Three-year-olds can retain their knowledge of word meanings they learned one year ago: retrieval practice is critical for retention

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Children build a large vocabulary during the first years of life, eventually achieving high levels of linguistic competency. Thus, after novel words are learned, children need to retain the meanings for long periods and retrieve their meanings within milliseconds of hearing them. All these processes are important. For example, speed of retrieval has been linked to the development of language abilities [1,4]. In this study, we provided a single learning session (which we call the initial encoding session), in which children learned novel words and got tested repeatedly. Repeated testing has been argued to serve the role of retrieval practice and has been shown to be critical for long-term retention [2,3]. One year after the single session (which we call the delayed re-test), we tested children's retrieval of words they learned one year ago, asking whether they could retrieve word meanings with only phonological information, and how fast the retrieval was.

In the initial encoding session, we included a learning phase, a testing phase, and an eye-tracking phase. Four blocks of learning and testing were conducted in an interleaved fashion, where children would learn 2 words per block and get tested immediately after learning. Four lists of words were created to counterbalance the order of presentation. Following the four blocks, we conducted an eye-tracking task, testing novel, learned and known words in a visual world paradigm, presenting one target picture and three distractor pictures in each trial (Fig. 1).

In the delayed re-test session, there was a behavioral selection task and an eye-tracking task. We used the same eye-tracking task from the initial encoding session. The behavioral selection task was similarly constructed, except the four pictures were used as a four-alternative force-choice task. We also calculated the speed of retrieval from the eye-tracking tasks from both initial encoding and delayed-retest using methods from [4].

In terms of the results, first, we found that children successfully learned novel words during the initial encoding (Fig 2A). Cluster-based permutation tests showed that looks toward learned novel words were significantly above chance (between 1.8 and 3.0 seconds, $p= 0.004$), like Known Chinese words (which were included as a baseline). In the delayed re-test, the same eye-tracking measure showed that children were still able to identify the referent (between 2.4 and 2.7 seconds, $p= 0.033$). Moreover, their performance was above chance in 4AFC tasks ($\chi^2(1) = 19.79$, $p< 0.001$; Fig 2D). In terms of speed of retrieval (Fig 2C), children's speed to recognize novel words was comparable to known Chinese words, during both initial encoding and delayed retest.

In conclusion, 3-year-olds were able to retain words that were taught a year ago in a single session without any subsequent exposure. We believe that this amazing feat of retention may be due to the fact that repeated testing was involved during the initial encoding session, as having an immediate testing component during the initial encoding phase is crucial for retention for both adults [3] and children [4]. This has been explained by the different information learners access during learning and testing. Learning activates a full range of information, whereas only the information supporting retrieval is activated during testing. The activation of the information supporting retrieval at test, rather than any other type of information, is specifically important for later retrieval. Consistent with these theories, we found that even 3-year-old children can retain word meanings for a long time. This is in contrast with studies that had no immediate tests following learning, where 2 to 4-year-olds cannot retain meanings after a 5-minute delay [5]. Lastly, the fact that a single session enabled long term retention shows that in principle, the retention of newly learned words does not require repeated exposure, an idea popular in the literature to explain vocabulary development.

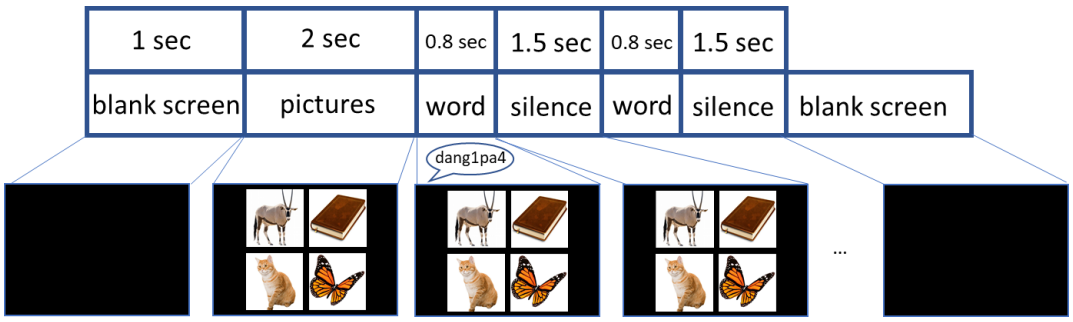

Figure 1. An illustration of the trial design of the initial encoding session.

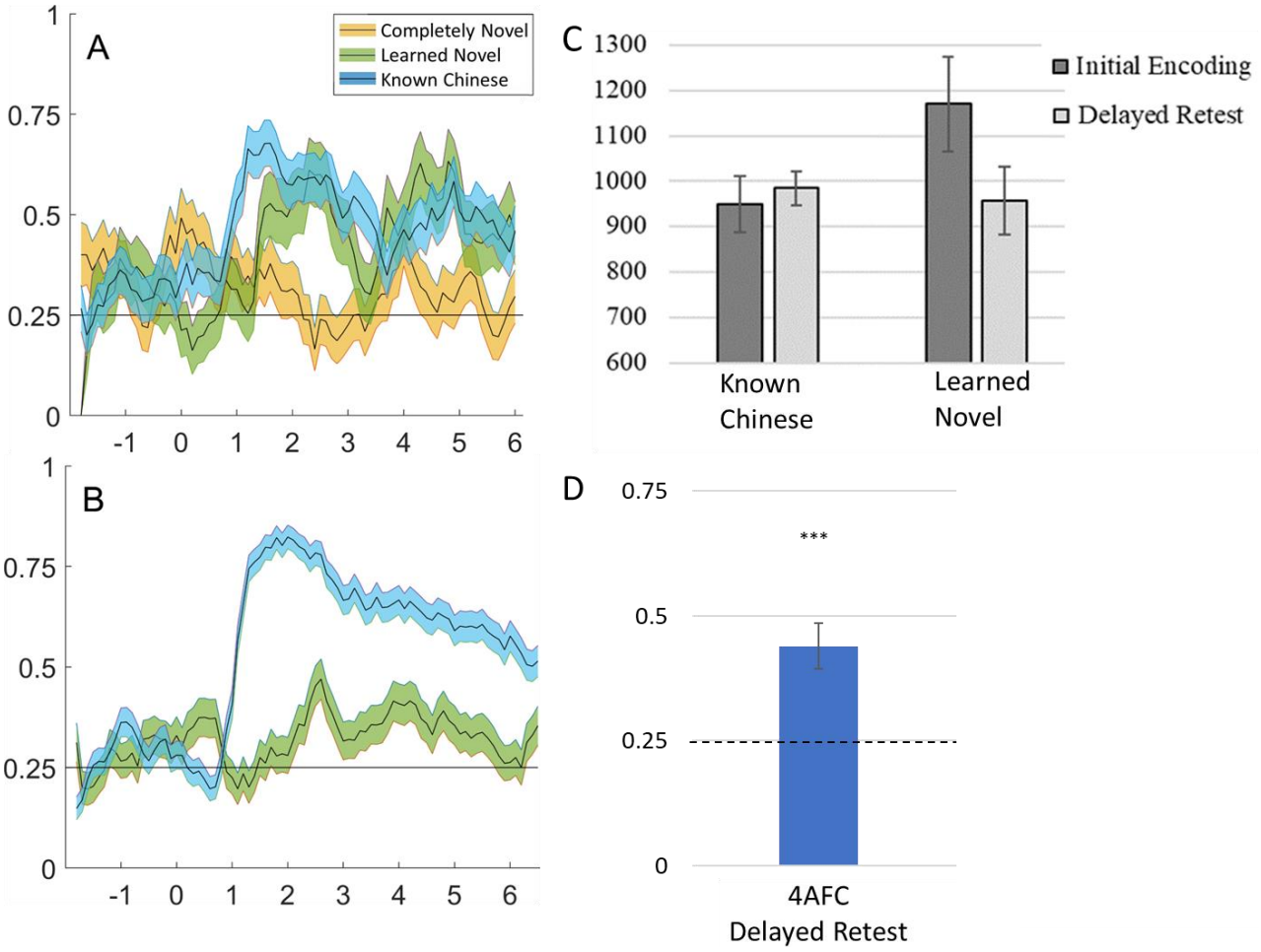

Figure 2. (A) Time course of the eye-tracking results from initial encoding. The y-axis represents the proportion looking to targets. (B) Time course of the eye-tracking results from delayed-retest. (C) Retrieval speed of different types of words for both sessions. (D) Accuracy in the behavioral test from delayed-retest. Error bars/color ranges represent the standard error of the mean.

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