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SHORT REPORT

Preschoolers have better long-term memory for rhyming text than adults

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Abstract

The dominant view of children's memory is that it is slow to develop and is inferior to adults'. Here we pitted 4-year-old children against adults in a test of verbatim recall of verbal material. Parents read a novel rhyming verse (and an integrated word list) as their child's bedtime story on ten consecutive days. A group of young adults listened to the verse, matching the exposure of children. All participants subsequently performed a free-recall of the verse, verbatim. (Parents and young adults knew they would be tested; children did not.) Four-year-olds significantly outperformed both their parents and the young adults. There were no significant differences in the ability to recall the gist of the verse, nor the integrated word list, allaying concerns about differences in engagement or motivation. Verbatim recall of verse is a skill amenable to practice, and children, we argue, by virtue of the prominence of verse in their culture and their reliance on oral transmission, have honed this skill to exceed adults'.

Research highlights

- Long-term, verbatim memory for a novel, rhyming verse was tested in three groups: 4-year-olds and their parents (who read them the verse) and in a group of young adults.
- Four-year-olds outperformed both groups of adults, with free-recall of nearly twice as many correct words of the verse, and far fewer errors.
- Children's memory for *verbatim* recall is excellent as they cultivate a skill for retaining verse.
- Children form a preliterate society reliant on memory for rhythm and rhyme for the oral transmission of their culture.

> But when they came to letters, this, said Theuth, will make the Egyptians wiser and give them better memories … Thamus replied: … this discovery of yours will create forgetfulness in the learners' souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves …. an aid not to memory, but to reminiscence …. (Plato, *The Phaedrus*, quoting Socrates, approx. 370 BC)

Introduction

Preliterate societies have relied on verbal memory and recall to transmit culture for thousands of years. While the memory abilities of members of these societies may not live up to the myth (Goody, 1998), the skill nonetheless finds continuous, obligatory exercise as there is no external storage. Here we describe a group of preliterate individuals that similarly exercise and rely on verbal memory – particularly for verse – for the transmission of their culture: young children.

In 1975 Ann Brown noted that 'rhymes, accompanied by music, are readily acquired and can be reproduced exactly even by quite young children …. The efficiency of using musical rhymes as information sources, while extensively used by media advertising aimed at children,

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and programs like Sesame Street, has not been studied by developmental psychologists' (Brown, 1975, p. 112). Forty years later, this statement is still largely true. This leaves unevaluated the suspicion of many parents: that their children – characterized as having weaker memory in every other domain (STM, Gathercole, 1998; LTM and declarative memory, Bauer, Wenner, Dropik & Wewerka, 2000; Hayne, Boniface & Barr, 2000) – remember their nursery rhymes better than they do. Here we compare long-term memory for verse in a group of 4-year-olds to that of their parents (who read them the verse) and to a group of young adults (who passively listened to the verse). Four-year-olds outperformed both groups.

Children's verbal memory

Children's verbal memory shows protracted development. Development brings increases in representational flexibility (Bauer & Dow, 1994; Barnat, Klein & Meltzoff, 1996; Gergely, Bekkering & Király, 2002; Király, 2009) and in the capacity of declarative memory (Hayne *et al.*, 2000; Bauer *et al.*, 2000), as well as gradual increases in working memory performance for verbal material into adolescence (Gathercole, 1998), that is likely related to emerging language abilities (Simcock & Hayne, 2003). Protracted development is also evident in the Paired Associate Learning (PAL) test of the Wechsler Memory Scale (e.g. Halperin, Healey, Zeitchik & Ludman, 1989; Beardsworth & Bishop, 1994; see also Heil & Jansen, 2008) and in contrasts between verbatim and gist memory; e.g. Reyna and Kiernan (1994) found that verbatim memory for prose decayed faster than gist, in 6- and 9-year-olds (see also Brainerd & Gordon, 1994).

Children's verbatim memory for verse specifically (rhyming stories, songs, and poems) has not been well studied. Instead, the focus has been on whether verse helps children remember *content* (do rhymes help children learn?). Results have been mixed. For example, Sheingold and Foundas (1978) found that while rhyming helped 6-year-olds remember the sequence of story events, content memory was the same as for prose. Hayes and his colleagues (Hayes, Chemelski & Palmer, 1982; Hayes, 1999) found that memory for content presented in verse was actually worse than when presented in prose, unless children were tested specifically on content carried by the rhyming words themselves. Similarly, it was found that children show better memory for content when presented in prose form rather than an educational televised song (Calvert, 2001; Calvert & Billingsley, 1998). These and similar results have led to skepticism about the utility of verse as an educational aid.

How can we reconcile these results then with the conventional wisdom (Read, 1976; Brown, 1975) that children's memory for verse is somehow better than for prose? The critical factor is that the studies showing poorer memory for verse were based on tests of content, while anecdotal evidence that children better remember verse is typically based on their ability to *recall the verse itself*. For content retention, verbatim coding is not necessary. Indeed, Hayes *et al.* (1982; Hayes, 1999) supposed that since verse is better liked by children, and intrinsically encourages attention to phonological characteristics (i.e. the rhythms and rhymes themselves), children are biased toward the retention of this information, at the expense of content. This makes a concrete prediction: children's memory for the phonological characteristics of a verse – i.e. *verbatim* recall – should be excellent (see Calvert & Tart, 1993; Read, Macauley & Furay, 2014).

Memory for verse is a skill

Sachs's (1967) classic study in adults demonstrated that verbatim information decays quickly, even in short-term memory. With verse, memory is more robust. Tillmann and Dowling (2007) had adult participants attempt to discriminate between a phrase drawn from a memorized text versus a paraphrased lure. For prose, verbatim memory declined over time, but for verse, it did not. This is consistent with Rubin's (1995) observation that verse aids memory by providing constraints during recall (e.g. the position of a to-be-recalled word in the rhyme scheme of the verse may influence retrieval: a memory that the next to-be-recalled word is not just an animal, say, but also a one-syllable rhyme for 'rat', trims the possibilities; see Rubin, 1995; Rubin & Wallace, 1989; see also Bower & Bolton, 1969).

Importantly for our study, the exploitation of such constraints is a skill amenable to practice – analogously to experts' famously skilled memory for chess positions (Chase & Simon, 1973; for a review see Ericsson & Kintsch, 1995; a phenomenon that appears even with young, 10-year-old chess experts, whose memory can exceed that of naïve adults (Chi, 1978; Schneider, Gruber, Gold & Opwis, 1993)). With verse, Rubin, Wallace and Houston (1993) found that when novice adults memorized and recalled a set of ballads, they were better at memorizing and recalling a subsequent, novel ballad than untrained adults; various useful constraints, for example 'surface-level' cues (rhyme and rhythm) and content-level cues (stereotyped event structure), had been acquired. We argue that children – by virtue of the prominence and ubiquity of verse in their life, their preliterate inclination to memorize it, and their

dependence on oral transmission – practice this skill more than adults.

Method

Participants

Thirteen *Parents* (mean age = 35;6 years, *SD* = 3;4 years, age range: 29–41 years, all females) and their 14 *Children* (one twin pair; mean age = 4;8 years, *SD* = 2 months, age range = 4;6–4;10 years, 10 females) from Budapest, Hungary participated in the study (one additional pair was excluded due to the child's refusal to participate during testing). Four-year-olds were chosen for this study because they were not yet reading (as confirmed by their parents) but had experience with verse. Thirteen university students from Eötvös Loránd University in Budapest participated in the *Young Adult* group (mean age = 25;10 years, SD = 4;2 years, age range: 21–33 years, 7 females), and received class credit. All participants were native Hungarian speakers. Sample sizes were determined by an a priori power analysis and were similar to Rubin *et al*. (1993). All experiments were conducted in accordance with the relevant ethical regulations, and the approval of the Ethical Committee of the Faculty of Education and Psychology, Eötvös Loránd University. Adults gave informed consent prior to participation; children, assent.

Materials

Our verse was a short, 167-word, rhyming (AABB rhyme scheme) poem, '*The Radish-nosed King*' by Aliz Mosonyi (see Supplementary Materials). We chose this poem because, while suitable for 3–5-year-old children, it has a varied, interesting vocabulary, verse structure, and content that makes it engaging for adults as well. The verse was novel to all participants.

We also tested participants with a 'word list' of eight unrelated words. This list was included as a measure of general attention and engagement. Four of these words were nonsense words that conformed to the phonological rules of Hungarian (*irim*, *tentusz*, *kavu*, *bólum*), and four were meaningful words selected from the 400 and 800 most frequent words in the Essex Children's Printed Database (*kalap [hat]*, *ruha [dress]*, *csónak [boat]*, *tenger [sea]*). We introduced this distinction to probe the contrast that Calvert and Billingsley (1998) reported in the verbatim recall of 'Frere Jacques' where English-only speaking children better recalled the 'nonsense' (French) version than the meaningful English 'Brother John' version. Critically, the word list was integrated with the verse but, by design, did not share in its rhythm and rhyme. Integration was achieved by adding a short introduction to indicate that the main character (the Radish-nosed King) spoke the words on the list. The word list either preceded or followed the verse (counterbalanced within groups). When it appeared before, the verse started with, 'I will tell you a story about the Radish-nosed King who is a very peculiar fellow. When the King is angry, he shouts like this: {*Kalap!*, *Irim!*, *Ruha!*, *Tentusz!*, *Csónak!*, *Kavu!*, *Tenger!*, *Bólum!*}'; after the verse it read, 'I've told you a story. . . .'

Procedure

Parent–child protocol

Parents were asked to read *The Radish-nosed King* (from a picturebook) as their 4-year-old's bedtime story for ten consecutive nights. We chose this procedure because Reyna and Brainerd (1995) suggested that a greater opportunity to practice enhances recall of verbatim and content information even in young children. Parents were instructed to avoid discussing or reading the verse outside these readings. Parents were asked whether their child had interrupted the reading (e.g. with comments or questions). Only one mother reported that her child asked her to explain the word 'cigánykerekeztek' [*do cartwheels*]. (This is consistent with a pilot study using the same procedures, where videotaped recordings of the reading sessions showed no substantive interaction.) Importantly, parents were told that they would be tested at the end of the series of sessions, while children were not.

Young adult protocol

Young Adults received the instructions and test materials as an audio recording (recorded by a female reader, who used child-directed speech to mimic the recitation style of parents, and signaled when to turn the pages of the book). Young adults were asked to listen, and only listen, to the verse at bedtime for ten consecutive days, while looking at the pictures in the book (the text was excised), thus mimicking the experience of the child group. Young adults were given a written schedule, periodic reminders, and were asked to report any lapses in protocol (none were reported). Young Adults were told that they would be tested on their recall.

Free-recall and gist tests

On the day following the last session, a battery of tests was administered. First, all participants attempted a free-recall of the verse, verbatim, using just the original storybook's illustrations as cues (please see Supplementary Materials

for an example recording from a child participant). We used free-recall as this places greater demands on verbatim memory than recognition tests, and more efficiently assesses knowledge of surface structure, i.e. the full set of words, in sequence. These procedures are similar to those used in Rubin *et al.*'s (1993) work on memory for ballads, and parallel those of oral traditions in preliterate societies (Goody, 1998). During recall, if a participant paused for more than 3 seconds, or asked for help, they were prompted with the next word in the verse. (We introduced prompts since Beardsworth and Bishop (1994) found that children who were unable to recall a verse after a 45-minute delay often showed dramatic improvements when given a single prompt.) Following verse recall, participants attempted to recall the word list. Prompts were not given during word list recall. Next, participants were asked about the gist (e.g. 'What was the story about?'). If a participant failed to list the main characters and the three central events in the verse spontaneously, additional, open-ended questions were asked (e.g. 'Who else was there?', 'What happened next?').

Afterwards, we administered the Peabody Picture Vocabulary Test (Dunn, 1959, Hungarian adaptation: Csányi, 1976) to measure children's verbal competence. Also, the socioeconomic status of parent–child pairs was assessed using a standard SES questionnaire. Results from these tests are reported in the Supplementary Materials.

Scoring

Verse recall reflects the number of correct words, in proper sequence, produced during free-recall, including articles. Correct word stems, but with the wrong case, were considered correctly recalled. We also calculated *verse error*, a sum of *intrusion* errors (erroneous words produced during recall) and *confusion errors* (paranyms, synonyms, and word or line order transpositions). *List recall* was analyzed separately, counting each correctly recalled word and nonsense word (maximum: 8). *Gist recall* was coded by determining the number of recalled main characters (out of 3: the Radish-nosed King, the radish children, and the mouse) and the number of correctly recalled main events (out of 3: the anger of the Radish-nosed King, the actions of the mouse, and the King's forgiveness), as scored by six independent raters.

Results

Free-recall for the verse

Children correctly recalled significantly more words, with significantly fewer errors, than both adult groups. First, the dependent variable of the mean number of correctly recalled words (*verse recall*) was analyzed, using an ANCOVA with between-subject grouping variables for group (Children, Parents, or Young Adult) and 'list placement' (list before, or after, verse). The number of *prompts* each participant received was used as a covariate. The analysis revealed no significant effect of list placement ($F(1, 39) = 1.118$, $p = .298$) so it was dropped from further analyses. The number of *prompts* did not play a significant role in recall performance ($F(1, 39) = 0.513$, $p = .479$) either. However, we found a significant main effect of group ($F(2, 37) = 6.230$, $p = .005$; $\eta^2 = 0.277$). Post-hoc analyses revealed that Children recalled more words on average (mean *verse recall*: 117.4 words, $SD = 30.7$, out of the 167 total words in the verse) than Parents (mean *verse recall*: 87.2 words, $SD = 38.6$; $t(25) = 2.284$, $p = .081$, effect size $r = 0.397$) and Young Adults (mean *verse recall*: 70.3 words, $SD = 34.5$; $t(25) = 3.831$, $p = .003$, effect size $r = 0.584$ (see Figure 1). The difference in performance between the two adult groups was not significant ($t(24) = 1.220$, $p = .606$), and there was no significant interaction between the factors ($F(2, 37) = 0.990$, $p = .381$). All *t*-tests were two-tailed and Bonferroni corrected.

Verse errors

The number of inaccurately recalled words was compared using a univariate ANOVA (with group serving as a between-subject variable). Since Levene's test of homogeneity of variance was significant ($F(5, 34) = 7.113$; $p < .001$), we used Welch's ANOVA. This analysis yielded a significant effect of group (Welch d (2, 16) = 17.160, $p = .0002$; $\eta^2 = 0.360$). Post-hoc analyses confirmed that Children made fewer errors (mean *verse error*: 7.6 words, $SD = 7.94$) during recall than Parents (mean *verse error*: 41.6 words, $SD = 33.88$; $t(25) = -3.740$, $p = .009$, effect size $r = .599$) and Young Adults (mean *verse error*: 54.9 words, $SD = 35.23$; $t(25) = -5.00$, $p = .0002$, effect size $r = 0.707$). There was no significant difference between parents and Young Adults ($t(24) = -0.980$, $p = .697$; see Figure 1).

Potential differences in the pattern of error categories were analyzed using a repeated measures mixed-type ANOVA with the number of errors by error type (*intrusion* versus *confusion*) as within-subject variables and group as a between-subject variable. The main effect of group was significant ($F(2, 37) = 10.330$; $p < .0001$, $\eta^2 = 0.358$), as was error type ($F(1, 39) = 25.570$; $p < .0001$, $\eta^2 = 0.409$). In addition, there was a significant interaction between the two factors ($F(2, 37) = 5.230$, $p = .01$, $\eta^2 = 0.220$). Post-hoc tests showed that

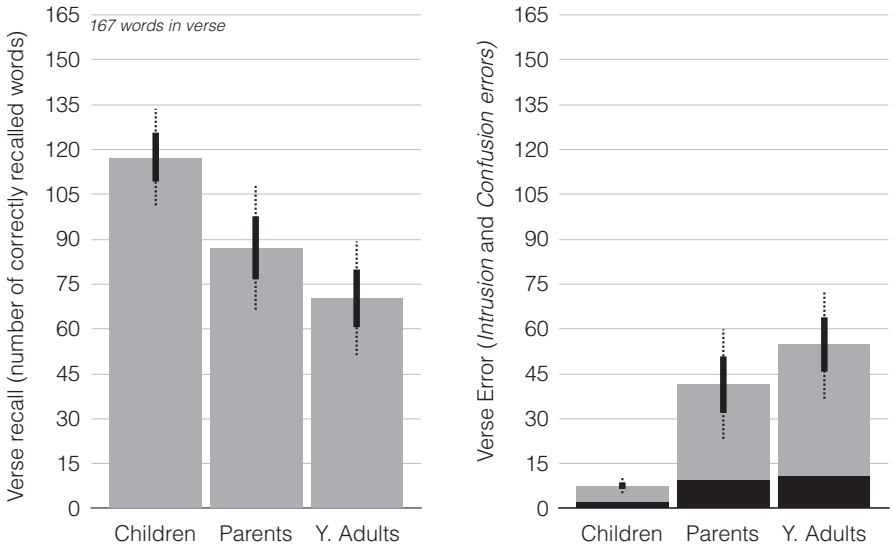

Figure 1 *Verbatim, free-recall performance of rhyming verse; 4-year-olds versus adults. Mean verse recall (left panel) and verse error (right panel) is presented for each group. Verse error consists of intrusion errors (top, gray area of stacked bar) and confusion errors (black area). Solid error bars indicate standard errors; dotted, 95% confidence intervals.*

Children's pattern of errors significantly differed from that of Parents ($F(1, 25) = 13.960$, $p = .009$, $\eta^2 = 0.358$) and from the Young Adults' ($F(1, 24) = 23.315$, $p < .0001$, $\eta^2 = 0.493$): Children made relatively fewer *intrusion* errors (mean *intrusion* errors: 5.6, $SD = 3.36$; mean *confusion* errors = 2.0, $SD = 1.8$), in comparison to Parents (mean *intrusion* errors = 32, $SD = 28.0$; mean *confusion* errors = 9.6, $SD = 10.6$) and Young Adults (mean *intrusion* errors = 44, $SD = 33.0$; mean *confusion* errors = 10.9, $SD = 8.8$). A repeated measures ANOVA showed no significant difference in error patterns between the two adult groups ($F(1, 24) < 1$).

In addition, we investigated sequencing errors alone. A one-way ANOVA showed no significant difference between the mean number of sequencing errors made by each group: $F(2, 37) = 3.128$, $p = .056$ (Children: mean = 1.28, $SD = 1.2$; Parents: mean = 3.23, $SD = 3.05$; Young Adults: mean = 1.76, $SD = 1.58$).

Word list recall

The three groups' performance on the word list recall was statistically indistinguishable (see Figure 2). Data were analyzed using a univariate ANOVA, with between-subject variables of group and list placement. There was no significant difference among the groups or list placement, and there was no significant interaction between factors (all Fs < 1; Children: mean = 5.71, $SD = 1.64$; Parents: mean = 6.00, $SD = 1.73$; Young Adults: mean = 5.85, $SD = 1.63$).

We next examined the effect of meaningfulness on *list recall*. A repeated measures mixed-type ANOVA was conducted with meaningfulness (*meaningful* vs. *nonsense* words) as within-subject variables and group as a between-subject variable. (Since there had been no effect of the list placement, this factor was not used.) The main effect of group was not significant ($F(2, 37) < 1$; $p = .906$), nor was there a significant effect of meaningfulness on performance ($F(1, 39) < 1$; $p = .396$), but there was a significant interaction between the factors ($F(2, 37) = 7.760$, $p = .002$; $\eta^2 = 0.296$). Post-hoc tests, however, did not find significant differences for word list types (meaningful vs. nonsense) between groups (Bonferroni-corrected t-tests, $p = 1.00$, for each comparison).

Gist recall

All three groups performed similarly for gist recall, with mean scores (out of 6) of 5.57 ($SD = 0.852$), 5.53 ($SD = 0.77$), and 5.85 ($SD = 0.376$) for Children, Parents, and Young Adults, respectively. The effect of group was not significant ($F(2) < 1$). Gist recall scores were not normally distributed (Kolgomorov-Smirnov test: 0.467, $df = 40$, $p = .0001$) and were effectively at ceiling, and so primarily confirm that there were no gross lapses in effort, retention, or adherence to our protocol.

Effect of word position on verse recall

We also looked at the relationship between *verse recall* and the position of a word within a line of the verse

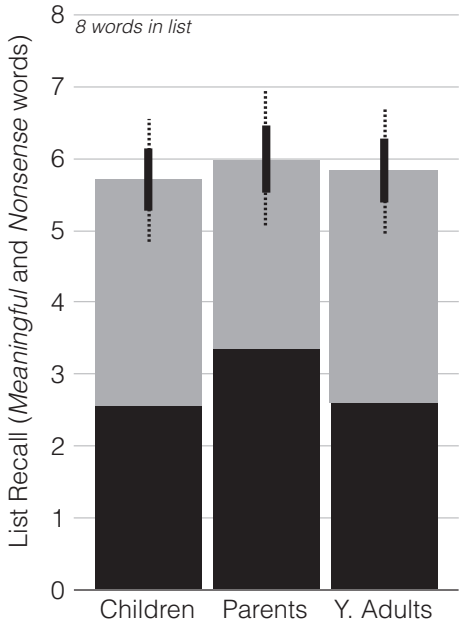

Figure 2 *Average number of words correctly recalled in the word lists. Word list recall for the four meaningful (top, gray area of stacked bar) and four nonsense words (black area) for each group. Solid error bars indicate standard error; dotted, 95% confidence intervals.*

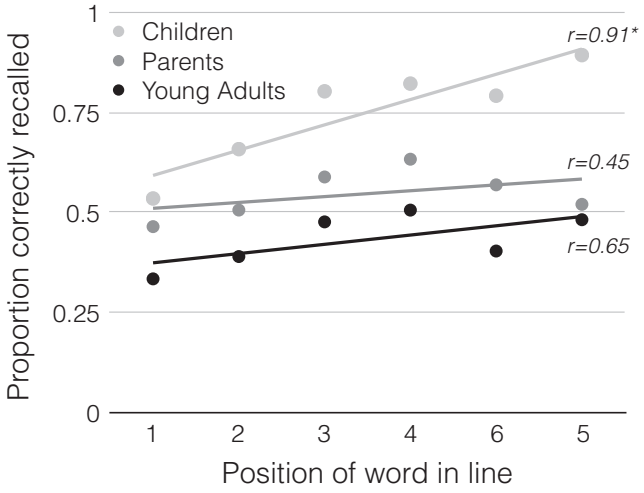

Figure 3 *Proportion of times a word was correctly recalled as a function of its position in the line, for all groups. Linear fits are shown with corresponding r values. Data are collapsed over the lines of the verse (e.g. the data points shown in position 1 represent the average recall rate over the first-position words from all 40 lines of the verse). Constraints on rhythm and rhyme increase with line position.*

(Figure 3). All groups showed a trend for better recall of words that appear later in a line; a correlation that was especially pronounced, and significant, in Children ($r = 0.91$, $p = .013$; $r = 0.45$, $p = .375$; and $r = 0.65$, $p = .161$, for Children, Parents, and Young Adults, respectively).

Discussion

In this study, parents read a novel rhyming children's poem as their 4-year-old's bedtime story for ten consecutive days. A group of young adults passively listened to the same verse for ten consecutive nights, simulating children's exposure. Following this, we measured participants' verbatim free-recall. In contrast to results in other memory domains, children significantly outperformed both adult groups. When memory was tested on a random word list embedded in the verse, and for the gist of the verse, children and adults performed similarly; children's verbatim memory advantage was for verse per se.

Engagement during reading

Given our own lapses in mindfulness, it is tempting to suppose that adult participants may have drifted into a distracted state while reading (parents) or listening (young adults), resulting in poorer encoding than the assumedly more engaged children. This is unlikely for a few reasons. To begin with, we specifically chose a verse that, while suitable for children, was short (~1.5 minutes to read out loud), complex, and entertaining enough to be of sustained interest to adults. It is worth remembering too that participants in both adult groups knew they were taking part in an experiment, and that they would be tested on their recall of the verse (children had no such knowledge); a salient motivator, especially for the young adult group of university students. During debriefing, we asked about lapses in engagement and none were reported.

More directly though, we can look to the magnitude and ubiquity of the children's advantage. This is no small effect: children remembered nearly twice as many words as adults did, with far fewer errors. This main effect finds confirmation both in a pilot study we ran that pitted 4-year-olds against their parents, and a recent follow-up with another ($N = 10$) Young Adult group (which only achieved a mean *verse recall* of 56 words; for further discussion, please see Supplementary Materials). To assess the ubiquity of this pattern, we ranked 50 participants (14 children and 26 adults from our main study plus the 10 from the follow-up) by *verse recall*, and found that the top three performers were exclusively 4-year-olds (with nearly all, 12 of 14, having above median performance) and the bottom 22 were exclusively adults.

But most directly, the integrated word list (see *Materials*) was included as a control to gauge the effect of general factors – like engagement – on performance. Since the word list was embedded in the verse, then general factors should affect memory for the word list as well. Simply put, if adults were simply more distracted than children, they should have done more poorly than children on the verse *and* the word list. However, adults did not show poorer memory on these control measures; their relatively poor performance was confined to the verse. The explanation for these results then cannot appeal to such general factors, but must be verse specific.

Implications of the verbatim verse advantage in children

The current results reconcile the apparent conflict between the anecdotal evidence that children have excellent memory for verse with the research that shows that less information is retained when presented in verse: children have excellent *verbatim* memory for verse (that may come at the expense of content). To evaluate this, we looked for evidence in the pattern of performance within the verse. Specifically, children's advantage should be especially evident for words that appear in later positions in a particular line, since these later words are more constrained by the rhythm, and especially the rhyme, of preceding words (e.g. later words are more likely to be the final, rhyming words). To examine this, we looked at the relationship between *verse recall* and the position of the word in the line. While all groups tended to have better recall for words that appear later in a line, the trend was much stronger, and significant, in children. Put together, this helps restore the promise of verse as an educational tool: if to-be-learned material is coded *verbatim* in a verse, with the help of rhyme as a constraining literary device, as in the alphabet song or when, say, introducing new vocabulary for animal names (see the findings of Read *et al*., 2014) children should readily retain it, perhaps better than their teachers.

In conclusion, an oral tradition in children

Testing how well children remember a novel children's verse presents a fortuitous coincidence, like testing memory for novel ballads in balladeers. As has been recognized by cultural anthropologists for many years, children form a dispersed, but interconnected community with a distinct oral culture (Opie & Opie, 1959). We argue that children are better than adults at recalling verse because they exercise the skill more in order to participate in the transmission of their culture through songs and stories, poems and taunts (consider that '*Eenie, meenie, miney, mo*', the most ubiquitous counting-out rhyme in the English-speaking world, has been transmitted faithfully for over a century (Rubin, Ciobanu & Langston, 1997)). Over development, practice diminishes due to shifts in culture, and the availability of external, written memory and memory processes introduced by and related to literacy. (Further research is required to determine whether the difference between adults and children is even deeper: perhaps children's advantage is not just a matter of better-practiced verbatim memory for verse, but reflects the deployment of specialized mechanisms, e.g. tuned to prosody (Nelson, Hirsh-Pasek, Jusczyk & Cassidy, 1989), that subserve early language learning (Rubin, 1995)). Echoing Socrates, Merlin Donald (2010) suggested that, 'teaching children to read and write, or training them in the use of any exographic system, including those employed in music and mathematics, proved to change the mnemonic strategies they use' (p. 73). Children then, we argue, form a preliterate society, hidden in plain sight, similarly reliant on a well-practiced memory for rhythm and rhyme for the oral transmission of their culture.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Data S1. Additional supplemental data, analyses and stimuli.

Video S1. Verse recall by a child: Example video.