatial verbs productively: for both ages, the RPI was positive in sign (.125). However, this difference did not manifest itself as a statistically significant interaction between Voice Modeled and Verb Semantics, $F(1,30)$ < 1. This interaction was also nonsignificant ($p > .25$) in the GSK tests on raw probabilities and on logit-transformed probabilities.[2] The RPSSAI in this experiment is negative for both age groups ($-.06$ and $-.25$, respectively), suggesting that whatever difficulty children have with spatial passives as opposed to actional passives is manifest in the process of passivizing spatial verbs productively, not in the difficulty of learning spatial passives when they are modeled in the input.

Comprehension

Comprehension data are presented for comparison purposes in Table 8. Comprehension of the passive versions of actional verbs taught only in the active

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[2]For reasons to be discussed in connection with Experiment 3, we also calculated success probabilities as proportions of the trials in each condition in which the child produced either a well-formed active or a well-formed passive (i.e., discarding trials in which the children reversed the roles of subject and object, used an incorrect verb, or gave an uninterpretable response). The RPI, when calculated in this way, rises to .17 for the younger group and .24 for the older group.

Table 8.   *Experiment 2, comprehension task: Proportion correctly acted out*

Age	Taught in active voice		Taught in passive voice	
	Act out active	Act out passive	Act out active	Act out passive
	Action verbs			
3–4.5	.75	.56	.81	.63
4.5–5.5	1.00	.88	.94	.81
Mean correct	.88	.72	.88	.72
	Spatial verbs			
3–4.5	.44	.62	.56	.50
4.5–5.5	.81	.88	1.00	.50
Mean correct	.62	.76	.78	.50

was above chance for both age groups, though significantly so only for the older group (with $n = 16$, 12 children, or 75%, must answer correctly for the group to score above chance at the one-tailed .05 level). For the spatial verbs, both groups acted out passivized verbs that they had heard only in the active at levels above chance, the older group significantly so.

In sum, we find once more that preschool children are not conservative passivizers in general, nor do they avoid passives of nonactional verbs across the board. They do not passivize nonactional verbs in great numbers, to be sure, but much of this effect can be attributed to children's relative difficulty with passives in general, spatial verbs in general, and productive forms in general. When these factors are held constant, a small but nonsignificant tendency to passivize spatial verbs less freely than actional verbs can be seen.

Experiment 3

As mentioned, according to the hypothesis of Constrained Productivity, children are not conservative across the board, but apply adult-like constraints that define the domains of verbs to which a productive lexical rule may apply. For the passive, the relevant constraint presumably involves the semantics of the verb, but perhaps not in the ways discussed in the literature on children's comprehension of different types of verbs. Contrasts between actional and experiential verbs, or between actional and spatial verbs, confound two differences: the meaning of the predicate itself, and the assignment of thema-

tic roles to the grammatical functions "subject" and "object". For example, a spatial verb like *abut* differs from *kick* not only in denoting a static spatial relation rather than an action, but in subcategorizing for a theme subject and a location object rather than for an agent subject and a theme object.

Jackendoff (1972), in one of the only explicit accounts of why some verbs passivize and others don't, argues that it is the thematic role assignment, not the meaning of the predicate, that governs passivizability. He proposes that there is a hierarchy of thematic relations, shown in (4), and a constraint that the *by*-object be lower on the hierarchy than the subject.

(4)   theme   location/source/goal   agent

This *Thematic Hierarchy Constraint* (THC) is meant to account for why verbs that are ambiguous between actional and spatial readings in the active voice (e.g., 5a) are unambiguously actional in the passive voice (e.g., 5b): in the passive, the spatial reading would require a location subject and a theme *by*-object, violating the constraint. Jackendoff (1972) also argues that for measure verbs like *cost* and *weigh* (also, *last* and *equal*), the amount argument functions linguistically as a goal, for example, taking locative prepositions (see 6a); thus their passives (e.g. 6b) violate the THC. Pinker (1984) uses similar arguments to show how the THC could rule out *John was escaped by Bill's arguments* and *Irv was resembled by Jack*.

(5)   a.   John is touching the   wall.
            agent   theme
            theme   location

      b.   The wall is being touched by   John.
            theme   agent
            *location   *theme

(6)   a.   Eggs are selling at a dollar a   dozen.
            theme   location

      b.   The eggs cost a dollar a   dozen.
            theme   location

            *A dollar a dozen is cost by the eggs.
               location   theme

Jackendoff did not explicitly consider short passives (those lacking a *by*-phrase), but it is easy to extend the THC to them. Short passives, even though they do not express the "underlying subject" argument on the surface, imply the existence of one (Keyser & Roeper, 1984): *The ship was sunk* implies that someone or something caused it to sink, in contrast to *The ship*

sank where the sinking could have no immediate causal agent (for example it could have been the result of lack of preventive maintenance). In addition, short passives can support purpose phrases such as in *The ship was sunk to collect the insurance* (cf., **The ship sank to collect the insurance*) which require the existence of an agent. One can assume, then, that the participles in short passives implicate an argument corresponding to the subject of the related active form, but that it is not mapped onto a *by*-phrase, but onto a null grammatical function ϕ (Bresnan, 1982). The function "ϕ" and the function "*by*-object" would then play the same role in delineating grammatical passives in the THC. As required, this rules out **John was resembled; *Five hundred dollars was cost; *John was escaped*, and so on.

Jackendoff's constraint offers us a clear set of predictions as to how the mapping between thematic relations and grammatical functions, rather than the semantics of the predicate itself, might constrain passivizability. If it is a correct description of the constraint on the adult English passive, and if children are prewired to try to instantiate universal constraints on rules in their developing grammars, we might expect that if they had a constraint on their passive rule, it would involve something like the mappings specified by the THC. (Note that children's productive passives reported in Study 1 were not ungrammatical due to violations of the THC.) In the next two experiments, we test this possibility.

First, we focus on actional verbs, which take agent and theme roles. The part of the thematic hierarchy pertaining to agents and themes yields a prediction that verbs whose agents are subjects and whose themes are patients should passivize, whereas if a verb had its agent expressed as an object and its theme as a subject, it should not passivize. Unfortunately, there do not seem to be any such verbs in English. However, one can invent artificial verbs of this sort, such as *floose* in *The dog floosed the giraffe*, meaning that the giraffe leapfrogged over the dog. These verbs, first used in experiments by Marantz (1982), are learnable, with some difficulty, by children of 5 years and older. Though denoting actions, they are unpassivizable according to the THC, because their derived subjects are agents and their derived *by*-objects are themes. We will call them *anticanonical* verbs. If children's rule of passivization is sensitive to a constraint of the form of the THC, children should show a deficit in productively passivizing anticanonical verbs above and beyond any difficulty they might have learning such verbs when exemplified in the input.

Method

Subjects

Two groups of 16 children were tested, one with children of ages 5–6 (mean: 6 years 1 month), one with children of ages 7–8 (mean: 7 years 11 months). Older children were used in this experiment because Marantz (1982) found that children younger than 5 years had great difficulty learning anticanonical verbs. Subjects came from a summer day camp and a day care center at MIT and from two community schools in the greater Boston area.

Materials

The toys and word forms were the same as those used for the actional verbs of Experiment 2. The four actions taught were: to leapfrog over, to knock over, to slide down the back of, and to rub the head of. As before, each word was paired with each meaning an equal number of times over the course of each experiment; each child was taught two canonical verbs, one in the active voice and one in the passive voice, and two anticanonical verbs, one in each voice. For "canonical" verbs, the agent was the subject and the patient the object; for "anticanonical verbs", the reverse was true. Over the course of the experiment, each action served equally often as a canonical and as an anticanonical verb, and each of these eight combinations was taught equally often in each voice.

Procedure

The teaching and testing procedures were identical to those used in Experiment 2, except that the control procedure using existing English verbs was eliminated.

Results and Discussion

Productivity with canonical action verbs

Production probabilities are shown in Table 9. As in the previous two experiments, many children produced passives that they never heard in the active: in this case, 56% of the younger children, and 81% of the older children. Comprehension of nontaught passives was 88% for both age groups, significantly above chance.

Table 9.   *Experiment 3, elicited production task: Proportion of successful elicitations*

		Taught in active voice		Taught in passive voice	
Age	Response	Elicit active	Elicit passive	Elicit active	Elicit passive
		Canonical verbs			
5–6	Correct	1.00	.56	.88	.75
	Wrong subject	.00	.00	.06	.06
	Wrong voice	.00	.44	.00	.12
	Wrong subj. & voice	.00	.00	.00	.06
	Uninterpretable	.00	.00	.06	.00
7–8	Correcʲ	1.00	.81	1.00	.88
	Wrong subject	.00	.00	.00	.12
	Wrong voice	.00	.12	.00	.00
	Wrong subj. & voice	.00	.06	.00	.00
Mean correct		1.00	.69	.94	.81
		Anticanonical verbs			
5–6	Correct	.88	.12	.62	.62
	Wrong subject	.06	.00	.25	.06
	Wrong voice	.00	.56	.06	.06
	Wrong subj. & voice	.00	.31	.00	.25
	Uninterpretable	.06	.00	.06	.00
7–8	Correct	.88	.44	.44	.88
	Wrong subject	.06	.00	.06	.00
	Wrong voice	.00	.06	.19	.00
	Wrong subj. & voice	.06	.50	.31	.12
Mean correct		.88	.28	.53	.75

Contrasting the passivizability of canonical and anticanonical verbs

The Analysis of Variance shows that, as predicted, children were significantly less willing to passivize anticanonical verbs productively. When the passive form of a *canonical* verb was not modeled but had to be generated productively, children's tendency to produce the passive form went down slightly, from .81 to .69. But when unproductive and productive passive forms of *anticanonical* verbs are compared, we find that the decrement in producing the passive when the active was modeled is much more severe, falling from

.75 to .28. This difference yielded a RPI that was positive in sign, as in Experiments 1 and 2, but in this case it was considerably larger: .31 for the younger children, and .375 for the older children. Furthermore, it was statistically significant: for the interaction between Voice Modeled and Verb Type, $F(1,30) = 7.47$, $p = .010$, and in the GSK test, $\chi^2(1) = 7.94$, $p < .005$ on the raw probabilities, and $\chi^2(1) = 4.81$, $p < .05$, on the logit-transformed probabilities. (The ANOVA also showed that older children produced more elicited passives than younger children, $F(1,30) = 4.91$, $p < .05$; canonical verbs were elicited more successfully than anticanonical verbs, $F(1,30) = 13.45$, $p < .001$; and the passives were elicited more successfully when the verb was taught in the passive, $F(1,30) = 21.92$, $p < .001$. These effects were also significant in the GSK tests.)

Thus we have reliable evidence that children's rule of passivization is sensitive to the verb's assignment of grammatical functions to thematic roles: the by-object must be more agentive than the subject. This ordering is consistent with that part of Jackendoff's Thematic Hierarchy Condition that pertains to agents and themes. Furthermore, this effect seems to manifest itself in the generation of new passive participles: children had little trouble producing anticanonical passives when these passives had been modeled for them explicitly (the RPSSAI is 0 for the younger children and negative $(-.12)$ for the older children).

We now consider a possible complication in the interpretability of these findings owing to the unusual nature of anticanonical verbs. Since these verbs call for argument assignments that are exactly opposite to those of all other English verbs, there is a general tendency among children to treat them as canonical verbs and to use agent referents as their subjects (Marantz, 1982). Furthermore, when such errors are made, the subjects of active sentences are identical to the subjects of correct passive sentences, making errors of "Wrong Subject and Voice" particularly tempting to a child in our conditions where the discourse context calls for a sentence beginning with a patient. In calculating success probabilities in this experiment, errors in which children fail to learn the verb's argument assignments are in effect lumped together with errors in which children learn the verbs' assignments properly but do not use the voice elicited. The problem is that if children don't get the verb's argument assignments right, it is not clear how to interpret their inability or reluctance to utter the passive version of the verb with those assignments. Now, it is possible, and it would be consistent with our hypothesis, if children, when faced with a situation in which they would be tempted to passivize an anticanonical verb, alter the verb so as to preserve the THC. But we have no way of knowing that this is what happened; it could be that children simply get confused when faced with the simultaneous problems of remembering the assignments of the anticanonical verbs and passivizing them productively,

and revert to some default strategy of expressing agents as subjects.

In other words, the cleanest test of adherence to the THC would come from data for which one was confident that the children had learned and remembered the argument assignments of the anticanonical verbs, and in which failures were due only to their reluctance to passivize those verbs. In the present experiment, relevant evidence comes from comprehension data, shown in Table 10. Children did *not* reverse interpretations of anticanonical verbs: in all cases, comprehension scores are above chance levels, not below, and comprehension of passives for the two groups combined ($n = 32$) was significantly above chance ($p < .05$ two-tailed). Thus, overall, children did not seem to be allowing a default "agent = subject" strategy to overrule the argument assignments of the verbs demonstrated in the teaching phase. More to the point, in the production task, it is possible to restrict our attention to trials in which the children did not err on the verb's argument assignments. We can look at productions of correct passives as a proportion of the trials in which the verb's arguments were expressed correctly (i.e., trials which contained productions of correct passives *and* trials which contained actives that, while not pragmatically optimal in the context of the leading question, were correct with respect to the argument structure of the taught verb). This frequency is calculated as in (7):

$$(7) \quad \frac{\text{freq (passive voice, correct subject)}}{\text{freq (passive voice, correct subject)} + \text{freq (active voice, correct subject)}}$$

When these success probabilities are considered, the trend of being relatively reluctant to passivize anticanonical verbs remains: the RPI is .44 for the younger children and .12 for the older children. Though no statistical tests can be performed on these scores, the fact that they remain positive even under this stringent test removes some of the worry that children's appearing to obey Jackendoff's constraint in this experiment was due to some complex interaction between the memorability of the verb and its passivizability.[3]

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[3]This result also obtains in a replication of Experiment 3 which we conducted with a new sample of 32 children in the same age range. In this replication, the children were less successful at retaining the verb's argument structure: the younger group comprehended anticanonical verbs at levels *below* chance, and the older group at levels very close to chance. Furthermore, error rates in the production task were higher in all conditions, and there were many more errors where the child reversed the verb by using the wrong subject. (Possibly this was due to our testing a larger proportion of children from working-class and lower-middle class day care centers.) For the reasons sketched out in the preceding paragraphs, this makes the raw success probabilities difficult to interpret. Nonetheless, it is reassuring that when success rates are calculated as proportions of the trials for that condition in which children reproduced the correct argument assignments of the verbs, as was done for Experiment 3, the RPIs were quite similar: .35 for the 5–6-year-olds, and .11 for the 7–8-year-olds.

Table 10. *Experiment 3, comprehension task: Proportion correctly acted out*

	Taught in active voice		Taught in passive voice	
Age	Act out active	Act out passive	Act out Active	Act out passive
		Canonical verbs		
5–6	1.00	.88	1.00	.94
7–8	.94	.88	1.00	1.00
Mean correct	.97	.88	1.00	.97
		Anticanonical verbs		
5–6	.62	.75	.62	.62
7–8	.62	.69	.56	.75
Mean correct	.62	.72	.59	.69

Comprehension

Since we have referred to the comprehension data, we will present the results of the statistical analysis of them, specifically of the number of sentences correctly acted out (0 or 1), including both active and passive test sentences. The only significant effects on the ANOVA were Verb Type, with canonical verb sentences acted out more successfully, $F(1,30) = 22.99$, $p < .001$, and the interaction between Verb Type and Voice Tested, $F(1,30) = 4.49$, $p < .05$, reflecting the fact that for canonical verbs, active sentences were somewhat easier to act out than passives, whereas for anticanonical verbs, passives were somewhat easier to act out than actives. Presumably this is due to occasional reliance of a "first noun = agent" act-out strategy, first reported by Bever (1970), which would adventitiously yield correct performance for passive anticanonical verbs.

Experiment 4

If passivizability depends crucially on the mapping between thematic roles and grammatical functions, then just as it was possible to observe different degrees of willingness to passivize the same actional verbs, depending on which thematic role was assigned to subject, it should be possible to observe such differences within a single set of nonactional verbs, say, verbs of spatial relations. Again, the Thematic Hierarchy Condition motivates a prediction

about what the relative orderings within the domain or range of the mappings must be: a verb whose subject is a theme and whose object is a location should not passivize, whereas a verb whose subject is a location and whose object is a theme should passivize. Verbs of the former type in English include measure verbs (*cost, last, weigh,* and *equal*) and the static spatial senses of verbs like *touch* or *fill*; verbs of the latter type are rare but might include the nonactional senses of *surround* and *embrace*.

In this experiment, we invented four verbs denoting spatial relations, and varied whether their subjects were locations and their objects themes or vice versa. We will call the former "Location-Theme" verbs, and the latter "Theme-Location" verbs. If children are sensitive to mappings between thematic roles and grammatical functions, and order the members of the range of the mapping in the manner specified by the THC, they should productively passivize only location-theme verbs, not theme-location verbs. If, on the other hand, they are simply reluctant to passivize any verb form that does not pertain to an action, then performance should be low across the board in this experiment, with no difference between verb types.

Method

Subjects

Two groups of 16 were tested, one with children of ages 5–6 (mean 5;11), one with children of ages 7–8 (mean 7;9). Children of the same age range as Experiment 3 were used here, because the overall low level of performance of younger children in Experiment 2 with spatial verbs could lead to a floor effect that would interfere with our tests of the linguistic constraint. Subjects came from a summer day camp at MIT and several day care centers in Boston, Cambridge, and Somerville, some working-class and some middle-class.

Materials

Four verbs denoting spatial relations were invented. One can be translated as "to be at the center of" or "to have located at one's center". The "locations" at which objects could be centered consisted of an LP record, an aluminum pie plate, a paper plate, or a paper clock face; the "themes" occupying the center of the previous objects consisted of a button, a penny, a nickel, or a paper clip. The second verb meant "to be at the end of" or "to have located at one's end". Its possible locations consisted of a ruler, a comb, a carrot, or a celery stick; its possible themes were the same as for the

"centered-upon" verb. The third verb meant "to be hanging from" or "to have suspended from oneself", and was similar to one of the spatial verbs used in Experiment 2. The "locations" for this verb consisted of a clothes hanger, a rectangular wooden frame, and a ruler (the latter two having S-hooks embedded in them) and the "themes", which also had S-hooks enabling them to be hung from the "location" objects, consisted of plastic utensils (knife, fork, or spoon), a pencil, and a pen. The fourth verb meant "to be wrapped around" or "to have wrapped around oneself", and involved a piece of yarn, a rubber band, a pipe cleaner, and a ribbon acting as themes, and a soda can, a drinking glass, a mug, and a milk carton acting as locations. Each verb meaning appeared equally often across the experiment with its theme as its subject and with its location as its subject.

Procedure

The teaching phase was identical to that of Experiment 3, except for some changes in the teaching orders designed to make pairs of adjacent trials more evenly distributed across given pairs of conditions, words, and verb meanings. The teaching method, and the procedure for the elicited production task, were identical to those used for the spatial verbs of Experiment 2, with the objects assembled out of view of the child and presented simultaneously in the appropriate spatial relationship to him or her.

Because the predicates in this experiment are nonreversible—for example, it is much easier to have a penny situated at the center of a record than a record at the center of a penny—if we had administered an act-out comprehension task, children would have been able to perform well on it using perceptual cues alone. Thus we substituted a judgment task for the comprehension task used in the previous experiments. In this task, a pair of objects was arranged according to one of the verb meanings, and an active or passive sentence appropriate to that arrangement and to the argument assignment of the verb was uttered to the child. With respect to the way the verbs had been taught, all the sentences were true, and all were predicted to be grammatical except for two of the passive sentences which violated the THC. One sentence was presented to the child for each verb in each voice. The child was then asked to tell the experimenter whether the sentence was "good" or "no good". Before the task was administered, the child was given examples of "good" and "no good" sentences, including grammatical and ungrammatical passives so that he or she would focus on grammaticality rather than plausibility, parsability, or other factors. "Good" and "no good" sentences alternated during this training phase: *Eat the apple; Apple the eat; Brush your teeth; Teeth your brush; John has a bicycle; A bicycle is had by*

John; Billy looks like Sammy; Sammy is looked like by Billy; Pac Man costs twenty-five cents; Twenty-five cents is cost by Pac Man; The book weighs five pounds; Five pounds is weighed by the book.[4]

Results and Discussion

Production probabilities are shown in Table 11. As in Experiment 2, several children, though not a majority, uttered passives of spatial verbs that they had previously heard only in the active voice: 31% for location-theme verbs, 19% for theme-location verbs (these figures were identical for the two age groups). Once again, children do not appear to be conservative passivizers, nor do they restrict productive passivization to actional predicates.

Comparison of "passivizable" and "nonpassivizable" spatial verbs: Production task

For the younger children, there was a tendency to passivize location-theme verbs more readily than theme-location verbs, relative to their tendency to utter nonproductive passives of the two verb types. This difference is in the direction predicted by Jackendoff's Thematic Hierarchy Condition. The RPI capturing this tendency was .375 for the younger children, a higher figure than those obtained in Experiments 1 and 2, in which nonactional verbs were contrasted with actional verbs. As in Experiment 3, we thought it worthwhile to calculate success probabilities as proportions of trials in which either well-formed actives or well-formed passives for the elicited verb were uttered, rather than as proportions of all trials, to ensure that the relative passivizability difference was not related to the sheer difficulty of remembering the verbs' argument assignments. Doing so left the RPI relatively unchanged at .29. For older children, however, there was no difference in passivizability between the two types of verbs in the production task: the RPI was 0 (though it turned positive when calculated in terms of logit scores), and was un-

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[4]Since some of these training sentences may be ungrammatical by virtue of the THC, it is possible that the child could have learned the constraint there and then by looking for a principle that accounted for the training exemplars. This is highly unlikely: aside from its implausibility on the face of it, the sentence with *have* is actually a counterexample to the THC; in addition, Gropen and Pinker (1986) found in a control experiment (to be discussed again later) that children could not be taught arbitrary syntactic rules in an experiment of this type, only novel verbs. But even if it was true, it would be consistent with our theory that the child attempts to constrain his or her rules in terms of mappings between thematic roles and grammatical functions, as opposed to the countless other properties of verbs that the child could entertain as possible constraints.

Table 11.   *Experiment 4, elicited production task: Proportion of successful elicitations*

Age	Response	Taught in active voice		Taught in passive voice	
		Elicit active	Elicit passive	Elicit active	Elicit passive
		Location-theme verbs ("passivizable")			
5–6	Correct	.69	.31	.50	.44
	Wrong subject	.00	.00	.06	.12
	Wrong voice	.06	.19	.12	.06
	Wrong subj. & voice	.00	.25	.19	.25
	Uninterpretable	.25	.25	.12	.12
7–8	Correct	.81	.31	.50	.69
	Wrong subject	.19	.06	.19	.06
	Wrong voice	.00	.31	.12	.00
	Wrong subj. & voice	.00	.12	.19	.19
	Wrong vb or form	.00	.06	.00	.00
	Uninterpretable	.00	.12	.00	.06
Mean correct		.75	.31	.50	.56
		Theme-location verbs ("unpassivizable")			
5–6	Correct	.75	.19	.50	.69
	Wrong subject	.00	.00	.00	.06
	Wrong voice	.00	.44	.19	.12
	Wrong subj. & voice	.00	.12	.25	.00
	Wrong vb or form	.00	.06	.00	.00
	Uninterpretable	.25	.19	.06	.12
7–8	Correct	1.00	.19	.69	.56
	Wrong subject	.00	.00	.00	.12
	Wrong voice	.00	.69	.06	.25
	Wrong subj. & voice	.00	.06	.12	.06
	Wrong vb or form	.00	.00	.06	.00
	Uninterpretable	.00	.06	.06	.00
Mean correct		.88	.19	.59	.62

changed when success probabilities were calculated as proportions of well-formed responses.

In the Analysis of Variance on the number of successfully elicited passive utterances, the interaction between Voice Modeled and Verb Type failed to reach significance ($p > .15$ for the ANOVA; likewise for the GSK tests).

When the data from the younger children, in whom the effect was found, were analyzed separately, the interaction just misses being marginally significant, $(F(1,15) = 2.87, p = .11)$.

Comparison of "passivizable" and "nonpassivizable" spatial verbs: Judgment task

In this experiment there is another source of information relevant to testing children's sensitivity to mappings between thematic and grammatical relations. Unlike comprehension tests, which are virtually certain *not* to provide evidence on the grammaticality of sentences for the subject (so long as they are comprehensible), the sentence judgment task employed in this experiment could indeed reflect subject's grammaticality intuitions, especially insofar as judgments of different sentence types differ systematically. Proportion of sentences judged as "good" are shown in Table 12. In this task, we find that the RPI is positive both for younger children (.125) and for older children (.25), reflecting a preference for verbs mapping subject and *by*-object onto thematic roles in the order specified by the THC. An ANOVA on these data reveals that this difference is marginally significant: for the interaction between Voice Modeled and Verb Form, $F(1,30) = 3.86, p < .06$. (In addition, actives were judged as "good" marginally more often than passives, $F(1,30) = 3.86, p < .06$. No other main effect or interaction approached significance.)

In sum, this experiment confirms that children are not in general unwilling to passivize spatial verbs productively. They do differ somewhat in their

Table 12. *Experiment 4, judgment task: Proportion judged as "good"*

Age	Taught in active voice		Taught in passive voice	
	Judge active	Judge passive	Judge active	Judge passive
	Location-theme verbs (passivizable)			
5–6	.50	.75	.56	.75
7–8	.81	.81	.75	.81
Mean	.66	.78	.66	.78
	Theme-location verbs (unpassivizable)			
5–6	.56	.75	.56	.88
7–8	1.00	.56	1.00	.81
Mean	.78	.66	.78	.84

willingness to passivize spatial verbs, and to judge novel passivized sentences as grammatical, depending on the mapping between thematic roles and grammatical relations, and this difference is in the direction predicted by Jackendoff's Thematic Hierarchy Condition. The difference, though larger than the differences obtained when actional and nonactional verbs are contrasted, is not quite large enough to reach statistical significance in children's productions, and large enough only to reach marginal levels of statistical significance in their grammaticality judgments.

Comparing actional and spatial verbs across experiments

It is also possible to perform a test exactly analogous to that in Experiment 2, where the passivizability of actional verbs is contrasted with that of spatial verbs. One can do so by comparing the canonical action verbs of Experiment 3 with the "passivizable" spatial verbs of Experiment 4 in an Analysis of Variance in which Age and Verb Type are between-subjects factors, and Voice Modeled is a within-subjects factor. As in Experiment 2, we find that the RPI is positive overall (.13), indicating that spatial verbs are productively passivized somewhat more reluctantly than action verbs. However, the interaction reflecting this effect (Verb Type × Voice Modeled) is not statistically significant (nor was any other effect in the analysis). The RPI was in fact positive only for the older children, and within that group, the relevant interaction was marginally significant ($F(1,15) = 4.31, p < .06$). Once again, any relative difficulty children had with spatial verbs pertains to productively passivizing them, not learning them when they are exemplified in the input: The RPSSAI was zero for both age groups.

General Discussion

In this section we attempt to do four things. First, we argue against the possibility that our results are experimental artifacts. Then we summarize the empirical findings of the studies reported in the paper together with some of their theoretical implications. This is followed by a new account of the exact constraint on passivizability in the grammar of adult English and how it is related to children's constraint on the passive, set in the context of a comprehensive theory of the structure and acquisition of the verb lexicon. Finally, we examine alternative accounts of children's passive rule.

Methodological issues

A possible criticism of the experimental methodology is that the experiments simply encourage the child to mimic the experimenter by producing sentences similar to the experimenters' passives but containing the verb just taught, independent of the natural proclivities for passivizing or not passivizing that are dictated by the child's grammar and used in natural settings. We argue against this possibility on two grounds. First, the prevalence of ungrammatical passives in the spontaneous speech examined in Study 1 shows that the phenomenon of children passivizing verbs that they had never heard in the passive is not confined to our experimental situation. In general, it is possible to worry both about the naturalistic data, since one cannot be certain about the status of the parental input or of the structural analyses of the child's output, or about the experiments, owing to their artificiality. However, when the same results occur with both methodologies, it becomes increasingly untenable to deny our conclusions that children are not restricted to the passive participles they hear in the input.

How sound is then the strategy of using converging naturalistic and experimental evidence to demonstrate the productivity of a child's rule? It would certainly seem sound if one could show that in a domain where children are predicted to be *conservative*, the two sources of evidence agreed in showing a *failure to generalize*. This indeed can be shown. Pinker (1984) considers a number of possible errors involving the distribution of auxiliaries, which unlike passives, are dictated by Universal Grammar to display idiosyncratic, word-by-word behavior and hence should be learned conservatively. It turns out that many types of errors, such as inverting quasi-auxiliaries (**Better you pout?*), do not occur in children's spontaneous speech despite the presence of the source form (e.g., *You better not pout*) and of synonymous transformed forms (e.g., *Should you pout?*) in their speech (Kuczaj & Maratsos, 1979; Pinker, 1984). Interestingly, such errors also cannot be elicited in an experimental setting: Major (1974) had children perform a task in which they were to convert an experimenter's declaratives into questions, and although the children inverted many auxiliaries in their responses, they refused to invert *better*. Thus it is not true that if you wait long enough, you will find that children make any error you look for; nor is it true that if you have the child play a game in which any error you are interested in is the "natural" response, children will comply. Rather, patterns of occurrence and non-occurrence of overgeneralizations seem to depend on the domain of generalization, and can be seen consistently across experimental and non-experimental settings.

Second, in the experiments, the children's output was different enough from what the experimenter provided as input that we must have been tap-

ping the children's knowledge of passivization, acquired outside the experimental setting, rather than their ability to mimic a particular sequence of words or otherwise "play a game" exemplified by the experimenter's behavior. All the passives provided to the child were full *NP is being V+ed by NP* constructions; they were uttered in the same discourse and perceptual contexts that were used for active sentences; and they were used at least once with each class of verb involved in the experiment. But the children's utterances that we classified as "passive" involved additional properties conforming to properties of the passive in English but not exemplified in the models: (a) they were used preferentially in discourse contexts in which the active object was the topic; (b) there were many omissions and substitutions of forms (e.g., using *get* in place of *be*, substituting other prepositions for *by*, omitting the oblique phrase altogether) that are predictable from the grammar of the English passive;[5] (c) the children's likelihood of passivizing a verb was systematically related to the pairing of thematic roles and surface grammatical functions in a way predicted by a constraint motivated by properties of adults' rule of passivization. Most strikingly, the reluctance to passivize manifested itself not as an across-the-board avoidance of passives, productive forms, or certain types of verbs, but selectively, in just the conjunction of these circumstances (contrasted with the appropriate baselines) in which the constraint was predicted to hold. In sum, the utterances of children that we have been calling passives respected the syntactic, pragmatic, and thematic properties of the English passive, even though the passive stimuli that were modeled in the experiment did not exemplify any of these properties. We thus conclude that children's behavior reflected their antecedently-developed grammar of passivization.

   This conclusion is also supported by a study by Gropen and Pinker (1986). Using a paradigm similar to one used in Experiments 1–4 but involving dative constructions, they ran a control condition in which children were exposed to verbs in the pseudo-construction *Move the turtle of a ball*, meaning transfer a ball to the turtle. Children chose to use novel verbs in this pseudo-construction only 4% of the time, compared to 41% of the time in the double-object construction. Thus the experimental methodology seems to be successful in eliciting verbs in constructions that children already know, and is not a way of teaching arbitrary word sequences to children.

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[5]Specifically, in Experiment 2, the younger children used *get* instead of *be* 19% of the time and the older children used *get* 22% of the time; for Experiment 3, the figures were 27% and 42%; in Experiment 4, the figures were 46% and 32%. The presence of a *by*-phrase was noted in Experiment 2 only. Ten percent of the passives lacked a prepositional phrase altogether, and an additional 5% substituted the preposition *of* or *in* for *by* (substitutions of prepositions in passives have also been found in children's speech by Horgan, 1978, and Maratsos & Abramovitch, 1975).

A different line of potential criticism is that children's passives were not the products of applying a passive rule to a new verb to yield a novel passive form, but of the child forming an analogy between the verb just taught and existing verbs in his or her lexicon, and producing a passive form for the new verb that mirrors the forms stored for analogous existing verbs. There are two versions of this criticism: that children were thinking of a *particular* English verb and transferring its grammatical properties onto the taught verb, and that children were thinking of a general *type* of English verb, and transferring the properties of verbs of that type to the novel verb.

As for the first version of the criticism: although some of the verbs we taught may have English analogs (e.g., "see through binoculars" and *see*, "nuzzle the neck of" and *rub*), in Experiments 2–4 the verb forms were either not similar to any common verb (e.g., the spatial relation verbs such as "to nest" or "to be at the center of", which rarely exist as transitive verbs in English), or have analogs that, because they take oblique objects in the active, are not passivizable (e.g., "jump over", "slide on").[6] Nonetheless, we obtained significant productive passivization of these verbs. Note as well that intrusions of existing English verbs into the children's productions were extremely rare.

We argue that the second version of the criticism, invoking analogy to a class of "similar" verbs, is based on a distinction between analogy and rule that is too vague to be theoretically significant in the current discussion. Analogy depends on the notion of similarity, which as Goodman (1972) has pointed out, is in the eye of the beholder. If children passivize *floose* on the analogy of *jump*, they are inferring that due to *floose* being a verb with an agent subject and a theme object, and *jump* being a verb with an agent subject and a theme object, and *jump* being able to appear in nonfinite form with an *-ed* suffix, an agent *by*-phrase, and a theme subject, then *floose* can also appear in nonfinite form with an *-ed* suffix, an agent *by*-phrase, and a theme subject. But this "analogy" is in no sense "in the input"; many others are logically possible, such as "*pilk* ends in *-ilk*, and *milk* ends in *-ilk*, and *milk* appears in the context *there's some milk*, therefore *pilk* can appear in the context *there's some pilk*." In other words, if our subjects were forming class-based analogies, they were exploiting certain dimensions of similarity, such as words' verbhood, transitivity, morphological alternation, and alternative assignment of thematic roles to surface functions, and ignoring others,

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[6]Sometimes such verbs are passivizable in English, if the preposition is incorporated into the verb to form a new, complex verb, as in *John was thought well of* (Bresnan, 1982), but in this case the English analog does not match the forms produced by the children, who uttered sentences such as *the horse was gumped*, never *the horse was gumped over*.

such as their phonology, frequency, the particular noun phrases they happened to have appeared with, the tense they appeared in, and so on. But it is exactly these parallels and nonparallels, necessary for the analogy to work in the right way, that a rule of passivization expresses explicitly. Therefore the constraints underlying successful analogy would have to refer to representations of the same information about the relevant dimensions of similarity and productive extension as an explicit rule of passive, and the difference between them at the level of underlying mechanisms becomes obscure. One could point to the fact that analogies would have to be based on properties of *particular* sets of lexical entries acquired individually, whereas a rule exists independently of particular words. But again, this difference is only apparent—the rule of English passivization itself has to have been acquired on the basis of specific verbs observed in their active and passive forms (Pinker, 1984).

There is one other possible criticism we will address: that children, in both the spontaneous speech samples and the experiments, used productive passives as a stopgap means of satisfying a momentary communicative need, but that their grammars did not actually sanction or generate the forms; perhaps they were in some sense speech errors (Fodor, 1985). However, there does not seem to be any indication that the productive passives were speech errors, such as self-corrections or phonetic intrusions; nor would such forms be classified as speech errors if they were uttered by adults (e.g., when a sports commentator, after hearing *clothesline* used repeatedly by an announcer as an active transitive verb, uses it in the passive). Furthermore, the communicative need to utter a passive in the experiments could not have been overwhelming, given that the active form always was available, and indeed was strongly preferred when the THC rendered the passive ungrammatical. Finally, our other measures, performance in the comprehension and judgment tasks, also showed high performance for nonwitnessed passives. Most notably, in the judgment task, which is virtually identical to the measure used to assess generation of a form by the mental grammars of adults, children judged productive passives as "good" a majority of the time, and their judgments as a whole were selective enough to reflect the influence of a subtle linguistic constraint of the sort expressed by the THC.

Summary of findings and their implications

1. Children are productive passivizers

This is a robust conclusion, borne out strongly by the analyses of spontaneous speech reported as Study 1 and by each of the four experiments. When children start producing passives in large numbers in their speech, a substantial minority of the sentences are forms that could not have been derived directly from the input. When children produce innovative forms in their speech, a substantial minority of them are passives. And when children are taught new action verbs in the active voice and placed in a discourse context where passives are appropriate, they use passives anywhere from 25% to 88% of the time. This consistent pattern of findings argues against Baker's (1979) conjecture that the way children avoid overgeneralizing semiproductive lexicosyntactic alternations is by conservatively registering which verbs appear in which syntactic contexts in the input and restricting their usage to just those forms. Similarly, it casts doubt on the strongest version of the theory advocated by Fodor (1985) (motivated in large part by Baker's arguments) whereby grammars would contain no mechanisms capable of coining new lexical subcategorizations. At the very least, passivization would stand as an exception to this claim. (Fodor, 1985, does consider this possibility. However, see also Pinker, 1984, in preparation; Gropen & Pinker, 1986; Mazurkewich & White, 1984; and Bowerman, 1983, for arguments that dativization and causativization are also productive rules for children.)

2. Learning active and passive forms from the input is easier than coining them productively

In addition to the analyses reported so far, for each of the experiments, ANOVAs were conducted on the entire set of production data, including both elicited actives and elicited passives. In each of these analyses, there was a statistically significant interaction between Voice Modeled and Voice Elicited, such that actives were easier to elicit than passives when the verb had been modeled in the active voice, but passives were easier to elicit when the verb had been modeled in the passive voice. The spontaneous speech analyses are loosely consistent with the finding that nonproductive passives are easier: the first productive passives always came in later than the first nonproductive ones. Adam uttered his first passive at 3;0 and his first productive passive at 3;3; Eve uttered her first passives at 1;7 and had failed to utter any productive passives by 3;3; Sarah uttered her first passives at 2;5 and her first productive passives at 3;3. (It is difficult to tell, of course, to what extent

this delayed onset is a sampling artifact stemming from the relative infrequency of productive passives.) If productive passives do emerge later than the onset of passives in general, it would be consistent with the robust experimental effect favoring modeled over productive forms, and with Bowerman's (1982a) finding that a variety of productive overgeneralizations in verb usage (causativization, *un*-prefixation, result complements, locative alternation forms) are preceded by extended periods of conservative usage of adultlike forms.

This pattern is consistent with the rule acquisition theory of Pinker (1984) whereby the child is equipped with a learning algorithm that allows him or her to record independent lexical entries for the various forms of verbs as they are heard in the input (for active, passive, dative-shifted, etc.). Later, the child coins a second mechanism: a productive verb paradigm that captures the similarities underlying the sets of related verb forms learned one-by-one, and that can then be used productively to derive new lexical entries from old ones. The evidence summarized here suggests that the first, input-driven acquisition mechanism is the stronger one even when productive rules or paradigms have been acquired.

3. Children's rule of passivization is sensitive to the mapping between thematic roles and grammatical functions within subclasses of verbs

Within the class of actional verbs, children are extremely reluctant to create a passive participle that would link the subject position to the agent role and the *by*-object position to the patient role. This was a selective deficit, measured above and beyond the difficulty of *learning* passive participles with that property from the input, and above and beyond the difficulty of productively passivizing verbs in general. Furthermore it is not an artifact of the nonlinear dependent measure, since the interaction expressing the selective deficit was also significant in the appropriate nonparametric analysis.

Within the class of spatial verbs there was also evidence for sensitivity to linkages between syntax and semantic roles, but it was weaker: children were somewhat more reluctant to passivize verbs productively, or to judge novel passives as acceptable, when the verbs' subjects were themes and their objects were locations, compared to verbs with the reverse assignment. Of the five tests of semantic contrasts performed in this set of experiments, this was the second largest selective deficit (though unfortunately it was never more than marginally significant). Thus when we focus on contrasting mappings of thematic roles and grammatical functions within a class of verbs, Jackendoff's Thematic Hierarchy Condition makes the right predictions in both cases.

The analyses of spontaneous speech do not bear on the applicability of the

THC (all the children's errors were due to other factors), but two developmental phenomena reported in the literature support the claim that children respect it. First, as noted in Pinker (1984), the verb *follow* is difficult for children to passivize in English, German, and French (Sinclair, Sinclair & de Marcellus, 1971; Turner & Rommetveit, 1967). *Follow* is an unusual action verb in that it connotes a nonagentive subject. If children attribute the agency in acts of following to the leader and not the follower, or if they interpret the follower as a theme and the leader as a goal, the passive of *follow* would violate the THC. Second, Demuth (1985) reports that children learning a Bantu language (in which passives are obligatory in a variety of constructions, such as subject *wh*-questions) produce many correct passives of actional verbs at a comparatively young age. The only incorrect usage of a passive consisted of one girl's repeated reversal of subject and oblique noun phrases in passive sentences with the verb *surpass* when referring to the relative maturity of herself and a friend. Since the subject and object of the predicate *surpass* play the roles of theme and location respectively (assuming that it conforms to the prevalent pattern for verbs expressing comparisons to reference points; see Jackendoff, 1972, 1983), the passive violates the THC and so should be prone to reversal by the child.

4. Children have a tendency to passivize nonactional verbs less productively than actional verbs

In all three comparisons of actional and nonactional verbs—actional versus perceptual in Experiment 1, actional versus spatial in Experiment 2, canonical actional in Experiment 3 versus passivizable spatial in Experiment 4—the RPI indicated that children did not passivize nonactional verbs as easily as they passivized actional verbs, holding constant the difficulty of passivization and nonactional verbs as independent factors. In addition, of course, there are the findings of Maratsos et al. (1979, 1985), de Villiers et al. (1982), and Gordon and Chafetz (1986) that passives of existing nonactional verbs are difficult for children to understand. Though our effects were small, and those of previous investigators difficult to interpret owing to their use of comprehension tests with existing verbs, the fact that the effect seems to show up regardless of how one tests for it suggests that it is a real effect.

This allows us to summarize the semantic effects on children's passivization as follows: children robustly passivize canonical action verbs. They are strongly and significantly less willing to passivize anticanonical action verbs. For nonactional verbs, they show an intermediate pattern: they do not refuse to passivize them, but they do show a weak but consistent tendency to passivize them less willingly than actional verbs (and with verbs of spatial relations

they show a weak tendency to prefer passivization of verbs with location subjects over verbs with theme subjects).

A theory of the constraints on the English verbal passive in children and adults

Though we have shown that children are neither conservative nor semantically unconstrained, to solve Baker's learnability paradox we must show how children's constraint is related to one that successfully distinguishes passivizable from nonpassivizable verbs in adult English. So far, we have appealed to Jackendoff's THC as a hypothesis about the adult constraint and have shown that children are sensitive to it in some cases. But the THC is not without problems when applied to adult judgments and the current developmental data, and in this section we propose an alternative.

First, the Thematic Hierarchy does not capture the constraint on children's passive exactly. Although the Thematic Hierarchy Condition applied to action verbs is the only constraint that is mandated by the statistical analyses, the repeated discovery of a trend against passivizing perceptual and spatial verbs, together with the much weaker effect of the THC for location-theme than for agent-theme verbs, hints that the THC may not be telling the whole story.

This may be just as well, for the THC does not seem to work exactly for adults (Anderson, 1977; Gee, 1974; Hust & Brame, 1976).[7] (1) There are many motion verbs with theme subjects and location objects that passivize: *Russia was invaded by a horde of locusts; His body was pierced by the arrows; The rocks were hit by the breakers; John was infected by a virus;* and *The house was struck by lightning.* (2) For many speakers, *The wire was touched by the bolt* is ambiguous between actional and spatial readings, just as the active version is, contrary to Jackendoff's claim. It is only the relative preference between readings, not the grammaticality of the spatial reading, that changes from active to passive. (3) Many verbs of spatial relationships seem to have theme subjects and location objects, but passivize: *The driveway was rimmed/encircled/bordered/paralleled/spattered/dotted/covered by splotches of paint.* (4) For many psychological verbs, the experiencer behaves as a goal (e.g., *The problem was boring/intriguing/challenging/impressive TO John)*, but when they appear as transitive verbs with the experiencer as object, they are passivizable: *John was bored/intrigued/challenged/impressed by the pro-*

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[7]We are grateful to Melissa Bowerman for providing us with a very convincing argument to this effect, parts of which we reproduce here.

blem. (5) Several of the classic nonpassivizable verbs are explicitly *allowed* by the THC: according to the theory of thematic relations, possessors are locations, yet *have* and *lack*, with possessor subjects, fail to passivize; *contain* and *fit* would seem to involve location subjects, yet they too fail to passivize. In *The wound gushed blood* and *The ceiling dripped water*, the subject is a source, and the passives are just as bad.

Here we present a new account of constraints on the adult and child passive. The account is based on the Thematic Core theory of Pinker (in preparation) (itself an extension of the theory of Pinker, 1984), which attempts to account for the acquisition of a variety of predicate argument structure alternations (such as the dative, causative, and locative or *"spray/load"* alternations), and to explain why they are constrained by various semantic conditions.

Premises of a theory of constraints on verb forms

1. Thematic relations in verb definitions

Verbs have definitions associated with them, which specify relations among their arguments. These predicate-argument relations fall into a fairly small set of possible types, called "thematic relations". One type of thematic relation, which can be called "locational", pertains to a thing (the theme) that occupies a location, or changes its location (possibly along a path, to a goal, or from a source). Another kind of thematic relation, which can be called "actional", pertains to a thing (the agent) acting or impinging on another thing (the patient). Verb definitions can have one or both kinds of thematic relations in their definitions, defined over the same set of arguments. In *The ball rolled into the room*, the verb *roll* has theme and path arguments (locational); in *Fred kissed Ethel*, the verb *kiss* has agent and patient arguments (actional); in *John rolled the ball into the room,* the verb *roll* has both locational and actional arguments: *John* is an agent; *the ball* is both a patient of John's action and a theme of the resulting change of location; *into the room* is a path of the change of location. See Jackendoff (in press) and Rapaport and Levin (1985, 1986) for arguments that the agent-patient roles and theme-location-path roles are distinct, and for arguments against the version of Chomsky's (1981) "theta-criterion" that would restrict each argument to having no more than one theta role.

In their most general sense, agent-patient relations need not involve physical motion; the static "exertion" of force, as in *The ridge kept the log from rolling down the hill*, is an example of the same kind of semantic relationship.

See Talmy (1985a) for a semantic theory in which static and changing exertion of force are treated as special cases of a general notion of "force dynamics". In this theory, the notions of agent, patient, and various sorts of linguistically-expressed causation (direct, indirect, permissive, etc.) would be defined in terms of more primitive interactions among entities. Specifically, "agonists" (generally, patients) would be construed as having an inherent tendency toward motion or stasis, and "antagonists" (generally, agents) would be construed as impinging on them with an opposing force.

2. Thematic relations in nonlocational semantic fields

Thematic relations pertain not only to physical actions and locations, but also to more abstract relations that can metaphorically be construed as involving actions and locations. Gruber (1965) and Jackendoff (1972, 1978, 1983, in press) have pointed out that languages often use some of the same prepositions, verbs, and complement syntax to express physical location and motion and to express abstract states and changes. They argue that the same thematic relations are used to signify physical location and "location" in abstract "spaces" defined by states, identities, circumstances, possession relations, existence, and communication (e.g., in *John went from being sick to being well*). Given this widely accepted hypothesis, it is a short step to suggest that the actional or force-dynamic relations as well can be extended metaphorically in "spaces" of possession, state, and so on. For example, *John forced the ball to drop* and *John forced Mary to leave* would both be seen as involving some "agonist" or patient (the ball, and Mary, respectively), with an inherent tendency toward stasis, that would be impinged upon by an "antagonist" or agent which would impose a force on it causing it to "move" (Talmy, 1985a).

3. Linkages between syntactic predicate-argument structures and thematic relations

Every predicate argument structure (i.e., syntactic subcategorization frame, or set of surface grammatical functions used by a verb to express its arguments) has associated with it a "thematic core": a representation of a certain combination of thematic relations in one or more semantic fields that are mapped onto the grammatical functions in the predicate argument structure. For example, the *SUBJECT VERB OBJECT SECOND-OBJECT* or double-object predicate argument structure (e.g., *John gave Mary a book*) has the following approximate thematic core: X (an agent, mapped onto SUBJECT) causes Y (a theme, mapped onto SECOND-OBJECT) to go into the possession of Z (a goal, mapped onto OBJECT). A verb can appear in a predicate

argument structure just in case the relation among the arguments in its definition is semantically consistent with the thematic core of the predicate argument structure. Thus *give*, but not *sleep*, can appear in this predicate-argument structure.

The linkages between individual thematic roles in thematic cores and individual grammatical functions in predicate-argument structures is in turn mediated by a set of unmarked universal linking rules: agents are mapped onto subjects; patients are mapped onto objects; locations and paths are mapped onto oblique objects. Themes are not mapped onto any unique grammatical function but can be expressed as oblique, object, or subject; specifically, as the "highest" function on that list that has not already been claimed by some other argument of the verb (under the further constraints that no more than one argument can be mapped on to any grammatical function and that the subject function be mapped onto an argument).[8]

4. The vagueness of which arguments bear which thematic relations

The standard set of thematic relations, because they can pertain either to physical or to abstract relations, are inherently vague and ambiguous. In many cases it is not clear whether a verb's arguments are examples of one kind of thematic role or another. For example, in *I filled the glass with water, the glass* can be construed either as a theme which undergoes a change of state (from not full to full), or as a locational goal into which a theme (the water) moves. See Bowerman (1982b) for an extensive discussion of this point and its implications for language acquisition. Likewise, in an act of perception, is the perceiver an "agent" because he or she exerts effort in perceiving, causing a stimulus to come into awareness, or is the stimulus an "agent" because it is salient and "calls attention" to itself, forcing itself into a perceiver's awareness?

This ambiguity, of course, vitiates much of the predictive power of the thematic cores associated with predicate-argument structures. What good is it to know that, say, "verbs can take an object and a *to*-object only if they involve a theme and a goal of possession", if one cannot tell a priori whether

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[8]Having lexical entries and linking rules map arguments directly onto surface grammatical functions is consistent with the assumptions of Bresnan's Lexical Functional Grammar (Bresnan, 1982). In versions of Chomsky's Extended Standard Theory such as the Theory of Government and Binding (Chomsky, 1981), these mappings are in many cases mediated by the application of a movement rule displacing an argument from a lexically-specified position in deep structure to a new position that must be filled in order to satisfy some independent principle. The present account can be translated into an EST framework by couching the mapping in terms of links between sets of semantic roles, on the one hand, and combinations of case-assigning and theta-role-assigning privileges of classes of verbs, on the other.

a given verb takes a theme and a goal of possession? Certain verbs like *give* do so by definition, and other verbs like *sleep* do not by any reasonable construal, but what about the verbs in the gray area in between such as *throw* or *carry* or *bake,* where changes of possession are possible but not necessary results?

5. *Language-particular conflation classes which resolve thematic ambiguities*

Individual languages resolve this ambiguity in different ways by creating "conflation classes" (Talmy, 1985b) each of which (a) sanctions a class of possible verb definitions in a language, consisting of a particular combination of sets of thematic roles in a specific semantic field, and (b) maps the verb definitions onto a predicate argument structure whose thematic core is compatible with that type of definition. These conflation classes consist of semantically cohesive sets of verbs, such as verbs of motion followed by contact, or verbs of causation of change of possession (see Levin, 1985). Lexical rules map between conflation classes; they allow a verb root in one class to enter a second one, in which it is construed as having a new or extended set of thematic roles. As a result, the verb is licensed to appear in a new predicate argument structure.

For example, English has a rule that maps the class of verbs of causation of autonomous physical motion onto the class of verbs of change of possession of the moving object (the class which includes *throw, toss, kick, slide, roll, slap, bounce,* etc.). In other words, the class dictates that an argument that is ordinarily a theme of location change can also be assigned the role of theme of possession change. These verbs then inherit the privilege of appearing in the predicate argument structure whose thematic core involves possession transfer, given as an example in paragraph (3) above: *She threw/tossed/kicked/slid him the ball.* In other words, in and of itself the verb *kick* would not be construed as having a thematic role of "possessor", but English defines a conflation class in which verbs of causation of autonomous motion along a path inherit an additional set of thematic roles associated with change of possession resulting from the motion; as a result, they can appear in predicate argument structures whose thematic cores involve possession change. Other verbs, such as those whose definitions involve accompanied, continuous causation of motion (*carry, pull, push, schlep*) happen not to have been given as a class an extended definition involving resulting change of possession, and they do not appear in the double-object form (**She pulled me the box*); thus subtle semantic distinctions among subclasses of verbs can result in differences in their syntactic behavior, often giving the appearance of there being arbitrary lexical exceptions to alternations. In sum, the constraints on which

verbs can or cannot alternate between two predicate argument structures, such as prospective possession for the dative or direct physical causation for the causative (Mazurkewich & White, 1984; Pinker, 1984) arise as a consequence of the compatibility of a verb's definition with the thematic core of a predicate argument structure, as mediated by the language-specific conflation classes and the rules that copy verbs from one class to another.

Crucially, rules mapping among conflation classes are the cause of constrained productivity: when a child recognizes that a verb's definition is compatible with the definition of a conflation class, he or she can productively use that verb in the predicate-argument structures associated with a linked conflation class. Equally crucially, the conflation classes themselves, their links to predicate-argument structures, and the class-class mappings are the result of semiarbitrary, language-particular choices, and are acquired conservatively.[9]

The learning of conflation classes and rules linking them is one manifestation of Bowerman's (1982b) suggestion that for many verbs, thematic roles must be learned as part of the language being acquired, and cannot simply be read off of the conceptual representations of the verb's arguments. See Pinker (in preparation) for a more detailed exposition and for an application of the theory to several sets of predicate-argument structures.

Application of the theory to the passive

Returning now to the passive predicate-argument structure, the theory must specify two things: the thematic core associated with it, and the classes of verbs that are designated as passivizable as a result of having definitions for which there are rules modifying them so as to be compatible with the thematic core. The thematic core for the passive is: X (mapped onto the surface subject) is in a state or circumstance characterized by Y (mapped onto the *by*-object or an understood argument) having acted upon it. Thus X is a theme of a circumstance, and a patient of an action. This constraint is similar to that proposed by Anderson (1977), who pointed out that the passive subject is generally a theme or something that can be construed as a theme (though he defined "theme" in a way that is closer to the notion of a "patient").

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[9]Actually, it is an oversimplification, and empirically false for any structure other than the passive, to say that the classes are acquired conservatively. The classes themselves are not immediately given in the input and must be induced, presumably using conceptual clustering techniques applied to patterns of shared syntactic and semantic properties among sets of lexical entries acquired individually. Often this will result in overgeneralizations as overly broad classes are created in intermediate stages. The process of the learning of classes is not so much the testing of increasingly inclusive classes when narrow ones are contradicted by positive evidence, as it is the continuous redefinition of classes so as to mirror the pattern of attested and nonattested alternations among different kinds of verbs. See Pinker (in preparation).

For many languages, this would be close to sufficient to specify the constraint on the passive; it is common for languages to restrict passivized subjects to patients affected by an action (Keenan, 1985). An "affectedness" constraint also seems to hold in English in nonprototypical passives such as stranded-preposition passives (*This bed was slept in* / **This symphony was left during;* Davison, 1980), adjectival passives (*An unsold car* / **An unsold customer;* Wasow, 1977; though see also Levin & Rapaport, 1986); and nominal passives (*The city's destruction by the Romans* / **The story's reading by the students;* Fiengo, 1981). Thus passive predicate argument structures in general are subject to a tendency to express an asymmetrical relation in which the passive subject is in the circumstance characterized by having been affected by an action instigated by an agentive oblique object.

The English verbal passive, of course, is far more permissive; most classes of transitive verbs, even those that do not involve physical actions, have the privilege of passivizability assigned to them. We suggest that this latitude is possible because what counts as the patient of an action is not self-evident given that, within the Gruber/Jackendoff/Talmy theories of thematic relations, thematic roles can refer to nonphysical analogs of location and force. Languages have the option of defining classes in which thematic labels are assigned to arguments whose roles abstractly resemble those of physical thematic relations; English in particular has evolved a set of distinct semantically-cohesive classes of nonphysical verbs for which the thematic roles of agent and patient are defined more abstractly and thus for which the passive predicate-argument construction is permissible. What they all have in common is some construal of the underlying subject and object arguments as abstract agents and patients, respectively. Several other subclasses do not admit of such construal, and passivizability has not been extended to them.

Presumably the crosslinguistic variation in whether only verbs with actional agents and patients, or verbs with more metaphorical ones, can passivize represents a tension between the tendency for the passive to have a narrow semantic and discourse function—to convey the notion that an entity has been affected or impinged upon—and the tendency for the passive to have a broad syntactic function—to allow a normally non-subject argument to enjoy the syntactic privileges that are often confined to subjects (see Foley & Van Valin, 1985; Keenan, 1985).

In the space available we cannot motivate all the analyses of the passivizable and nonpassivizable classes (see Pinker, in preparation), but the following summarizes the general line of argument:

First, all the subclasses of verbs that have actional patients obviously are compatible with the passive thematic core. This includes related forms of

verbs in which the patient can be alternately construed as the entity caused to undergo a location change (*The book was handed to John; The hay was loaded into the wagon*), and in which the patient can be construed as the entity caused to undergo a possessional or physical state change (*John was handed a book; The wagon was loaded with hay*). See Levin (1985), Rapaport and Levin (1985), and Pinker (in preparation) for arguments that the patient is reconstrued in these examples.

Second, if an action verb is passivizable but its subject and object are not the agent and patient of the physical motion, then they must be the agent and patient in some parallel level in the verb's definition; that is, in some more abstract sense that submits to a Talmyan force-dynamic analysis. For example, the subject of *receive* is usually conceived to be a goal. However, a closer analysis of when *receive* can be used shows that its subject must be more than a goal: one cannot talk literally of a tree receiving an arrow, or a mailbox receiving a package, or even a person receiving a snowball that has hit him on the back of the head. Rather, *receive* implies that the goal also *enables* the theme to reach it (either at the time it arrives, or by some proactive arrangement such as having a mailing address). An enabling cause can be construed as an abstract "agent" by Talmyan force-dynamic analysis: the enabler removes or weakens the antagonistic "force" that opposes the tendency of the theme to arrive at its destination. As an abstract agent of enabling causation, the subject of *receive* can be construed as an abstract agent as well as as a goal, and its object can be construed as a patient as well as as a theme, and the verb can passivize. Similar analyses would admit subclasses of verbs that have enabling instruments as their subjects (e.g., *The key opened the door*; Levin, 1985, points out that instruments that are not enabling instruments cannot be the subject: **The spoon ate the cereal / *The cereal was eaten by a spoon*. Related arguments have been made by Schlesinger, 1982).

Third, both major subclasses of psychological transitive verbs in English passivize: those like *please*, and those like *like*, with inverse linkages of experiencer and stimulus to subject and object. As mentioned, which role is construable as an "agent" (or cause, or instigator) in acts of perception or cognition is ambiguous. Not surprisingly, then, languages differ among themselves as to whether the stimulus or experiencer is consistently mapped onto the subject role (Talmy, 1985b). English allows two subclasses, one with each type of mapping (each one compatible with a particular construal of what is the abstract "agent" and what is the "patient"). Although English deems both classes as passivizable, one class might be more naturally so than the other. Maratsos et al. (1985) found that all the passivized experiential verbs in samples of parental speech they examined belong to the class in which the stimulus is subject (e.g., *scare*). They suggest that a stimulus is more naturally

seen as a causal or agentlike entity than an experiencer, and offer this as a possible cause of children's difficulty with passives of verbs with experiencer subjects. In support of this notion, we note the study by Brown and Fish (1983), in which subjects were asked to rate whether the truth of sentences such as *John likes Bill* or *John impresses Bill* were due to properties of the referents of their subjects or their objects. Though the raters were asked to ascertain the cause of event *tokens*, rather than psychological events in general, it is suggestive that they showed a large overall bias to rate the psychological causality as flowing from the stimulus to the perceiver, as the conjecture of Maratsos et al. would require.[10]

Fourth, many verbs expressing abstract relations can also be seen as involving generalized agents and patients, if propositions and situations are seen to possess abstract "force" tendencies that can result in other propositions or situations having epistemic, ontological, or deontic properties that they otherwise would not (Talmy, 1985a). This can be seen clearly for the verbs that ambiguously take humans or abstract propositions as causes; in both cases the active subject in some sense affects, causes, or is responsible for the state or existence of the active object.

(8) a. John justified the new treaty.
         The new treaty was justified by John.

     b. The horror of the last war justified the new treaty.
         The new treaty was justified by the horror of the last war.

(9) a. John proved the theorem.
         The theorem was proved by John.

     b. These steps prove the theorem.
         The theorem is proved by these steps.

(10) a. Bob created a golden opportunity for us.
         A golden opportunity was created for us by Bob.

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[10]Interestingly, for active verbs there was only a tiny tendency to attribute greater causal force to the grammatical subject than to the grammatical object: Stimulus arguments were given greater causal weights than experiencer arguments by 2.37 rating points for verbs in which they were subjects and 2.19 for verbs in which they were objects. But the size of this bias doubles in the passive, where stimulus arguments are favored as causes over experiencer arguments by 2.17 rating points for verbs in which they were *by*-objects and only 1.80 rating points for verbs in which they were surface subjects. (We exclude the verb *scorn* which Brown and Fish point out was misclassified.) If this pattern is genuine, it would be consistent with our hypothesis that the fact that English allows the passivizability of the class of experiencer-stimulus verbs is related to the possible, though not completely natural, construal of experiencers as abstract agents.

b.   Falling interest rates have created a golden opportunity for us.
A golden opportunity has been created for us by falling interest
rates.

Fifth, let us consider verbs of spatial relationships, some of which passivize,
others of which do not. According to the current hypothesis, transitive verbs
of pure spatial relations (*contain, gush, drip, lack, fit*) have no patient argu-
ments and thus do not passivize, period. Spatial verbs that do passivize can
be shown, by independent tests, to encode more than pure spatial relations;
specifically, they include in their definitions a notion of one entity being
responsible for the state of another. Passivizable spatial verbs fall into two
subclasses. One set was used by Gee (1974) as his primary case of positive
exceptions to Jackendoff's principle ruling out passives with source or goal
subjects:

(11) a.   He was hit by a car.
b.   The house was struck by lightning.
c.   The rocks were slapped by the breaking waves.
d.   Russia was invaded by a horde of locusts.
e.   St. Sebastian's body was pierced by arrows.
f.   Her body was infected by a virus.

In these examples the locations, sources, or goals in the verbs' locational
thematic relations are also patients or affected entities, and the themes in the
locational relations are natural forces or entities with momentum or potency,
hence are antagonists or abstract agents, in their parallel set of actional rela-
tions. Thus there exists a component in the verbs' definitions in which the
passive subject is a patient, and the verbs in the class are allowed to passivize.
The second set of examples is as follows:

(12) a.   The mountain was capped by snow.
b.   The street was lined by trees.
c.   The house was surrounded by a moat.
d.   The paragraph was headed by a catchy title.
e.   The canyon was spanned by a bridge.

An interesting thing about these verbs, but not the unpassivizable spatial
verbs *contain* and *lack* (considered in its spatial sense), is that they all also
appear in the *with* version of the locative (or "figure/ground" or "*spray/load*")
alternation:

(13) a.   Hurricane Gloria capped the mountain with snow.
b.   The planner lined the street with trees.
c.   The landscapers surrounded the house with a moat.

d.   I headed the paragraph with a catchy title.
e.   The engineers spanned the canyon with a bridge.

f.   *I contained a ship with the bottle.
g.   *The architects foolishly lacked the building of a bathroom.[11]

According to Rapaport and Levin (1985), the objects of these verbs are themes of a change of state, and their *with*-objects are quasi-instruments of change of state ("state-changers") and themes of change of location. Thus (13a) can be paraphrased as "Hurricane Gloria changed the state of the mountain by adding snow to it". Assuming that these thematic roles carry over to the simple transitive versions of the sentences lacking agents (12), in which the results of the addition of material "frozen in time" is being focused on, we see that their subjects and objects are not primarily locations and themes, but themes and state-changers, respectively. Thus, (12a) can be paraphrased as "the presence of snow on top of it makes the mountain be in a different state than it would otherwise", or, more accurately, "the mountain is in the state characterized by snow being on it". Since being in or going into states can be analyzed analogously to movement and force, and since force can be exerted statically as well as dynamically, we can view the state-changer role as an abstract agent, causing the agonist (theme) to be in a state that its natural tendency would not have brought it into. Thus the theme of these verbs is compatible with the notion of generalized patient and it can passivize.

In support of this analysis, one can note three related phenomena. First, the pseudo-cleft construction, which is often said to pick out events, applies to the passivizable but not the unpassivizable "spatial" verbs: *What the fur does is line the coat; What the trees do is line the street*, etc.; but *?What this bottle does is contain the ship* and *What this building does is lack a bathroom*. The pro-verb *do* can be substituted for the state-change-by-addition verbs because the state-changer is construed as having some function in defining the state of the theme. Second, one can form compound preverbal adjectival passives fairly easily from most of the state-change verbs but not from the pure spatial verbs: *a snow-capped mountain; a tree-lined street; a bridge-spanned canyon*, etc., but *a bottle-contained ship; *a bathroom-lacked building*. This is not necessarily a consequence of the inability of the pure spatial verbs to passivize to begin with, because many adjectival passives do not have

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[11]There is also a sense of *contain* which implies counteracting an object's tendency to escape: *Moshe Dayan contained the Egyptian army; The force field contained the superhot plasma. Contain* used in this sense passivizes—*The army was contained by Dayan*—and it also passes the other tests to be outlined that the purely geometric version of *contain* fails. Thus it is not a counterexample to the account being presented here.

verbal counterparts: *an uninhabited island / *People uninhabited the island.*
Rather, it seems to be because lining, but not containing, is seen as a way of
changing the state of a theme. Finally, even using a periphrastic circumlocu-
tion to express the idea of an object existing in one state and changing to
another by the addition of an object to it differentiates the two subclasses:
*That mountain is much nicer now snow is capping it; That street is much nicer
now that trees are lining it; That paragraph is much nicer now that a catchy
title is heading it;* but *?That pint of beer is much nicer now that a bottle is
containing it.*

This leaves a handful of subclasses of transitive verbs that the grammar of
English has not designated as passivizable, presumably owing to the difficulty
or impossibility of their active subjects being construed as agents and their
active objects as patients in *any* way, abstract or concrete. The anticanonical
verbs used in Experiment 3 would be the best example. Among existing
verbs, English does not seem to have been able to bestow an abstract actional
or force-dynamic set of thematic roles for the arguments of measure verbs,
or of verbs like *resemble* or *marry*, which, having symmetric or interchange-
able arguments, do not permit one of them to be viewed as the agent and
the other the patient in any sense of those roles. As a final tough case, let us
consider *have* and *lack* in its possessional sense, which contrast with *own* and
possess. As has often been pointed out (see e.g., Miller & Johnson-Laird,
1976), there are several different kinds of possession, including inalienable
possession (e.g., John's nose), property (e.g., John's car), relationships (e.g.,
John's father), custody (e.g., John's library book), and temporary association
(e.g., John's lottery number). Many of these distinctions are encoded in the
morphology of different languages. English uses the words *have* and *lack* to
refer to the pure concept of possession, ignoring all these distinctions,
whereas *own* and *possess* refer principally to property possession. What do
property ownership and custody entail above and beyond generic possession?
Roughly, an alienably possessed object might be construable as having an
inherent tendency to "move away" from the owner, but the owner exerts a
stronger opposing force keeping it with him and allowing him to do with it
what he pleases. In other words, the owner is an antagonist with respect to
the possessed object acting as agonist. Thus property possession, as opposed
to pure possession (which, like measure verbs, can be seen as involving a
theme-location relation and nothing else), can be seen as an exemplification
of generalized agent-patient relations and the subclass of such verbs can pas-
sivize.

Whether all the details of this analysis are correct is not crucial for our
purposes. What is essential is that (a) the passivizable verbs fall into any one
of a number of semantically-cohesive subclasses; (b) which subclasses are and

are not deemed passivizable is not arbitrary, but is related to whether their verbs can be analyzed as involving agent subjects and patient objects, at least in some abstract sense;[12] (c) nonactional classes are acquired conservatively, class-by-class, but once a class is acquired the individual verbs in the class are passivized productively.

Developmental predictions, and their degree of support in the experiments

The theory's developmental predictions stem from its division of verbs into three major kinds: canonical action verbs, which are universally passivizable by definition; anticanonical action verbs, which are universally nonpassivizable by definition; and nonactional verbs, which are deemed passivizable by individual languages on a class by class basis, with a probability corresponding to the ease of construing their subject and object arguments as abstract agents and patients (and to the functional "need" for the language to be able to promote arbitrary arguments to subject or to demote them to oblique functions). The predictions are thus that once children have picked up the thematic core of the passive construction (and its prevalence across languages would suggest that it is easily acquired or possibly even innate), then they should have no trouble passivizing canonical action verbs. But children should have to learn, on a class by class basis from positive evidence, which of the nonactional classes that are construable in principle as having abstract agent and patient arguments are in fact so construed in the particular language and hence are passivizable. Classes of verbs that are difficult or impossible to construe even abstractly as having active agent subjects and patient objects should be rarely found and should be difficult or impossible to learn to passivize.

Our findings are consistent with this pattern. Children of all ages were productive passivizers of canonical actional verbs, which presumably all languages treat as having agent and patient arguments. For perceptual and psychological verbs, the mapping of arguments onto grammatical relations is inconsistent across languages (Talmy, 1985b), with the perceiver sometimes expressed as a subject, sometimes as an object, and sometimes as an oblique

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[12]An obvious problematic case consists of "exceptional case-marking verbs" such as *expect, consider, regard, view* and so on, which yield passives such as *He is considered to be a fool by his students*. Delineating the class by semantic criteria is not problematic, and the class, once delineated, can be stipulated to be passivizable, but it is not clear in what sense the passive subject could be construed as a patient, even an abstract one. One possibility is that this class is simply highly marked; the other is that the "raised object" in fact plays the role of a stimulus entertained by the expecter, considerer, and so on, in addition to whatever role it is assigned by the embedded predicate.

object. This would be explainable in terms of there being an inherent ambiguity in terms of whether a perceiver is agent, patient, or goal. Accordingly, children would have to learn that English had two classes of transitive psychological verbs (in fact, reversals of the subject and object of psychological verbs occasionally appear in children's spontaneous speech; Bowerman, 1982a) and that both were passivizable. If anything, the arguments of Maratsos et al.(1985) and of Brown and Fish (1983) suggest that it is the stimulus that is more naturally construed as the causal entity in psychological states, and that would make it even more likely that the experiencer-stimulus verbs used in this and previous experiments would be less natural candidates for passivizability than actional verbs. The children tested by us and by previous investigators accorded these verbs an in-between status vis-à-vis passivizability: they did not refuse to passivize them, but their relative willingness to passivize them productively fell short of their corresponding willingness to passivize actional verbs.

A similar account would apply to spatial relation verbs, which lack agent and patient arguments and hence are generally not transitive verbs across languages or even in English, which generally expresses pure spatial relations with prepositions, nominalizations, and adjectives. They would have to learn that English does have a set of quasi-spatial verbs that convey the notion that one entity is responsible for the state of another by virtue of being spatially contiguous to it; as such, that class of verbs passivizes. Again, our subjects do not seem to have extended the privilege of passivization to spatial verbs as much as they did to actional verbs, though some of the children did passivize them some of the time. Finally, for verbs that are virtually impossible to construe as having active agent subjects and patient objects, namely the anticanonical verbs, children were extremely unwilling to passivize them.

This leaves us with a way of reconciling children's partial conformity to Jackendoff's THC, the nonviability of the THC as a constraint on the adult passive, and the novel theory of constraints on predicate argument structures summarized above. What the THC is right about is that the passive is sensitive to the mapping between thematic roles and grammatical relations, and that in particular, that patient and agents must be mapped onto passive subject and oblique (or null) functions. Children are demonstrably sensitive to that constraint. What it is wrong about is its claim that nonactional verbs are passivizable or not as a function only of whether their themes are mapped onto the passive subject and their locations onto the oblique or null functions. Rather, the crucial variable seems to be whether the language has deemed a semantic subclass as passivizable, and that seems to be related to whether the verb's subject and object are construable as abstract agents and patients. Although we did find that children weakly preferred passives of spatial verbs

whose subjects are themes, as the THC would predict, we also found that
children weakly preferred verbs that are actional over those that are nonac-
tional, which is consistent with the thematic core theory but not the THC.
Why did we even find the slight preference for passivizing location-theme
verbs? It could simply reflect children's lack of a consistent way of assigning
any kind of abstract agent and patient roles to the objects; in the absence of
any such scheme, they could have construed our "location" objects, which
were all larger and more complex than our "theme" objects, as more powerful
or potent or autonomous than the themes, and hence somewhat more plaus-
ible as antagonists or abstract agents.

Alternative hypotheses of the constraints on children's passive

We have argued that children's rule of passivization is sensitive to a constraint
that the passivized subject must be a patient, either concretely for action
verbs, or abstractly for individual classes of verbs acquired gradually. We
have already argued against any categorical restriction of children's passive
rule to actional verbs (as did Maratsos et al., 1985). In this section, we discuss
three alternative hypotheses that have been proposed concerning constraints
on children's passive rule.

Semantic transitivity

Maratsos et al. (1985) entertain the notion that children's passive rule may
preferentially apply to semantically "transitive" relations, in the sense of
Hopper and Thompson (1980). According to Hopper and Thompson, highly
"transitive" verbs involve two participants: a potent, volitional agent, and a
highly individuated object which is totally affected by an action. Maratsos et
al. suggest that, depending on their degree of overlap with this maximally
transitive schema, verbs fall into a continuum of transitivity: actions resulting
in a change of state are most transitive, followed by actions resulting in no
state change, followed by perceptual verbs with stimulus subjects, followed
by perceptual verbs with experiencer subjects, followed by verbs of static
relationships such as those that do not passivize in adult English. This hypo-
thesis is consistent with what we have proposed, since our notion of a gene-
ralized or abstract patient, the existence of which gives a class of verbs the
potential to be deemed passivizable, is similar to Hopper and Thompson's
concept of transitivity as interpreted by Maratsos et al. However, the concept
by itself is too vague to yield a descriptively adequate account of passivizability
in English; to do that we find it necessary to invoke a set of specific verb

subclasses over which the privilege of passivizability is defined and to which the semantic relation of "transitivity" or "patienthood" is extended. Furthermore, Hopper and Thompson do not claim that transitivity constrains the passive either universally or in English; in fact, their central thesis is that *syntactic* transitivity (containing a subject and a direct object) is correlated with *semantic* transitivity (potent volitional agent, telic punctual action predicate, individuated affected object). Thus according to their theory, passives, which of course are syntactically intransitive, should be *less* semantically transitive than actives. Thus semantic transitivity seems to have at best a heuristic role to play in accounting for the development and constraints on the English passive.

Post facto observations on states for short passives: Mutual activity or instrumental causation for long passives

Horgan (1978), in one of the few studies of children's production of passives, drew several conclusions about semantic restrictions on children's passives that are different from ours: she suggested that preschool children's short passives (those lacking *by*-phrases) are inherently stative, and that for children younger than 11 years, full passives are restricted either to expressing mutual activity by two animate entities, or to expressing instrumental causation. Though our hypothesis is consistent with the possibility that some children's passives extend to well-defined classes of verbs while excluding others, it would seem unlikely to us that any child would exclude the class of actional verbs, which maximally match the thematic core of the passive predicate argument structure, from the passivizable classes. We will argue, however, that Horgan's conclusions are too strong given her data.

Horgan first claimed that passives with and without *by*-phrases are grammatically distinct constructions. But this is rejected by virtually all contemporary theories of the passive, which treat the *by*-phrase as an optional way of expressing an argument that is defined by the passive predicate in all cases and merely left implicit in short passives (see the introduction to Experiment 3 in this paper). Then Horgan concluded that for preschool children, short passives are "after-the-fact observation[s] on the state of things". But this appears to be a consequence of the fact that her data come from children's descriptions of pictures. In their spontaneous speech, children can describe the flow of events that they are participating in or anticipating, and in such cases they frequently use passives to describe future and hypothetical events including actions, as can be seen in Table 13 which provides examples from Adam. (These examples also show that the subjects of children's short passives need not be inanimate, as Horgan claimed.) In addition, Maratsos and

Table 13. *Examples of spontaneous passives from Adam that are not after-the-fact observations on states*

3;2	So it can't be cleaned?
3;3	When I get hurts, I put dose one of dose bandage on.
3;3	Mommy, its will be cooked ... in de minute. Yeah. It will be cooked in de minute.
3;4	He gon' get (apared).
3;7	I don't want the bird to get eated.
3;8	I want to be shooted.
3;10	Why he gon' be locked in a cage?
3;10	Saw the cows being milked [repetition of Mother's "And saw the cows being milked?"]
3;10	How could it go up if its not ... if it's not flyed? [a wheel of an airplane]
3;11	You don't like to be rolled into clay.
4;0	Mommy, de cow gonna get locked up. Now de cow gonna get locked up.
4;2	Oh he got killed.
4;2	Is that where I was borned?
4;7	I don't want my animals get killed.
4;8	I wanna get something fixed.
4;9	De (top) might get killed.
4;11	I'm gonna ask Mommy if she has any more grain ... more stuff that she needs grained.
4;11	They gonna get cut and cut [talking about crackers being ground up]
4;11	It needs some paint to be painted.
4;11	Mommy, Paul wants to be chained.
4;11	You better sit down before you get killed.
5;2	I don't care if my table gets messed up.
5;2	He's not fixed yet.

Abramovitch (1975) found that many children could comprehend short passives as descriptions of actions leaving no visible state, and that short and full passives developed in close temporal synchrony. Thus there is no evidence that young children's short passives are fundamentally different from their full passives.

Together with there being no grammatical reason to distinguish short and full passives, this means that Horgan's conclusions about the properties of children's full passives may really be observations about the discourse and semantic factors that influence children's choice of when to include *by*-phrases as opposed to leaving the demoted subject argument implicit. Horgan found in her data that full nonreversible actional passives (inanimate surface subject, animate *by*-object) did not occur until age 9; for younger children all full passives were either reversible (both arguments animate) or instrumental (both arguments inanimate, as in *The lamp was broken by the ball*). The simplest explanation of this pattern is that children opt to make the agent argument explicit when the roles of the two participants in an event are

maximally confusable, that is, when neither is distinguishable from the other a priori as a likely cause of an event by its gross intrinsic properties; when an animate being acts on an object, they find less need to specify the identity of the actor explicitly.

Horgan also found that until the age of 11, children produced either one type of full passive (reversible animate) or the other (instrumental), never both. She concludes that some children have a passive dedicated to expressing "mutual activity" by two actors, others have a passive dedicated to expressing non-agent (instrumental or agentless) causation. But approximately 80–90% of the children in Horgan's age groups below the age of 11 produced no full passives at all in her data set, and she provides no figures as to how many of the remaining children actually produced restricted full passives of one or the other type. Thus her conclusions about there being immature passives restricted to mutual activity or to non-agent causation may apply to tiny minorities of children, and even for them it is possible that the restrictions are due not to a grammatical constraint on a passive rule but to a communicative bias as to when to include the *by*-phrase, given that most of the children produced short passives that did not obey these restrictions.

Adjectival passives only

Borer and Wexler (1987) point to Wasow's (1977) distinction between verbal and adjectival passives (which can be seen in the ambiguity of *The door was closed* as referring either to a state or an event), and argue that young children's passives are exclusively adjectival. The development of the verbal passive, they suggest, awaits the biological maturation of an ability to form "argument chains", which are needed in the verbal passive (but not the adjectival passive) to link the postverbal NP trace with its surface subject position (which was filled when the deep structure postverbal NP moved into that position). They base the hypothesis on four findings: Horgan's claim that children's spontaneous short passives were exclusively stative; findings by Horgan and others that virtually all of young children's passives lack *by*-phrases; the findings of Maratsos and his colleagues that experiential passives are difficult for children to understand; and findings by Ruth Berman that verbal passives in Hebrew are acquired much later than adjectival passives. We find Borer and Wexler's hypothesis difficult to accept for two reasons: the empirical facts they allude to are shaky or have alternative interpretations, and they have little to do with the criteria distinguishing adjectival from verbal passives.

As mentioned, Horgan's claim that children's passives are restricted to after-the-fact observations on states seems to stem from her technique of

having children describe pictures; the passives in Adam's spontaneous speech (Table 13) and children's good comprehension of passives of actional verbs leaving no visible state change (in our experiments and those of Maratsos et al., 1979, 1985) suggest that passives need not refer to static states for young children. Though it is difficult to ascertain the semantic properties of children's spontaneous passives, many of the examples in Table 13 are at least as consistent, and maybe more so, with a dynamic reading than with a static reading; that is, many of these sentences seem more analogous to the reading of *The door was closed* as *Someone closed the door* than as *The door was not open*.

By-phrases are indeed rare in children's speech, but that is true to the same degree in the speech of adults (Brown, 1973; Weiner & Labov, 1983) who do control the verbal passive. Furthermore, 85% of the passives produced in Experiment 3 contained a *by*-phrase, and in comprehension studies, the presence of *by* is the most important surface cue used by children to give a string a passive interpretation (Stromswold et al., 1985). Thus there is no evidence that children's passive rule lacks a role for the *by*-phrase.

As for the passivizability of nonactional verbs, as Experiments 1, 2, and 4 show, children show no absolute restriction against producing or comprehending passives of perceptual and spatial verbs once input availability is controlled (a point also made by Maratsos et al., 1985), and the slight reluctance they show to passivize such verbs compared to actional verbs seems to apply to their process of deriving passive participles productively, not to their ability to use existing participles in a passive surface structure.

Finally, Borer and Wexler note that the Hebrew verbal passive is extremely rare in parental speech to children. This leaves open the possibility that Israeli children do know the verbal passive but fail to utter it for the same reasons that adults do; also that if the verbal passive is acquired late, it could be a consequence of infrequent input.

But even if these empirical claims were substantiated, their relevance to the hypothesis that children's passives are exclusively adjectival is tenuous, because except for stativity, the alleged properties of children's passives do not distinguish the verbal from the adjectival forms according to the standardly accepted criteria. Experiential verbs can yield passives that are adjectival according to each of Wasow's (1977) criteria, such as appearing in prenominal·position (*a feared man / a wanted child / an imagined stimulus / a respected scholar / a perceived threat*), as a complement to verbs such as *remain* and *seem (Despite his attempts to camouflage himself, John remained seen / The child's sense of rejection is inexplicable since by all appearances he seems wanted*), and with *very* as a modifier (*Your family was very respected/appreciated/resented*; these latter examples are from Wasow). If anything, it

is actional verbs that make marginal adjectival passives, such as *?the kicked boy; ?John seems punched;* and *?Mary was very licked*; Borer and Wexler were forced to posit an unexplained factor to account for this fact and then stipulate that this factor was absent from children's grammars. Furthermore, Wasow explicitly points out that adjectival passives can take *by*-phrases; examples include *This island is uninhabited by humans; John remained feared by all;* and *The child was unwanted by his parents.* Though "generic" agents seem better *by*-objects than specific ones, especially for participles prefixed by *-un (The plant was untouched by human hands/?by John)*, this is probably a consequence of the pragmatic constraint that adjective phrases denote states that are identifiable without idiosyncratic knowledge: there can be visible evidence that something was not touched by humans, but it is not clear what something would have to look like for one to know that it was not touched by John in particular.

   In sum, there is no reason to believe that young children's passives are exclusively adjectival. In general, we suggest that the most successful account of the acquisition of the passive will not treat the passive as a neutral exemplification of general syntactic processes, such as movement rules, but will take into account the thematic properties that are characteristic of the family of passive constructions. There is a set of affectedness constraints that appears in different but recognizable forms in the highly restricted passives of many other languages, and the English verbal passive, adjectival passive, nominal passive, and stranded-preposition passive. It cannot be a coincidence that a constraint of this ilk seems to appear in the verbal passive rule of American children, who are faced with the task of determining the exact form of such constraints in the passive constructions of the language they are acquiring.

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Résumé

L'acquisition du passif anglais pose un problème d'apprentissage. La plupart des verbes transitifs ont une forme passive (par exemple *kick/was kicked by*) et l'enfant qui apprend l'anglais sera donc tenté de formuler une règle productive permettant d'obtenir une forme passive à partir de la forme active correspondante. Mais certains verbes n'ont pas de forme passive (par exemple *cost/*was cost by*). Puisque les enfants ne disposent pas de données négatives leur disant quelles séquences sont agrammaticales, qu'est-ce qui les retient d'appliquer la règle productive du passif aux verbes exceptionnels? (Ou bien, s'ils appliquent la règle à ces verbes, comment reviennent-ils sur leur erreur?). Une possibilité est que les enfants ont une attitude conservatrice: ils ne produisent des passifs que pour les verbes qu'ils ont entendus dans des phrases au passif. Nous montrons que cette idée est fausse: on trouve dans la production spontanée des enfants des participes passés qu'ils n'ont pas pu entendre dans la production de leurs parents; dans quatre expériences où nous apprenions à des enfants de 3 à 8 ans des verbes nouveaux dans le contexte de phrases actives, ils produisaient librement des formes

passives de ces verbes pour décrire des événements inédits. Une autre possibilité est qu'à un certain moment les enfants possèdent une contrainte sémantique qui leur permet de distinguer les verbes qui ont un passif de ceux qui n'en ont pas un. Dans deux expériences, nous montrons que les enfants ne possèdent pas de contrainte absolue qui leur interdirait de mettre au passif des verbes de perception qui ne sont pas des verbes d'action ou des verbes de relation spatiale, même s'ils les mettent au passif plus difficilement que les verbes d'action. Dans deux autres expériences, nous montrons que la tendance des enfants à mettre un verbe au passif dépend de la relation entre les rôles thématiques et les fonctions grammaticales spécifiées par le verbe: les enfants évitent sélectivement de mettre au passif des verbes inventés dont les sujets sont des patients et dont les objets sont des agents, et ils mettent plus facilement au passif des verbes de relation spatiale dont les sujets sont des "emplacements" plutôt que des thèmes. Ces contraintes s'accordent bien avec la "Contrainte d'Hiérarchie Thématique" de Jackendoff sur la forme adulte du passif. Mais nous pensons que la contrainte sur le passif à laquelle obéissent les adultes, et qui est celle qu'approximent les enfants, est quelque peu différente: les verbes qui admettent un passif doivent avoir un objet qui est un patient, que ce soit littéralement le cas pour les verbes d'action, ou bien que ce soit en un sens abstrait élargi que chaque langue peut définir à sa manière pour des classes particulières de verbes qui ne sont pas des verbes d'action.