REPORT

Training 2;6-year-olds to produce the transitive construction: the role of frequency, semantic similarity and shared syntactic distribution

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Abstract

Childers and Tomasello (2001) found that training 2;1/2-year-olds on the English transitive construction greatly improves their performance on a post-test in which they must use novel verbs in that construction. In the current study, we replicated Childers and Tomasello’s finding, but using a much lower frequency of transitive verbs and models in training. We also used novel verbs that were of a different semantic class to our training verbs, demonstrating that semantic homogeneity is not crucial for generalization. We also replicated the finding that 4-year-olds are significantly more productive than 2;1/2-year-olds with the transitive construction, with the new finding that this is also true for verbs of emission. In addition, ‘shared syntactic distribution’ of novel verb and training verbs was found to have no observable effect on the number of 2;1/2-year-olds who were productive in the post-test.

Introduction

A number of studies have shown that most young English-speaking 2-year-olds are not able to use a novel verb productively in the transitive construction (as in ‘The dog’s meeking the car’), unless they have previously heard the novel verbs used in this construction. The ability to generalize the transitive construction to new verbs increases gradually, and at around the age of 4;0 almost all children demonstrate productive use of the transitive and other constructions (see Tomasello, 2000, for a review).

The only transitive construction training study with pre-schoolers in which productivity was tested with novel verbs is that of Childers and Tomasello (2001). In Experiment 1, 40 children with a mean age of 2;6 were trained on the transitive construction with 16 English action verbs over three sessions. Each child heard a total of 575 models of the transitive construction. In the fourth session, the children were tested with novel verbs using the same nouns as were used with the training verbs. Of the additional 10 children in the control condition – who also participated in similar games over three sessions, but were not trained on the transitive construction – only 20% were productive with the novel verbs, which is about the same percentage found with children this age in non-training studies (Brooks & Tomasello, 1999, Study 1). In contrast, of the 20 children who received transitive training with NOUNS ONLY (e.g. ‘The bird is swinging the bathtub, the bird is swinging the bathtub’), nine (45%) were productive; and of the other 20 children who were trained on NOUNS AND PRONOUNS (e.g. ‘The bird is swinging the bathtub, he is swinging it’), 17 (85%) were productive.

While this training – especially with NOUNS AND PRONOUNS – clearly improved the ability of 2;1/2-year-olds to generalize the transitive construction to novel verbs, the study did not explicate on what basis this occurred. In the current study we explore three possibilities that have been proposed by various usage-based acquisition theorists, computational modellers and cognitive linguists as being crucial in the formation and/or strengthening of syntactic schemas. All three proposals are compatible with the construction/cognitive grammar approach in which the basic units of grammar are constructions, such as the transitive (e.g. Goldberg, 1999). Acquisition theorists within this approach argue that grammatical constructions are gradually abstracted from concrete utterances in the input, as in the formation of schemas in other areas of cognition (e.g. Tomasello, 2000).
First, many researchers have emphasized the role of semantic analogy (e.g. Goldberg, 1999). Thus, the children in Childers and Tomasello’s study may have been able to generalize the transitive construction to the novel verbs by noticing that the novel verbs were semantically similar to the majority of the training verbs in that they all involved the caused-motion of one toy (the UNDERGOER) by another toy (the ACTOR). However, it would seem that the influence of semantic similarity alone would have led to an equal performance in the NOUNS ONLY and NOUNS AND PRONOUNS training conditions.

Another mechanism which has been proposed to play a role in syntax acquisition is that of distributional analysis (e.g. Maratsos, 1988; Elman, 1998; Gobet & Pine, 1997). Accordingly, another (not mutually exclusive with the first) possibility is that the children in Childers and Tomasello’s training conditions were able to notice that all the training verbs occurred in the same syntactic distribution, i.e. in the NOUNS ONLY condition, all verbs occurred in ‘the NOUN’s _____ing the NOUN’ context. This may have helped the children to make a connection between these verbs. However, for the NOUN models, a variety of different nouns were used, so the children heard variation with the nouns and the verbs. Therefore, for the children who also heard the PRONOUN models, ‘He’s _____ing it’, this connection between the verbs should be even clearer, because with the PRONOUN models the verb is the only part that varies. This is a possible explanation for how the children formed connections between the training verbs, but it does not account for how they then extended this category to the novel verbs. One plausible explanation for the latter is that the children noticed that the novel verbs shared two syntactic contexts with the training verbs: the same nouns, and the suffix -ing (the children heard the novel verbs in either the intransitive, ‘the bottle is meeking’, or the passive, ‘the truck is being meeked by the bird’).

Semantic analogy and distributional analysis have been proposed as mechanisms of category and schema formation. However, it is possible that 2½-year-olds already have a verb-general transitive schema, but one which is still too weak to aid them in actively producing novel transitives. Evidence that this may be the case for young 2-year-olds comes from their performance in preferential-looking studies (e.g. Bavin & Growcott, 1999; Fisher, 2000), their avoidance of ungrammatical word orders in elicited production studies (e.g. Akhtar, 1999; Abbot-Smith, Lieven & Tomasello, 2001) and evidence from naturalistic studies that many have verb-general transitive schemas based around particular pronouns (e.g. Lieven, Pine & Baldwin, 1997).

Once 2½-year-olds already have a weak verb-general transitive schema, it is possible that semantic analogy and distributional analysis no longer play a crucial role. This allows us to consider the role that a third mechanism may have played in Childers and Tomasello’s study, namely the role that frequency plays in strengthening schemas (e.g. Bybee, 1995; Langacker, 2000; MacWhinney, 1997). Thus, hearing 575 transitive models may have helped to strengthen the already existing transitive schemas, allowing the children to extend them to novel verbs. Their better performance in the NOUNS AND PRONOUNS condition would thus be a reflection of the fact that these children had stronger pronoun-based transitive schemas prior to the experiment.

In the current study, therefore, we adapted Childers and Tomasello’s NOUNS ONLY training procedure to investigate these three factors. First, to examine the effect of shared syntactic distribution we tested all the children on two novel verbs, one which shared certain syntactic contexts with the training verbs and one which did not. Our expectation was that the children would be better able to generalize the transitive construction to the ‘shared distribution’ novel verb than to the ‘non-shared distribution’ novel verb.

Second, to explore the effect of semantic similarity we ensured that both novel verbs were of a different semantic class (verbs of emission) than the training verbs (verbs of caused-motion). In contrast, Childers and Tomasello used one semantic class (verbs of caused-motion) for all the novel verbs and most of the training verbs. If close semantic similarity is crucial for generalization, we would expect that that the 2½-year-olds in our study would perform worse with both novel verbs than the 2½-year-olds did in the NOUNS ONLY condition in Childers and Tomasello. In addition, we also checked that 4-year-olds are productive with the transitive construction with novel verbs of emission, as this had never previously been reported in the literature.

Third, to investigate the effect of frequency, we used half the number of verbs (lower type frequency) and less than a quarter the number of total transitive models (lower token frequency) with the training verbs than did Childers and Tomasello. In so doing, we wanted to examine whether 8 verbs with 128 transitive models is sufficient frequency for effective training with children of this age.

While these are three different changes to Childers and Tomasello’s design, the predicted differences between the children in our study and in their study (if all three factors play a role) can be separated. First, if shared syntactic distribution helps generalization, we would expect for the novel verb with shared syntactic distribution, that our 2½-year-olds should perform better than
those in Childers and Tomasello’s NOUNS ONLY training procedure. For the novel verb without shared syntactic distribution, the same percentage of 2;1/-year-olds should pass the generalization test as was the case in Childers and Tomasello’s novel verb test. Second, if semantic analogy and reduced frequency of models hinder generalization, the 2;1/-year-olds in our study should perform worse with the novel verb without shared syntactical distribution than the 2;1/-year-olds in Childers and Tomasello’s NOUNS ONLY training procedure.

**Method**

**Participants**

The participants were 24 2-year-old children all speakers of British English, who were pre-assigned to one of two training conditions (described under ‘Design’). Both training conditions contained 12 children with a mean age of 2;6 (range 2;3–2;8). A further 18 2;1/-year-olds participated in between 1 and 4 sessions, but were not included in the study because they either missed the final session due to illness, or because they did not meet the inclusion criteria of both (a) using at least one training verb in the transitive and (b) using one training or novel verb together with at least one argument during novel verb testing (see ‘Procedure’). The latter criterion ensured that the children were still attentive during testing. The number of children we excluded is comparable to that for Childers and Tomasello’s Experiment 1, in which 15 children were excluded.

In addition, we also tested nine 4-year-olds (mean age = 4;2, range = 3;11–4;5). Four 4-year-olds completed the same training procedure as the 2-year-olds, but as it became clear that all four were highly productive with the transitive with the novel verbs, the remaining five children were trained and tested within one session only.

An additional 4-year-old was excluded due to experimenter error.

**Design**

All children in this study were trained on the transitive construction and one other construction with English verbs. After training, all children participated in a test with two novel verbs. The crucial factor manipulated in this study involved the novel verb test, namely whether shared syntactic context between training verbs and novel verb helped the child to generalize the transitive construction to the novel verb. Therefore, each child participated in the following two novel verb test conditions:

- **Shared syntactic distribution**: One novel verb (the ‘shared distribution’ novel) was modelled by the experimenter in the non-transitive syntactic construction on which the child had been trained (e.g. the passive for a child who had been trained on passive-active).
- **Non-shared syntactic distribution**: The other novel verb (the ‘non-shared distribution’ novel) was modelled by the experimenter in a syntactic construction on which the child had not been trained (e.g. the intransitive for a child who had been trained on passive-active).

To ensure that novel verb testing condition was not conflated with syntactic construction or tense, there were two between-subjects training conditions, to which the children were pre-assigned (see Table 1). In both conditions, the children heard the same training verbs modelled with NOUNS ONLY in the transitive and one other construction and in two tenses.

In one condition – passive-(active)transitive – the two constructions were passive and active and the two tenses were ‘gonna’ future and past. Thus, the four constructions modelled for each training verb in the passive-active training condition were: ‘the UNDERGOER’s gonna get VERBed’; ‘the ACTOR’s gonna VERB the

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<td><strong>Novel verb test</strong></td>
<td>Children hear novel verb used in passive and were asked questions to elicit the transitive</td>
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UNDERGOER'; ‘the UNDERGOER got VERBed’; ‘the ACTOR VERBed the UNDERGOER’.

In the intransitive-transitive condition the two constructions were intransitive and transitive and the two tenses were present simple and present progressive. Thus the four constructions used by the experimenter in the intransitive-transitive training condition were: ‘this UNDERGOER VERBs’; ‘this ACTOR VERBs UNDERGOERS’; ‘this UNDERGOER is VERBing’; ‘this ACTOR is VERBing this UNDERGOER’.

The assignment of novel game (pug or tam) to condition (‘shared distribution’ or ‘non-shared distribution’), and the order in which the novel games were played were both counterbalanced across children in each training condition.

Materials

Each child played eight training games and two novel (test) games, each involving two toy participants (a mixture of animate and inanimate for each game). Each novel (test) game was played with a different set of toy objects to each other and to the training verbs games. Each training game involved a caused-motion action, for which the child heard corresponding language models with one of eight English verbs (drop, roll, turn, bounce, move, flip, swirl, topple). The two novel test games (both verbs of emission) were (1) ‘to pug’, in which one toy caused another toy to emit a flashing light; and (2) ‘to tam’, in which one toy caused another toy to emit a novel sound.

Procedure

The children participated in four sessions over a two- to three-week period. Over the four sessions, each child played the eight training games twice. Thus over the four sessions, for each training verb (game) each child heard a total of 16 uses of the transitive construction and 16 uses of the other training construction (making a total of 128 transitive models and 128 models of the other construction over the four sessions).

During Sessions One and Two, which lasted roughly 15 minutes each, each child played five training games. For two of the five training verbs per day, after E said 16 linguistic models (8 transitive and 8 of the other construction) the same game was enacted once more (either by E or by the child) without any linguistic models, and the child was asked the following elicitation questions (roughly in this order): ‘What happens now?’ ‘What is the ACTOR gonna do?’ ‘What’s gonna happen?’ ‘What’s happening?’ ‘What is the ACTOR doing?’ ‘What did the ACTOR do?’ If the child answered one of these questions with a transitive construction, no further questions were asked for that enactment.

In Sessions Three and Four, which lasted roughly 30 minutes each, the child first played three training games and then two test novel games. For each child, one of the novel verbs was modelled in the intransitive construction (e.g. ‘the UNDERGOER is tamming’) and the other novel verb was modelled in the passive construction (e.g. ‘the UNDERGOER got pugged’), each a total of 32 times. For each novel verb, each child was given a total of four transitive elicitation opportunities over Sessions Three and Four (i.e. they were asked the six questions above a total of four times each). Within a session, for each novel verb, the child first heard 12 models (either with the intransitive or the passive construction), then had one transitive elicitation opportunity. Then the experimenter briefly switched games to one of the training verbs of which the child heard two transitive and two non-transitive models and had one elicitation opportunity (we called this the ‘training reminder’). Following this, the experimenter switched back to playing the novel verb game, uttered four more passive or intransitive models, and gave the child one more transitive elicitation opportunity. The procedure is shown in Table 2.

Scoring

All child utterances containing the novel verbs were transcribed separately by two individuals, and any utterance on which the transcribers did not agree was checked by a third (blind) transcriber. All non-imitative utterances containing an appropriate novel verb were then coded by E for whether they were Not Transitive (i.e. verb-only, passive or intransitive utterances) or Transitive, if the child used the test verb in an utterance containing the UNDERGOER of the action in postverbal position (whether or not there was an ACTOR subject).

Results

Figure 1 shows the percentage of children who used a novel verb at least once in transitive word order (i.e. as (ACTOR)-VERB-UNDERGOER), as a function of age. The difference between the age groups in terms of the number of children who use a novel verb at least once in transitive word order (i.e. demonstrated productivity with the transitive) was found to be significant ($p < .05$, 2-sided, Fisher’s Exact Test).

There was no observable effect for ‘shared syntactic distribution’: three 2½-year-olds produced transitive utterances with both novel verbs; four 2½-year-olds produced only transitive utterances with the ‘shared distribution
novel verb’; and four 2½-year-olds produced only transitive utterances with the ‘non-shared distribution novel verb’. There was also no effect for the ‘passive-active’ (five of 12 2½-year-olds demonstrated productivity) versus ‘intransitive-transitive’ training conditions (six of 12 2½-year-olds demonstrated productivity).

Interestingly, there were five 2½-year-olds who demonstrated morpho-syntactic creativity with the training verbs by overgeneralizing tense marking to non-finite contexts at least once (e.g. ‘The tortoise helps the tiger bounces’, Ken, 2;8). All five were also productive with the transitive construction with a novel verb. The reverse was also true; of the (additional) five 2½-year-olds who made semantic role errors with a training verb at least once (e.g. ‘The man drop the dolly’, when the dolly dropped the man), four never used a novel verb productively, and the fifth also made one semantic role error when using the transitive with a novel verb (and was the only 2½-year-old to do so). This provides supporting evidence that use or non-use of the transitive with novel verbs provides an indication of the strength of the children’s transitive schemas.

Comparison across studies: verb semantics and frequency

As a final analysis, we compared the percentage of ‘productive’ 2½-year-olds with those from Childers and Tomasello’s in order to determine the effects of semantic similarity and frequency differences. Here, we collapsed across training conditions (recall that children in both training conditions were trained on the transitive). Figure 2 compares the percentage of children in the current study who demonstrated productivity with the transitive construction with the three crucial conditions from Experiment 1 in Childers and Tomasello. The key finding is that despite our adaptations of the NOUNS ONLY training procedure we exactly replicated the percentage of 2½-year-olds in the NOUNS ONLY condition in Childers and Tomasello who were productive with transitive construction. From this we conclude that neither the difference in semantics of our novel verbs nor the lower frequency of transitive models during training had a detrimental effect on the effectiveness of this NOUNS ONLY training procedure.

Discussion

The current results replicate Childers and Tomasello’s finding that transitive training with NOUNS ONLY improves by more than twofold the ability of 2½-year-olds to productively use the transitive construction with novel verbs. That is, 46% of the 2½-year-olds in the current...
study produced a creative transitive utterance with a novel verb at least once, which is about twice as much as the percentage of children this age who have been found to do this without training (e.g. Brooks & Tomasello, 1999, Study 1; Childers & Tomasello, 2001).

Our manipulation of 'shared syntactic distribution' between the training and novel verbs had no effect on the percentage of 2½-year-olds who were productive with the transitive construction in the post-training test. When we compare the two studies, we see that the effect found by Childers and Tomasello remained constant in the current study although we used only half the number of verbs and less than a quarter the number of models in training, and despite the fact that our novel verbs were of a different semantic class to the training verbs. Furthermore, we replicated the finding that 4-year-olds are far more productive with the transitive than are 2-year-olds (e.g. Tomasello, 2000), with the new finding that this is also true for verbs of emission.

The fact that we found no effects for semantic similarity or for the shared distribution does not, however, mean that these mechanisms do not normally play a role in the formation of syntactic schemas. It may be that children perceive verbs of emission and verbs of causation-motion as similar because both are action-like and have ACTOR and UNDERGOER arguments (i.e. the two verb classes ‘verbs of emission’ and ‘verbs of causation-motion’ could be seen as sub-categories of the verb class of causal verbs). A better test of semantic similarity might therefore be to use novel verbs of perception or spatial location for which the grammatical object is not an UNDERGOER. However, findings by Pinker, Lebeaux and Frost (1987) indicate that semantic similarity effects may be difficult to show experimentally. They found that the ability of 3- and 4-year-olds to generalize the passive and active transitive to novel verbs was not significantly different for action verbs than for ‘perception’ or ‘spatial location’ verbs (see Gordon & Chafetz, 1990, for a critique).

As for the role of shared syntactic distribution, it may be that this leads to improved generalization only if the time period between hearing the training and novel verbs is shorter, so that, for example, the intransitive and transitive models of the training verbs and the intransitive models of the novel verb are simultaneously active in short-term memory (see for e.g. Gobet, Lane, Croker, Cheng, Jones, Oliver & Pine, 2001). Alternatively, it may be that ‘shared syntactic distribution’ plays a greater role in the early rather than the later stages of schema formation. That is to say, if a child has no transitive schema prior to the experiment, hearing the novel verb in a ‘shared’ construction may prove crucial for generalizing the transitive construction to novel verbs. However, if the child already has a transitive schema prior to the experiment, training would merely strengthen this schema to a level at which the child can use it to produce transitive utterances with any novel verb (see Munakata, McClelland, Johnson & Siegler, 1997, for a proposal that cognitive representations grow in strength during ontogeny).

If we examine the current findings together with those of Childers and Tomasello, it appears that an important factor in the success of their training method was that...
the children heard the transitive construction used multiple times in a systematic fashion within a short time period. The advantage of such training over naturalistic input may be, first, that in systematic training, the children hear transitive models within a certain ‘time-window’, so that each transitive utterance is processed while others are still active in memory, enabling the exemplars to be integrated (see e.g. Rovee-Collier & Gerhardstein, 1997). Second, in training the children did not hear too many other competing constructions within the same time period.

That said, the current study clearly does not clarify whether the ‘NOUNS ONLY’ training helps 2½-year-olds to show long-term improved generalization of the transitive construction, or whether this training merely syntactically ‘primed’ an abstract representation of the transitive construction which these children already have. There is indeed some evidence that children of this age do have verb-general transitive schemas although these appear to be fairly ‘weak’, as they are only found using methodologies which do not require a behavioural response (e.g. Bavin & Growcott, 1999; Abbot-Smith et al., 2001). It is an empirical question whether 2½-year-olds would retain their advantage in being productive after two weeks, for example. However, in our opinion, ‘priming’ and ‘learning’ are not dichotomous but are on a continuum. This is consistent with much recent evidence relating priming to a kind of implicit learning in both adults and pre-schoolers (e.g. Chang, Dell, Bock & Griffin, 2000; Hartsuiker & Kolk, 1998; Savage, Lieven, Theakston & Tomasello, 2003).

In sum, it should be emphasized that the transitive schemas of 2½-year-olds are ‘weak’: even after training, the 2½-year-olds were still significantly less likely than the 4-year-olds to generate truly creative transitive utterances. We think it is unlikely that this age effect merely reflects that the 2½-year-olds are simply poorer at our productivity task. These children all met the inclusion criteria of both, first, using at least one training verb in the transitive construction (i.e. they were all capable of producing the transitive construction with a familiar verb) and, second, using one training verb or one novel verb together with at least one argument during the test (i.e. they were all attentive during the test and were all willing to answer the elicitation questions). Moreover, previous research has shown that children much younger than these are capable of demonstrating productivity with novel nouns (e.g. Tomasello, Akhtar, Dodson & Rekau, 1997). The fact that 2½-year-olds are poorer at the novel verb productivity task than are 4-year-olds thus probably cannot be reduced to difficulties with production of novel words or production of the transitive construction per se. Rather it indicates that the development of syntactic constructions is a very gradual process, as is the development of schemas for non-linguistic action sequences (e.g. Bauer & Fivush, 1992). More research into the factors which influence the formation and strengthening of syntactic schemas – especially into the role of a possible ‘time-window’ in short-term memory – is sorely needed.

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References


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