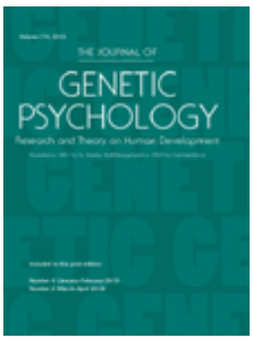

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Four-Year-Olds Share General Knowledge and Use Generic Language When Teaching

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ABSTRACT

Young children's receptiveness to teaching is unquestioned, but their understanding of pedagogy has only begun to be explored. Two experiments ($N = 90$; 45 female) with 4-year-olds from racially and ethnically diverse backgrounds were conducted to test if they exchange general information and use generic language when teaching. Children in both experiments taught more general than episodic information and used more generic than episodic language when teaching. Experiment 2 showed that children did not prefer to report general information or use generic language in a non-pedagogical context. The findings suggest that by 4 years old, children understand that the goal of teaching is to transmit general knowledge.

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Pedagogical cognition; social learning; teaching

The power of pedagogy

Teaching is a powerful mode of learning by which culture is passed on between generations and accumulates over historical time (Caldwell et al., 2018; Fogarty et al., 2011; Tennie et al., 2009; Tomasello et al., 1993). More than just preserving existing cultural forms, teaching encourages learners to seek knowledge beyond what they have been taught, thereby inspiring innovation and change (Small, 2014).

Natural pedagogy theory has argued and shown that even infants are receptive to teaching (Egyed et al., 2013; Futó et al., 2010; Topál et al., 2008; Yoon et al., 2008). For example, infants attribute negative qualities to an object when an adult rejects it pedagogically (by making eye contact, calling the infant by name, etc.), but they draw no object-related inferences when the adult disapproves of the object without using pedagogy (Egyed et al., 2013). By preschool age, pedagogically communicating what something is or how it works profoundly impacts children's cognition. When pedagogically introduced to objects, 3- and 4-year-olds form kind-general expectations and explore objects according to these expectations (Bonawitz et al., 2011; Butler & Markman, 2012; Csibra & Gergely, 2011; Shneidman et al., 2016). Pedagogical language helps preschoolers solve problems that are otherwise beyond their capacity (Moll, 2018), and pedagogical questions, i.e. questions asked with the goal to get the listener to learn, improve children's causal understanding (Daubert et al., 2020). In sum, infants and young children uniquely benefit from pedagogy compared to other forms of learning (Gweon, 2019).

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Origins of pedagogical cognition

Being responsive to pedagogical input is one thing; understanding what pedagogy is or aims to achieve is another. Examining children's pedagogical cognition is important not only because learners who understand teaching might benefit more from being taught, but also because young children possess nascent teaching skills, making them active forces of cultural transmission in their own right (Strauss & Ziv, 2004, 2012). Diffusion chain studies, which aim to simulate the accumulation of culture across generations, show that children of age 3 and older faithfully transmit information to novices (Flynn & Whiten, 2008; Whiten & Flynn, 2010). Other studies also found that preschoolers skillfully pass on knowledge (Abuhatoum et al., 2016; Ashley & Tomasello, 2001; Howe et al., 2015). By age 4, children tailor their pedagogical material to what learners do and do not know (Bass et al., 2019) and teach conventional rather than idiosyncratic procedures (Clegg & Legare, 2016). Five-year-olds can identify when someone acquired knowledge from pedagogy rather than exploration (Sobel & Letourneau, 2018) and teach what is difficult to discover by oneself (Ronfard et al., 2016). There is thus a good amount of evidence that preschoolers' pedagogical cognition progresses significantly between age 3 and 5 years (see also Davis-Unger & Carlson, 2008). By elementary school, children begin to explicitly define teaching as an act that serves to enhance a learner's knowledge (Sobel & Letourneau, 2016).

Pedagogy and generality

What makes teaching stand out from other kinds of social learning is its aim to spread *general* knowledge (Rödl, 2014). Teaching strives to impart knowledge that transcends particular events and generalizes to categories and kinds. We teach that carrots are healthy, and that dolphins use echolocation, not that this particular carrot is healthy or that this particular dolphin is using echolocation. (Exceptions include the teaching of history, where much of what is taught is episodic.) This allows learners to generate predictions and build a web of knowledge about how the world is and why things are the way they are. General knowledge can be identified by the generic form in which it is expressed. In English, generics are typically formed with a bare plural or definite singular noun phrase and a predicate in simple present tense (Cohen, 2002; Krifka et al., 1995). Generics convey core-conceptual knowledge about kinds (Brandone et al., 2012; Cimpian & Markman, 2009; Gelman, 2004; Thompson, 2008) and, as vehicles of general information, play a central role in pedagogy (Csibra & Gergely, 2011).

Two studies so far have examined children's transmission of general information in teaching contexts. Gelman et al. (2013) had 6-year-olds pretend to teach a peer about events depicted in a book and found that children produced more generic statements (e.g. 'Penguins are good swimmers') but less personal information (e.g. 'I watched a penuin show in school') than when pretending to have a regular conversation with a friend. In a subsequent experiment, 5-year-olds produced more generics when introducing objects to an alien than when talking about them with a peer. However, changing the peer audience to an alien audience brings with it a confound: unlike a peer, an alien knows nothing about penguins. It is therefore uncertain whether it was the teaching context or the audience's ignorance that led 5-year-olds to speak about kinds. Results from Baer and Friedman (2018) indicate that the audience's ignorance may have driven up generic language. In their study, 5-year-olds more frequently referred to objects' properties that were general—in the sense that many exemplars of the object share the property (e.g. of a cup: having a handle)—when talking about the objects to a novice than to an expert. Young children thus seem to grasp that novices, but not experts, lack basic general information about objects.

In a different experiment, Baer and Friedman (2018) tested more directly whether a pedagogical context evokes more general information sharing than a non-pedagogical context. The authors asked 4- and 5-year-olds to *teach* versus *tell* a given audience about objects. The results were mixed. Children shared more general information in teaching than telling contexts but, unlike what Gelman et al. (2013) found, they shared episodic information to the same degree in both contexts.

A methodical problem with Baer and Friedman's (2018) measurement of general information is noteworthy. The authors used a 5-point Likert scale to measure the *degree* to which children's information was general. The answer 'Has a handle' (of cups) was scored as 3 and the answer 'Has dots' was scored as 1, because there are more cups with handles than there are cups with dots. However, ranking statements by how common it is for exemplars of a kind to possess the predicated property conflicts with the widely accepted view that generics are not quantified statements and that genericity is not graded (Carlson, 1977; Krifka et al., 1995). Further uncertainty about what Baer and Friedman (2018) actually measured comes from the fact that their scales' scores were labeled, e.g. 'definitely' (5) and 'definitely not' (1), as containing general information. These labels suggest that what was tested was the rater's *confidence* that a piece of information was general, not the degree to which the information was general. In either case, treating generality as a continuous variable conflicts with the meaning of the concept of genericity and is likely to have inflated existing differences between the teaching and telling context.

The current study

Given the two existing studies' inconclusiveness and limits, it remains unknown whether children under age 6 transmit general information in a teaching context. We addressed this question in two experiments with 4-year-olds. The age was chosen because 4-year-olds share information with considerable reliability (Ashley & Tomasello, 2001; Flynn & Whiten, 2008; Howe & Recchia, 2005; Maynard, 2002) and grasp the kind-reference of generics (Brandone et al., 2012; Gelman & Raman, 2003; Gelman et al., 2008). Children this age thus meet the requirements of a task investigating whether children choose general information and use generic speech when teaching. If they do, then our study will have shown that by age 4, children are at least implicitly aware of the nexus between teaching and generality. Identifying children's pedagogical know-how and, more generally, their cognition about pedagogy, is important for a number of reasons. Advanced awareness of how teaching works has not only been linked to superior theory of mind abilities in Western and Non-Western children (Yoon & Kim, 2012; Ziv et al., 2016) but is also associated with enhanced pedagogical learning (Jeong & Frye, 2018). Developing a good grasp of how teaching works thus strengthens children's capacities as learners. Important implications of this are that children's pedagogical know-how might be a good index of their school readiness, and that training children's teaching skills might allow them to benefit to greater extents from others' pedagogical input.

Instead of recording children's ad hoc utterances, as in previous studies, we presented children with pairs of general (e.g. 'Sea otters hold hands when they sleep') and episodic (e.g. 'These sea otters are floating in the water') statements and measured which information they taught. The forced-choice method, although perhaps less reflective of real-life situations, circumvents problems with using children's ad-hoc content. Gelman et al. (2013) looked for children's bare plural noun phrases (e.g. penguins) to identify generic statements. However, not only generic information, but also episodic events can be narrated with these noun phrases (e.g. 'Penguins were jumping up and down'). And as we have seen, the generality of information measured by Baer and Friedman (2018) included not only what one would expect in teaching (statements about kinds/categories), but also frequency-based generality ('Many cups have handles') that has no special place in teaching. Measuring children's transmission of predetermined statements also enabled us to hold apart two aspects that were not previously distinguished, namely whether children 1) selectively teach content marked as general by the linguistic form in which it is communicated to them, and 2) whether children themselves use generic language when they teach.

Both experiments included learning and teaching phases. In learning phases, children were presented with pairs of statements about animals. One statement in each pair was general; it predicated a property or activity of the whole species (e.g. '*Giraffes* have black tongues'). The other statement was episodic; it predicated a property or activity of particular individuals (e.g. '*These giraffes* are rubbing their necks'). We measured which information type (general or episodic) children taught in subsequent teaching phases and, separately, the language format (generic

or episodic) in which they cast the information. We use the terminology 'general'/'episodic' for the first and 'generic'/'episodic' for the latter to hold the two aspects apart. Experiment 2 addressed shortcomings of Experiment 1, most importantly by including a control condition (Non-Pedagogical Condition) to test whether young children prefer general information and speak in generic terms specifically in pedagogical settings or pervasively across communicative contexts. Because the Non-Pedagogical Condition was added after the start of the COVID-19 pandemic, it was delivered online via Zoom.

Experiment 1

Method

Participants

A power analysis using the software package GPower (Erdfelder et al., 1996) revealed that with a power of .80 and alpha of .05, a sample of N = 27 was required to achieve a medium (d = .5) effect size. For design-related reasons, we decided on a sample of N = 30. Participants were 15 female and 15 male 4-year-olds (M = 4;7 months, range = 4;0—4;11 months). Another 4 children (2 female) were tested but excluded because they were uncooperative. Parents gave their consent for the child's participation prior to the experiment and the study was approved by the University of Southern California Institutional Review Board (UP-17-00266). Per parental report, 19 children were White, 5 Native Alaskan or Pacific Islander, 4 Asian, and 2 African American. Thirteen children were Latinx. Children's socio-economic status as measured by annual household income varied from under $20,000 to above $120,000. Children were tested individually at the University's child laboratory (21) or a children's museum (9). They received a small toy for participation.

Materials and design

The experiment consisted of three cycles of a learning phase followed by a teaching phase (Learning Phase 1 → Teaching Phase 1; Learning Phase 2 → Teaching Phase 2; etc.). In every learning phase, a different book (the pink, yellow, or blue book) with statements about four animals was read to children. Each book contained two pages about one of four animals and thus a total of eight pages. As Figure 1 shows, pages depicted animals performing an action or displaying a feature, e.g. giraffes showing their tongues or rubbing each other's necks.

Book order, animal order, and order of information type (general vs. episodic first, varied within subjects) were counterbalanced. Every book had a corresponding envelope with four black-and-white prompt cards (3 × 3 cm), each showing a line drawing of an animal from the book. The cards were neutral in that they showed no activities or properties (e.g. black tongues) mentioned in the statements. They were withdrawn in random order to prompt children to teach about the depicted animal to a pretend classroom, represented by a diorama including

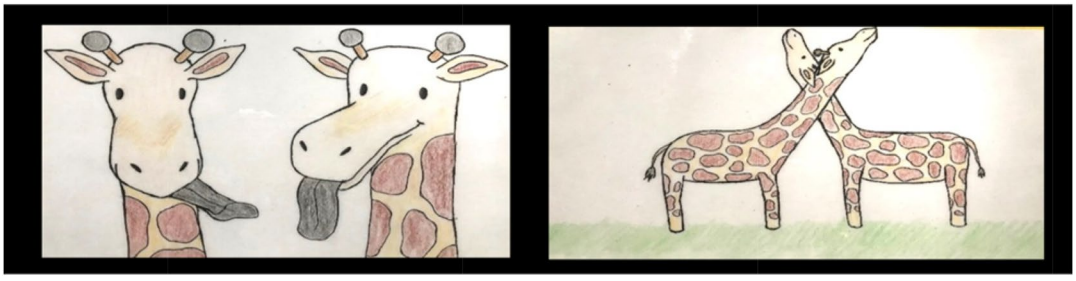

Figure 1. Pictures from two book pages from the learning phase of experiment 1.
Note. Children learned 'Giraffes have black tongues' (general statement, left) and 'These giraffes are rubbing their necks' (episodic statement, right).

small figurines sitting at tables and oriented toward a blackboard (45x30x25 cm). There were four trials (one per animal) for each of three teaching phases, amounting to 12 trials total.

Procedure

Children were tested individually by a female or male experimenter (E). The child was seated in a chair. E sat on the floor next to the child and announced, 'I have a book here, let's read it'. She initiated the learning phase by turning to the first page and reading the statement below the picture, e.g. 'Giraffes have black tongues' while pointing at the giraffes' tongues in the picture. After about 7 s, E turned to the next page and proceeded in the same manner until the book was finished. Next, E placed the classroom diorama 1 m in front of the child and initiated the teaching phase by exclaiming 'These are children in a classroom. They want to learn something about animals. You can teach them, ok?' E randomly withdrew a prompt-card from the envelope and said '[*Animal name in plural, e.g. giraffes*]: What is one thing you can teach them about [*animal name*]?' After the child answered, E said 'Ok' and retrieved the next prompt card and so on. If a child did not answer within 5 s, E repeated her request. If a child referred to entities not mentioned in the book, E specified: 'How about from the book. What did the book say about [*animal name*]?' E then removed the diorama, retrieved the next book, and started the second learning phase. The procedure continued until the third teaching phase was finalized. Sessions were video recorded.

Scoring and reliability

Participants' responses were scored based on the recordings. For each trial, it was judged if a child taught a general (scored '1' for correct) or episodic (scored '0' for incorrect) statement. Answers did not have to match original statements verbatim as long as they were meaning-preserving, e.g. 'Hummingbirds drink pollen' (original episodic statement = 'These hummingbirds are feeding at flowers') or 'Sheep have many bellies' (original generic statement = 'Sheep have four stomachs') were scored '0' or '1', respectively. A '2' for 'other' was scored if a child i) gave no answer or said she does not know or remember (36 trials), ii) gave an unintelligible answer (4 trials), iii) said something that was not in the book (6 trials), or iv) blended parts from generic and episodic statements (1 trial). To assess inter-rater reliability, a second rater, who did not know which content was presented as general or episodic, first judged for 8 (> 25%) randomly chosen children which of two contents (e.g. of hummingbirds: fly backward/feed at flowers) a child reproduced. Based on an answer key, the rater then translated the content into '0' and '1'. If neither content was reproduced, a score of '2' was given. Inter-rater reliability was excellent, with Kappa = .95.

To investigate if children taught using generic or episodic language, an independent research assistant first transcribed children's answers and then judged what language format was used. Verb tense was decisive: '1' for 'generic' was coded if the verb was in simple present (e.g. 'They rub their necks') and '0' for 'episodic' was coded if the verb was in present or past progressive ('They were rubbing their necks') or simple past ('They rubbed their necks'). A '2' for 'neither' was coded if the utterance contained no verb, which occurred in 8 trials. A second rater, who was ignorant about which content was coupled with which information type, made the same determination for the answers of 8 (> 25%) randomly selected children. Inter-rater-reliability was excellent (Kappa = .97). Disagreements were resolved by discussion.

Results

In 313 out of a total of 360 trials, children produced information that was coded as either general or episodic in content (the remaining 47 were scored as '2' for 'other'; see 2.1.4). The following analyses are based on these 313 trials.

Information type taught: general vs. episodic

Two separate Generalized Linear Mixed Models (GLMMs) for repeated measures with a binomial error structure and a logit link function using the 'glmer' function in the 'lme4' package (GLMM; Baayen et al., 2008), with subject included as random effect, were run in R to test for effects of demographic and experimental variables. They showed that neither age, gender, race, *p*s > .60, nor order of information type (episodic vs. general first) or trial had any effect on what children taught, *p*s > .37.

On average, children taught general information in 62% of the cases and episodic information in 38%. Figure 2 shows how many children taught general information within a specific range of percentages. It displays that 80% of children taught a minimum of 50% general information and that half of all children taught at least 60% general information. A t-test with 3,000 bootstrap iterations comparing children's responses to chance set at 50% revealed that children taught general information significantly above chance, t (312) = 22.55, $p < .001$.

Language format used: generic vs. episodic

Two GLMMs, one for demographic variables and the other for experimental variables, were conducted to test whether they impacted the language format children used. Age, gender, and race, *p*s > .17, as well as order of information type (episodic vs. general first) or trial had no effect, *p*s > .24.

As Figure 3 shows, children produced generic statements in 90% (283 trials) of cases, e.g. 'Giraffes rub their necks together', 'They keep their eyes open at night' (of ants). In 7% (22 trials) they generated episodic statements, such as 'They were carrying big crumbs' (of ants), 'Sheep are eating grass'. Statements could not be classified as generic or episodic for the remaining 3% (8 trials) of cases because they contained no verb. A t-test with 3,000 bootstrap iterations showed that children used generic language significantly more often than would be expected by chance (set at 50%), t (304) = 62.53, $p < .001$.

The data show that even if children selected episodic rather than general information, they mostly (87% of cases) cast the information in generic form. For example, they generalized the episodic statement 'These giraffes are rubbing their necks' to 'Giraffes rub their necks'. In contrast, children turned general into episodic information by substituting the present tense of the original statement with progressive or simple past tense, in only 4% of the cases.

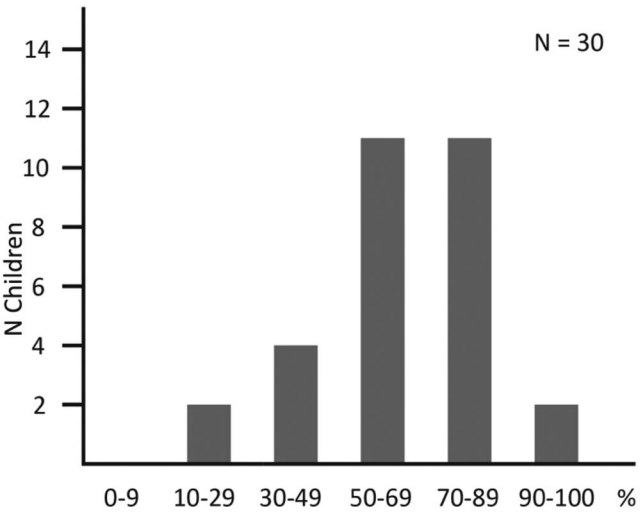

Figure 2. Number of children who produced a given percentage of general information in experiment 1.

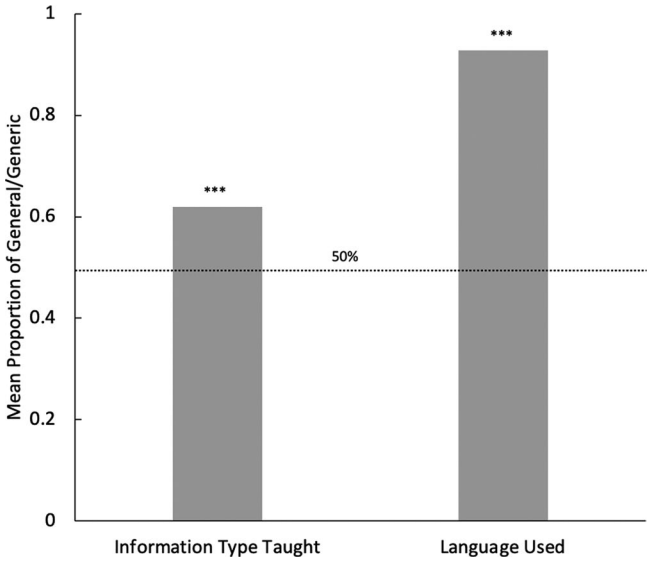

Figure 3. Mean proportion of children's general/generic responses in experiment 1.
Note. '*Information Type*' and '*Language Used*' refer to children's reporting of general fact content and children's use of generic speech, respectively. ***$p < .001$.

Discussion

The experiment suggests that by 4 years, children grasp that the aim of teaching is to spread general knowledge. Teaching conveys facts not about particular individuals but about kinds (e.g. Rödl, 2020). We are taught that giraffes, as a species, have black tongues, not that a particular giraffe has a black tongue. In the experiment, children displayed their knowledge of the generality of teaching in two ways. First, they selected mostly general information content and second, they predominantly used generic language to teach the information. One might wonder whether children simply relayed the information in whatever linguistic form they had heard it. This, however, was not the case, as in 87% of the cases in which children transmitted episodic information, they generalized the information, e.g. by changing 'These sea otters are floating on their backs' to 'Sea otters float on their backs'.

The findings support the view that young children are not only receptive to teaching but also have astonishing skills of teaching others (Strauss, 2005; Strauss & Ziv, 2012; Strauss et al., 2002). By 4 years old, children teach by equipping others with valuable general knowledge, as recognized by its generic form. Unlike testimony, which gives only snapshots of what occurred at particular times and places, teaching gives learners insights into how the world is generally made up.

Limitations of the experiment, however, demand caution. Children's prior knowledge of the animals may have biased their answers. Additionally, information content was yoked to information form. Some of the general, but none of the episodic, information referred to bodily properties (having hearts and stomachs, laying eggs) that are often mentioned in natural-historical descriptions of animals (Thompson, 2008). This content may have been more memorable or more strongly associated with teaching than the episodic content. The experiment also lacks a baseline condition to establish how often children recount general information and speak generically outside of pedagogy. Such a condition is crucial because it has been reported that generics are remembered and processed more easily than non-generic sentences (Cimpian & Erickson, 2012), and the topic of animals especially provokes generic speech (Brandone & Gelman, 2009). These problems were addressed in the next experiment, which investigated whether young children can judge solely by the linguistic format which information about fictional animals they should teach.

Experiment 2

In this experiment, fictional (but realistic) animals were used so that children's answers could not be impacted by prior knowledge. Additionally, information content (e.g. having a certain property) and information type (general vs. episodic) were independently manipulated. For example, 50% of the children learned 'The tart beetle sleeps on its back' (general) and 'This tart beetle's legs are sticking to things' (episodic), while the other 50% learned 'The tart beetle legs stick to things' (general) and 'This tart beetle is sleeping on its back' (episodic). Definite singular noun phrases, e.g. 'The Sparie', which refer to kinds as do bare plurals (Krifka et al., 1995), were used to simplify illustrations. In addition to the Pedagogical Condition, in which children were again asked to teach, a Non-Pedagogical Condition was conducted in which children had to narrate the animal events to a puppet.

Methods

Participants

The sample size of each condition was matched with that of Experiment 1. There were 60 participants total, with 30 (15 female) 4-year-olds in the Pedagogical Condition ($M = 4;7$ months, range = 3;10 – 5;0 months) and 30 (15 female) in the Non-Pedagogical Condition ($M = 4;6$ months, range = 4;2—4;11 months). Five additional children (four from the Pedagogical Condition) were tested but excluded due to uncooperativeness. Parents consented to their child's participation before the experiment. Per parent report, 47 children were White, 3 were African American, 4 were Asian, and 6 were of mixed race. Twenty-five children were Latinx. Children's socio-economic status as measured by annual household income varied from below $20,000 to above $120,000. Children in the Pedagogical Condition were tested in-person at the University's child laboratory (7), a children's museum (14) or a local preschool (9); they received a toy for participation. Due to the COVID-19 pandemic, the Non-Pedagogical Condition (30), which was added after completing the Pedagogical Condition, was conducted online. Parents received an electronic gift card for their child's participation.

Material, design, and procedure

In the Pedagogical Condition, the same classroom diorama as in Experiment 1 was used. Again, three colored books (pink, yellow, and blue) with four animals each were used. Because animals were fictional, an introduction page (e.g. 'This is a Sparie') preceded the two pages illustrating the information content, as shown in Figure 4. Prompt cards (3.3 × 3.3 cm) were used to elicit teaching about a given animal. For the Non-Pedagogical Condition, the books were digitized and shown on Zoom as sets of colored Google Slides (pink, yellow, and blue). A puppet

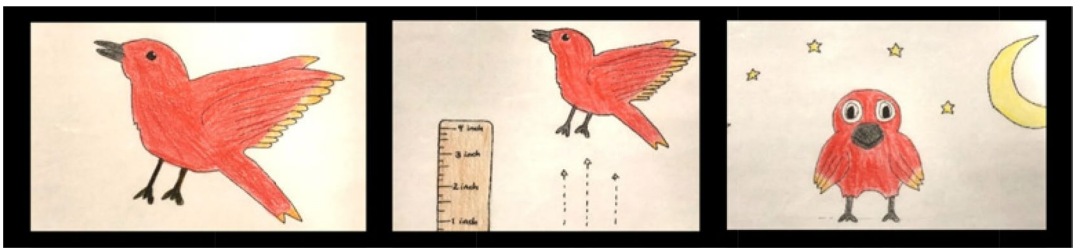

Figure 4. Pictures from three book pages in the learning phase of experiment 2.
Note. The animal ('Sparie') is introduced on the first page (left). The next two book pages illustrate information content presented as either general or episodic: 'The Sparie jumps 4 inches high'/'This Sparie is jumping 4 inches high' (center) and 'The Sparie keeps its eyes open at night'/'This Sparie is keeping its eyes open at night' (right)

(40 × 20 cm) instead of a classroom diorama was used for children to share what they had learned about the animals.

The design was as in Experiment 1 with the difference that information content (e.g. 'sleep on back' vs. 'have legs that stick to things') and information type (general vs. episodic) varied independently. Fifty percent of children learned, for example, 'The tart beetle sleeps on its back' (general) and 'This tart beetle's legs are sticking to things' (episodic), while the other 50% learned 'The tart beetle's legs stick to things' (general) and 'This tart beetle is sleeping on its back' (episodic).

The procedure of the Pedagogical Condition was as in Experiment 1, with the only difference that E first introduced the animal ('This is a tart beetle') on a separate page before presenting the two statements about the animal to the child.

In the online-delivered Non-Pedagogical Condition, E shared her screen with the child's parent and initiated the Learning Phase by stating: 'I have a book here, let's read it'. E then went through the pages in the way she did in the Pedagogical Condition. When she was finished with the teaching phase of a given book, she started the narration phase by holding up the puppet and stating 'This is Zoomy. He was gone and couldn't see or hear anything about the animals. You can tell him what you remember, ok?' E randomly removed a prompt-card from the envelope and said 'The [*animal name*]; what is one thing the [*animal name*] was doing?' In both conditions, the same prompts as in Experiment 1 were used if a child gave no or an unrelated answer.

Scoring and reliability

The same scoring and reliability procedures were used as in Experiment 1. Inter-rater-reliability for classifying children's responses as 'episodic' ('0'), 'generic' ('1'), or 'other' ('2') was very good (overall Kappa = .89; with Kappa = .84 and .91 in the Pedagogical and Non-Pedagogical Condition, respectively). A score of '2' was given in 112 (Pedagogical Condition = 62; Non-Pedagogical Condition = 50) out of 720 trials because the child gave no response/did not remember (72 trials; Pedagogical Condition = 42, Non-Pedagogical Condition = 30), said something unrelated/not from the book (34 trials; Pedagogical Condition = 17, Non-Pedagogical Condition = 17), or said something unintelligible (6 trials; Pedagogical Condition = 3, Non-Pedagogical Condition = 3). Inter-rater reliability for judgments of which linguistic form (episodic or generic) children used was excellent (overall Kappa = .95; with Kappa = 1 and .89 in the Pedagogical and Non-Pedagogical Condition, respectively). A score of '2' was given in 19 (Pedagogical Condition = 13; Non-Pedagogical Condition = 6) because the linguistic form was ambiguous since the verb was elided. Disagreements were resolved by discussion.

Results

To assess whether the different modes of administration (in-person vs. online) of the two conditions had an effect, we compared the number of valid responses (responses coded as 'general' or 'episodic') in the two conditions. Children produced an average of 10 valid responses in the Non-Pedagogical Condition, compared to 9 in the Pedagogical Condition—a difference that is not significant, $p = .74$, $d = .09$. We also compared children's attention in the learning phases of the two conditions by measuring for 25% randomly selected children from each condition how long they focused on the books' pages (in-person) or slides (online). Attentional rates were virtually indistinguishable in the Pedagogical and Non-Pedagogical Conditions (96.87% versus 96.48%), $p = .76$, $d = .03$. From these data we infer that it is safe to consider the results from the two conditions comparable.

In 608 out of 720 total trials, children produced information that was coded as either general or episodic in content (with scores of '2' for 'other' for the remaining 112 trials, see 3.1.3). The following analyses are based on these 608 valid trials.

Information type taught/narrated: general vs. episodic

The same two GLMMs as those in Experiment 1 were run to test for potential effects of demographic variables and experimental factors other than those related to the hypotheses. These models showed no effect of gender, age, or race, *p*s >.10; they also showed no effect of order of information type (episodic vs. generic first), or trial, *p*s > .14.

On average, children in the Pedagogical Condition taught 64% general and 36% episodic information; children in the Non-Pedagogical Condition narrated 51% general and 49% episodic information. Figure 5 represents for each condition how many children taught/narrated general information within a given range of percentages. Whereas 63% of children in the Pedagogical Condition taught a minimum of 60% general information, only 27% of children did in the Non-Pedagogical Condition.

Two t-tests each with 3,000 bootstrap iterations showed that in the Pedagogical Condition children taught general information significantly more often than expected by chance (set at 50%), t (297) = 5.06, p < .001; in the Non-Pedagogical Condition, by contrast, children taught general information at chance level, t (309) = −.34, p = .73.

To compare how often children reported general information in the two conditions, we ran a GLMM for repeated measures with a binomial error structure and a logit link function using the glmer function in the 'lme4' package. The model included condition (Non-Pedagogical coded as '0' vs. Pedagogical, coded as '1') as the predictor, subject as random effect, and information type taught/narrated ('general' coded '1', 'episodic' coded '0') as dependent variable. As Figure 6 shows, the GLMM yielded an effect of condition, with children reporting more general information in the Pedagogical than in the Non-Pedagogical Condition, ß = 0.62, p < .001.

Language used: generic vs. episodic

The same GLMMs as in Experiment 1 were run to test for possible effects of demographic and experimental variables other than those relevant for the hypothesis. Gender, age, or race had no effect, *p*s > .09, and neither did order of information type (episodic vs. generic first), or trial, *p*s > .45.

We measured the number of trials in which children used generic versus episodic language in the two conditions. In the Pedagogical Condition, children taught using generic language in 87% (248 trials) of cases and episodic language in the remaining 13% (37 trials), stating, e.g. 'It hided [sic] in leaves' (of Loba Lizard) or 'Had sand in its mouth' (of Leopard Fish). In the Non-Pedagogical Condition, 80% of children's statements were episodic in form and 20% were generic.

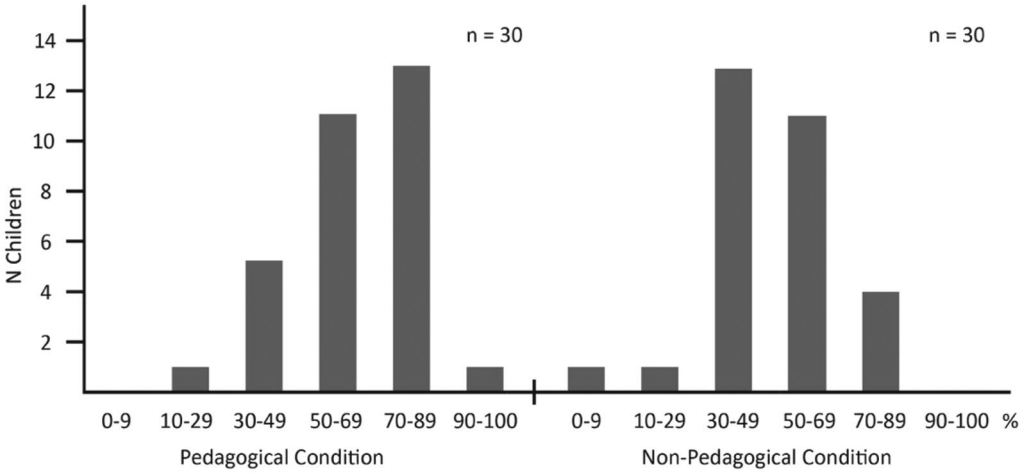

Figure 5. Number of children who produced a given percentage of general information in experiment 2.

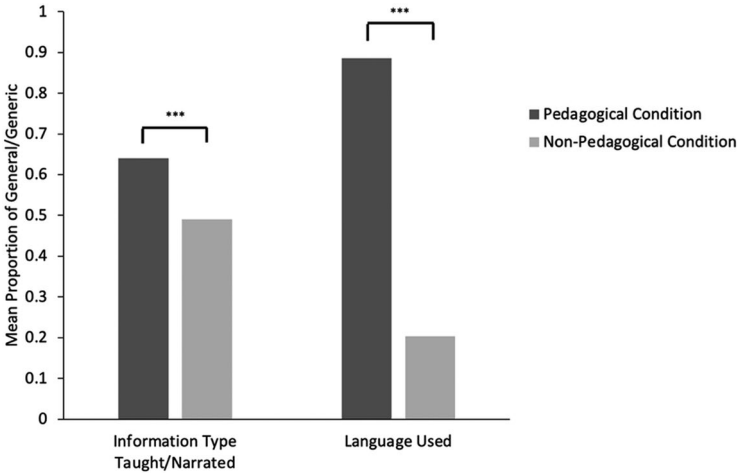

Figure 6. Mean proportion of children's general/generic responses between conditions in experiment 2.
Note. ***$p < .001$.

Two t-tests each with 3,000 bootstrap iterations showed that in the Pedagogical Condition children used generic language significantly more often than expected by chance (set at 50%), t (284) = 18.56, $p < .001$; children in the Non-Pedagogical Condition used *episodic* language significantly more often than expected by chance $t(303) = -12.79$, $p < .001$.

To compare children's language use across conditions, the same GLMM conducted to measure differences in reported information type was run, with the difference that the dependent variable was language format ('generic' coded '1', 'episodic' coded '0'). The model yielded an effect of condition, with children producing more generic statements in the Pedagogical than in the Non-Pedagogical Condition, ß = −7.29, $p < .001$.

As in Experiment 1, children who transmitted episodic information in the Pedagogical Condition frequently presented the information in generic form. Of the statements with episodic content, 86% were formulated in generic language, indicating that children generalized the information by replacing progressive tense with simple present, e.g. by turning 'This Sparie is jumping 4 inches high' into 'The Sparie jumps 4 inches high'. In the Non-Pedagogical Condition, children turned episodic information into kind-referring information in only 15% of cases.

Discussion

This experiment replicated the findings from Experiment 1 under more stringent conditions. First, by using fictional animals, we ruled out that children's teaching was biased by preexisting knowledge of animals. Second, we showed that children's preference for teaching general information cannot be explained by more salient or memorable informational content. General and episodic information with the same content was constructed by attaching a given predicate to either a species or an individual ('The Sparie jumps 4 inches high' vs. 'This Sparie is jumping 4 inches high'). There was thus nothing peculiar about the content of general information, which differed from episodic information only in linguistic form.

A Non-Pedagogical Condition in which children told a puppet about events revolving around the animals confirmed that children transmit general information and speak in generic terms less often outside of teaching contexts. This is important because prior work suggested that children process and remember generic statements better than non-generic statements (Cimpian & Erickson, 2012), and that, compared to other topics, animal themes lead to higher rates of generics in children (Brandone & Gelman, 2009). In our experiment, children relayed more general information and spoke in generic terms more often when the goal was to teach than to simply narrate. The fact that different modes of administration were used for the two

conditions of this experiment is not ideal. However, statistical comparisons of counts of invalid trials and of children's attention suggest that the in-person and online-collected data are comparable.

A shortcoming of the experiment might be that the classroom audience in the Pedagogical Condition was switched to a single listener for the Non-Pedagogical Condition. A more stringently controlled comparison would involve an identical number of audience members. Our selection of the audiences was based on considerations of what constitute prototypical teaching versus narrative scenarios. A prototypical teaching context involves a classroom, whereas a prototypical narrative context is one in which one individual tells another something. Multiple audience members, we thought, might evoke pedagogical associations in children. Although an identical number of audience members across conditions may have yielded a tighter control, the Non-Pedagogical Condition effectively rules out that children's responses in the Pedagogical Condition reflect pervasive mnemonic or attentional biases for general information, since no such biases were manifested in the Non-Pedagogical Condition.

General discussion

Our findings contribute to a growing body of research showing that by preschool age, children have remarkable knowledge of what teaching is and how it is done. Already in infancy, humans benefit from others' pedagogical efforts (e.g. Egyed et al., 2013; Yoon et al., 2008). No other form of learning shapes the way in which young learners conceptualize the world as much as teaching does (Butler & Tomasello, 2016). Pedagogy thus plays a special role in children's lives almost from the beginning (Csibra & Gergely, 2011). Astonishingly, soon after receiving the benefits of pedagogy, children by around age 3 start being able to return the favor and teach others: first by demonstrating actions and then increasingly by sharing propositional knowledge (Strauss et al., 2002). This reflects a change in preschoolers' conception of teaching, with preschoolers conceiving of teaching as demonstrating at first and later as uttering statements (Astington & Pelletier, 1996). What our study adds to the knowledge of this progression is that by the time children associate teaching with making statements, they are aware of a crucial aspect that distinguishes teaching from mere testimony (Rödl, 2014, 2020; Small, 2014). Testimony gives particular individuals particular bits of information—information that can alternatively be gathered by perception. Instead of hearing from me that Aunt Berta had oatmeal for breakfast, you could have observed the event yourself. By contrast, knowledge acquired via teaching, such as 'Oatmeal is healthy', is general and can, if at all, only be discerned through extensive observations. Teaching has therefore been argued to be the most efficient and reliable way to come by general knowledge, making it a major mechanism of cultural evolution (Tomasello et al., 1993).

As natural pedagogy theory states, generic speech plays a key role in pedagogy because it makes explicit that what is talked about are categories or kinds, not particulars. Confirming this idea from the learner's side, Butler and Tomasello (2016) observed through children's object explorations that toddlers make more inductive generalizations when pedagogical cues are combined with generic object labels (e.g. 'doffels'). On the side of production, Gelman et al. (2013) observed that 5- and 6-year-olds used generics when pretending to teach a learner, but instead tended to share personal information in pretend conversations with a peer. Baer and Friedman (2018) found that 4- and 5-year-olds share more general information—defined as information true of many or most objects of its kind—when teaching than when telling someone about things. However, children shared an equal amount of episodic information in teaching and telling contexts and tended to relay general information regardless of context.

We exerted more experimental control by using a forced-choice paradigm in which children could pass on one of two pieces of information (general or episodic). This made coding for content more straightforward and allowed us to separately analyze the form of language children used to transmit the information. In both experiments, children predominantly selected general, at the expense of episodic, information to teach. While in Experiment 1, cues as to whether a

piece of information children learned was general could potentially be found in the content (e.g. having four stomachs; laying the biggest eggs in the world), in Experiment 2 only the generic language signaled generality. In a Non-Pedagogical Condition, in which children were asked to narrate the animals' activities, children transmitted less general information and were less likely to use generic language (measured by simple present versus simple past or progressive tense). Our results differ from those of Baer and Friedman (2018) in that children shared less, rather than an equal amount of, episodic information in the Pedagogical compared to the Non-Pedagogical Condition. We also found no trend for children to prefer general over episodic information across communicative settings. These differences can in part be explained by the mutual exclusivity of general versus episodic information-sharing and the binary instead of graded coding approach of our study. Furthermore, answers were coded as general in our study only if their content matched the information children had previously learned in generic form, whereas in Baer and Friedman (2018) study, any ad-hoc references to properties shared by many exemplars of a kind were regarded general. Their study thus used more liberal judgments of what counts as general information.

Descriptively, children in both present experiments taught using generic language more reliably (90% and 86% in Experiments 1 and 2, respectively) than they shared general information content when teaching (62% and 64% in Experiments 1 and 2, respectively). This décalage might be explained by the fact that children are immersed in generic speech from infancy (Gelman et al., 1998; Pappas & Gelman, 1998), giving them ample opportunity to adopt a pedagogical manner of speaking, while arguably having much less experience with choosing specific content to teach. Another reason why children's choices of general information was less consistent than their use of generic language is that the entire learning phase may have had a pedagogical flavor. Because episodic information was mixed in with general information, children may have taken statements like 'This Dango is flying at night' to mean 'The Dango is a night-active animal'. Using examples to illustrate general facts or principles is commonplace pedagogical practice (e.g. Rowland, 2008). To prevent children from assuming that episodic information is general information guised in narrative form, one might more strictly separate episodic from general information in future studies, e.g. by reading an educational and a storybook to children and then having them choose one of the books to teach another child.

Theoretically, our study confirms Gelman et al.'s (2013) hypothesis that young children grasp the nexus between pedagogy and generality by showing that young children not only speak in generic terms when teaching—which these authors had demonstrated for 5- and 6-year-olds—but also select general information content. The findings furthermore support Tomasello's (2019a) proposal that preschoolers are aware that someone speaking in the role of a teacher addresses them 'in the name of science' and thus shares with them general, objective knowledge about the world rather than mere opinion or subjective impressions. Young children, our study indicates, have an incipient ability to speak in the name of science and spread scientific knowledge among learners.

Along with other studies, our investigation demonstrates that children master the practice of pedagogy from both sides, that of the learner and that of the teacher (see Qiu & Moll, 2022). This is in accord with shared intentionality theory, which states that even toddlers cognize simple cooperative activities from a 'bird's eye view' and perceive them as broken down into complementary roles, such as giver-taker, speaker-listener, etc. (Tomasello, 2019b). By age 4, children master not only the reversal of roles in basic, symmetrical relations, such as giver and taker during object exchanges, but also roles involved in more complex, asymmetrical relations such as that of the teacher and learner within a cooperative exchange of general information.

Limitations of this study have to be acknowledged. One is the lack of multiple age groups for comparison. The developmental steps children take before coming to learn that teaching is the sharing of general knowledge remain unexplored. Because children had to remember and reproduce statements presented to them a single time, we doubt that the method we used is suited for younger children. This hunch is confirmed by studies in which 3-year-olds were

mostly unable to complete information-transmission tasks (Baer & Friedman, 2018). Alternative, e.g. action-based, measures that allow for comparisons between toddlers and preschoolers should be devised. A potential method mentioned earlier involves having children choose between different books or instructional material. A further possibility would be to operationalize the general-episodic distinction within procedural, not declarative, knowledge by having children demonstrate or display, rather than articulate, knowledge for a learner.

Future investigations should also inquire whether young children spread general knowledge more widely than testimonial knowledge. Unlike testimony, which is typically meant for specific individuals, teaching is an open conversation that potentially addresses all of humankind (Oakeshott, 1959; Rödl, 2014). Relatedly, it has been shown that toddlers predominantly share with novices what they themselves acquired via pedadogy rather than what they learned non-pedagogically (Vredenburgh et al., 2015). In that study, toddlers were *asked* to share what they knew. To take this general line of work further, one might examine whether children teach what they know spontaneously, even to strangers, while relaying testimonial knowledge only when it is requested or personally relevant for the learner. Such investigations will further deepen our understanding of the origins and early forms of pedagogical cognition.

Lastly, our findings point to a potentially fruitful direction for cultural evolutionary theorizing, as they suggest that human-specific forms of social learning differ from non-human-specific ones not primarily in what learners do or how they do it (e.g. Tomasello et al., 1993), but in what learners and teachers each take themselves and their partner to be doing; namely, in the case of teaching, exchanging general knowledge. Moll and Kern (2020) refer to teaching as a 'self-conscious' process in which learner and teacher know of their joint engagement in a cooperative undertaking the goal of which it is to advance the learner's knowledge. More research should be conducted to unravel children's understanding of the shared nature of a pedagogical goal and, more generally, of the importance of participating in cooperative pedagogical encounters with others for the advancement of their knowledge and skills.

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Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

The data that support the findings of this study are available through Open Science Framework at https://osf.io/j82eu/?view_only=44287b206e334e6eb933479cddc18ae8

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