# Twice Upon a Time: Children Use Syntactic Bootstrapping to Learn the Meanings of Yesterday and Tomorrow

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**Abstract**

Time words like 'yesterday' and 'tomorrow' are abstract, and are interpreted relative to the context in which they are produced: the word 'tomorrow' refers to a different point in time now than in 24 hours. We tested 112 3- to 5-year-old Hindi-speaking children on their knowledge of 'yesterday' and 'tomorrow', which are represented by the same word in Hindi-Urdu: 'kal'. We found that Hindi learners performed better than English learners when tested on actual past and future events, but that performance for hypothetical events was poor for both groups. Compatible with a "syntactic bootstrapping" account, we conclude that syntactic tense information – which is necessary for differentiating 'yesterday' from 'tomorrow' in Hindi – may play a stronger role in learning these words than mapping of specific words to particular past and future events ("event mapping").

**Keywords:** time cognition; temporal reasoning; word learning

Many common words in children's early vocabularies (e.g., 'cat', 'table', 'ball', etc.) label concrete objects in their environment (Gillette et al., 1999). However, children are also exposed to abstract words, including time words like 'yesterday' and 'tomorrow', which are among the most frequent words in children's input (Busby-Grant & Suddendorf, 2011). Although children begin to produce 'yesterday' and 'tomorrow' by around age 3, they rarely use them in an adult-like manner, with some studies estimating that only 7- or 8-year-olds show adult-like comprehension (Ames, 1946; Antinucci & Miller, 1976; Busby-Grant & Suddendorf, 2010; 2011; Eisenberg, 1985; Busby-Grant & Suddendorf, 2011; Nelson, 1998; Szagun, 1978; Tillman et al., 2017; Veneziano & Sinclair, 1995; Weist, 1989). Words like 'yesterday' and 'tomorrow' likely pose a problem because, unlike many labels for concrete things, they are deictic expressions, whose reference shifts from day to day (Fillmore, 1977). Consequently, to acquire their meanings, children not only need to know that 'yesterday' refers to events in the past, and 'tomorrow' to events in the future, but they must also learn that each word denotes a period of time exactly one day from the present – not just any time in the past or future. Thus, 'yesterday' and 'tomorrow' encode both tense information (reference to the past or future) and remoteness information (distance into the past or future).

In the present study, we explored two alternative sources of information that children might use to acquire these words. According to an "event mapping" account of time word learning, children learn the meanings of 'yesterday' and 'tomorrow' by mapping them onto the events they are used to describe (e.g., Friedman, 2003; Hinrichs, 1970; Johnson et al., 1988). On this account, children might hear their caregiver refer to a specific event and describe it using either the word 'yesterday' or 'tomorrow', and over many such iterations form the generalization that events described as 'yesterday' tend to happen in the past, while events described as 'tomorrow' tend to occur in the future. For example, children might anticipate future events when their caregivers tell them, "We're going to the zoo tomorrow," or "Halloween is next month" (Friedman, 1990, 1993; Hudson, 2002, 2006; Nelson, 1998). They might similarly hear such references for past events, "I asked you to clean your room yesterday" or "Remember, we went to the mall last week?" On this view, children might also rely on memory traces to learn other temporal information conveyed by these words, such as temporal order and remoteness. For example, they might infer that a birthday party last week is further from the present day than dinner yesterday because it seems longer ago in memory (Friedman, 2003; Hinrichs, 1970; Hudson, 2002; 2006; Nelson, 1998). Compatible with event mapping, children's ability to accurately judge the relative recency of important life events (e.g., birthday vs Christmas) and identify events that happen at different points in the past (e.g., one day vs seven days ago) improves between 3 and 5 years of age (Busby-Grant et al., 2009; Friedman, 1991; Friedman & Kemp, 1998). Thus, children might use this information to make inferences about the meanings of deictic time words.

According to a second hypothesis – which is not necessarily incompatible with the first – rather than focusing chiefly on relations between words and events, children might begin the acquisition of words like 'yesterday' and 'tomorrow' by attending to relations between these words and other structures of language itself – an idea sometimes referred to as syntactic bootstrapping (e.g., Brown, 1957; Carey, 1978; Fisher et al., 2020; Gillete et al., 1999; Gleitman, 1990; Gleitman et al., 2005; Landau & Gleitman, 1985; Naigles, 1990; 1996; Snedeker & Gleitman, 2004). For example, children might infer that because 'yesterday' is used in expressions that feature the past tense (e.g., "she sang yesterday"), it must describe events in the past. Although English tense markings and discourse structure do not provide direct information about temporal remoteness, learning the past/future status of deictic time words like 'yesterday' and 'tomorrow' might help children constrain the



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meanings of more complex phrases like 'the day before yesterday' and 'the day after tomorrow', and help them learn their relative temporal remoteness from the present (Williams et al., 2021).

However, the developmental timeline of children's acquisition of these words varies across studies. For example, Harner (1975) assessed 2- to 4-year-old children's use of 'yesterday' and 'tomorrow' in reference to past and future events, by testing them on two consecutive days. On the first day, children played with one set of toys, and on the second day, they were presented with two new sets, and were allowed to play with one of them. After this, they were asked to identify "yesterday's toys" (toys from day one) and "tomorrow's toys" (the set not previously used by the child). Harner found that 2-year-olds showed little comprehension of the deictic time words, 3-year-olds showcased better understanding, especially for 'yesterday', and by age 4, children understood both terms equally well. In contrast, more recent studies find that children only begin to comprehend the past/future status of 'yesterday' and 'tomorrow' sometime between 4 and 6 years of age, roughly 1-2 years after the timeline outlined by Harner (Tillman et al., 2017; 2018). Further, even at these ages, children struggle to infer the temporal-causal relations between deictic time words (e.g., that events that occur yesterday might cause the events of today and tomorrow to change; Zhang & Hudson, 2018), and that it takes them another 2-3 years to encode the remoteness information associated with each word (Tillman et al., 2017; Williams et al., 2021). Consequently, these studies suggest that children only fully comprehend the meanings of deictic time words by around 7 to 8 years of age.

One reason that some find later learning may be that they require children to engage in other, arguably more sophisticated forms of reasoning, such as mapping temporal events to spatial timelines (e.g.,Tillman et al., 2017; 2018; Williams et al., 2021), or asking them to reason about hypothetical past and future states — e.g., 'past' events that did not actually occur on a previous day, or 'future' events that actually occurred in the past (e.g., Busby & Suddendorf, 2005; Zhang & Hudson, 2018). For example, in one study by Zhang and Hudson (2018), children were asked to match a sentence describing a past action (e.g., "I carved the pumpkin yesterday") or future action (e.g., "I will carve the pumpkin tomorrow") to a picture depicting a present state (e.g., a whole or carved pumpkin) and found failure until age 5. Unlike in the study by Harner, where a child could map 'yesterday' to an event they actually experienced the day before, in Zhang and Hudson, children did not experience any of the test events the previous day, but instead had to make a causal-temporal inference, that if a pumpkin was in a carved state then it must have been carved in the past, whereas if it had not been carved, then it must correspond to a future carving event. Consequently, children's difficulties on such a task could be driven, in part, by an inability to engage in more complex hypothetical reasoning skills that are also developing at these ages (Beck et al., 2006; Buchanan & Sobel, 2011; Gautam et al., 2019; Kuczaj & Daly, 1979; Nyhout et al., 2023; Weisberg & Gopnik, 2013).

Independent of whether some tasks are more sensitive to children's knowledge than others, previous studies leave open the relative importance of event mapping and syntactic bootstrapping in learning these words. Harner's study leveraged children's autobiographical experience of playing with toys on two separate days to probe their knowledge of 'yesterday' and 'tomorrow', but she did not manipulate syntactic cues in her probe, and instead asked: "Show me a toy from yesterday" or "Show me a toy for tomorrow". Consequently, the role of competing linguistic and perceptual cues in children's judgments was never explicitly tested. Other studies (e.g., Tillman et al., 2017; Williams et al., 2021) reasoned that children learn the deictic status and temporal order of time words earlier in development because these aspects of time words are directly supported by the broader linguistic context (i.e., tense markings and discourse structure), whereas information about temporal remoteness is not similarly conveyed by these linguistic cues. However, the tasks they used did not explicitly test the role of these linguistic cues either, and consequently, could not tease apart the relative roles of event mapping and syntactic bootstrapping. Therefore, data from these studies are also compatible with the account that temporal language is mapped onto children's perceptual or event-related experience (Hudson & Mayhew, 2011).

Currently, there is little consensus about how children learn the deictic status of the time words they produce. To address this question, the present research investigated children's early knowledge of the words for yesterday and tomorrow in two languages: English and Hindi. Hindi offers a unique window into children's learning of time words, because unlike English it uses only one word, 'kal', to refer to both yesterday and tomorrow. Consequently, differentiating yesterday from tomorrow in Hindi relies necessarily on tense marking, since mapping the word 'kal' to events in the past and future would result in conflicting cues about its meaning. Also, while Hindi features morphological marking of both past and future tense, English only has tense marking of the past, and describes future events through alternative lexical and grammatical cues (Clark, 1973; Fillmore, 1977; Kush, 2015; Van Olphen, 1975). These differences are theoretically interesting because if children rely mainly on event mapping to learn these words, then this may be easier in English, since different words can be associated with different events. However, if learning instead relies more on syntactic bootstrapping, then Hindi learners may learn these words as early or earlier than English learners, given their more robust tense marking system. Finally, although 'yesterday' and 'tomorrow' are used with similar frequency in child-directed speech (MacWhinney, 2000; Sanchez et al., 2019), and children begin to produce 'tomorrow' earlier and more frequently than 'yesterday' (Ames, 1946; MacWhinney, 2000; Pawlak et al., 2006; Sanchez et al., 2019), some studies suggest that children comprehend and accurately use 'yesterday' prior to 'tomorrow', though evidence for this is

not consistent across studies (Clark, 1973; Busby-Grant & Suddendorf, 2010; Harner, 1975; Zhang & Hudson, 2018). On the event mapping hypothesis, children might understand 'yesterday' earlier than 'tomorrow' because they have memory for past, but not future events, making it hard for them to reason about the future (Prabhakar & Hudson, 2014). On the syntactic bootstrapping hypothesis, this difference may be explained by the fact that English does not have an explicit future tense, but it has a clear past tense. Therefore, if children use only event mapping to learn the meaning of 'yesterday' and 'tomorrow', then both English and Hindi learners should follow similar developmental trajectories. However, if children leverage syntactic cues to learn the meanings of these words, English learners may acquire 'yesterday' earlier than 'tomorrow', while Hindi learners may not show similar differences in referencing the lexical item 'kal' for past and future events.

In the present study, we tested these hypotheses by probing time word comprehension in 3- to 5-year-old Indian children who were learning either Hindi or English as their first language. In addition, to explore the role that real vs. hypothetical events might play in children's temporal reasoning, we tested them using two different tasks: a "Two-Day Real Events" task, modified from Harner's (1975) paradigm, and a novel "One-Day Hypothetical Events" task, in which children made judgments about a hypothetical character's toys relative to their present state. Crucially, all that differed between the events in the One-Day Hypothetical Events task and the Two-Day Real Events task was whether the events featured the remoteness and deictic status of yesterday and tomorrow, relative to the child's own timeline. In the One-Day task, the events compatible with yesterday occurred on the child's "today", as did the events for tomorrow. In this study, we compared performance across three language groups: (1) English no-tense, in which no tense markings were used to probe children's responses, (2) English tense, which used tense markings, and (3) Hindi, which necessitates a probe akin to the English tense group.

## Method

### Participants

Participants were 112 native Hindi- and English-speaking children between 3 and 5 years of age. Children in both language groups were recruited from schools in Delhi, India. Children in the region typically learn two or three languages, including English, Hindi, and regional languages spoken by their parents (Mohanty, 2010). Native proficiency was determined through parental report and medium of instruction at the school. The sample consisted of 50 native Hindi learners, and 62 native English learners, who were randomly assigned to one of two English language groups: tense (n = 32) or no-tense (n = 30). Twenty-one 3-year-olds, 45 4-year-olds, and 45 5-year-olds were included in the study.

### Materials and Procedure

**Two-Day Real Events Task**. Adapted from Harner (1975), this task was administered over two consecutive days. Children played with one set of toys the first day and another set the next day. On the second day, they were shown three sets of toys and asked to identify the toys associated with 'yesterday' and those associated with 'tomorrow'. Each set varied in color (i.e., red, yellow, and blue), but contained the same toys: three cars, two balls, and five blocks. On the first day, the experimenter showed the child three bags, saying: "Look! Each of these has toys of a different color. We get to play with toys of a different color every day". The experimenter then chose one of the bags and took out its contents saying, "These are the toys for today!". Children played with toys of one color (e.g., red toys) on the first day. On the second day, the experimenter reminded the child of the game while showing them the three bags: "Remember, we get to play with toys of a different color every day! These are the toys for today." The child was then given toys of a different color (e.g., yellow toys) to play. The remaining procedure resembled the first day. The experimenter then took out one toy (e.g., a ball) from each of the three bags and asked the child to identify the toy from yesterday (i.e., the toy they played with the previous day) and the toy for tomorrow (i.e., a toy with which they had not yet played).

Test questions differed across the Hindi and two English language groups: "Show me the toys from yesterday / for tomorrow" (English no-tense) and "Show me the toys you played with yesterday / you will play with tomorrow" (English tense). In Hindi, the questions resembled the English tense group: "मुझे वे खिलौने दिखाओ जिनसे तुम कल खेले थे" (1) and "मुझे वे खिलौने दिखाओ जिनसे तुम कल खेलोगे" (2), which refer to the past and future respectively.

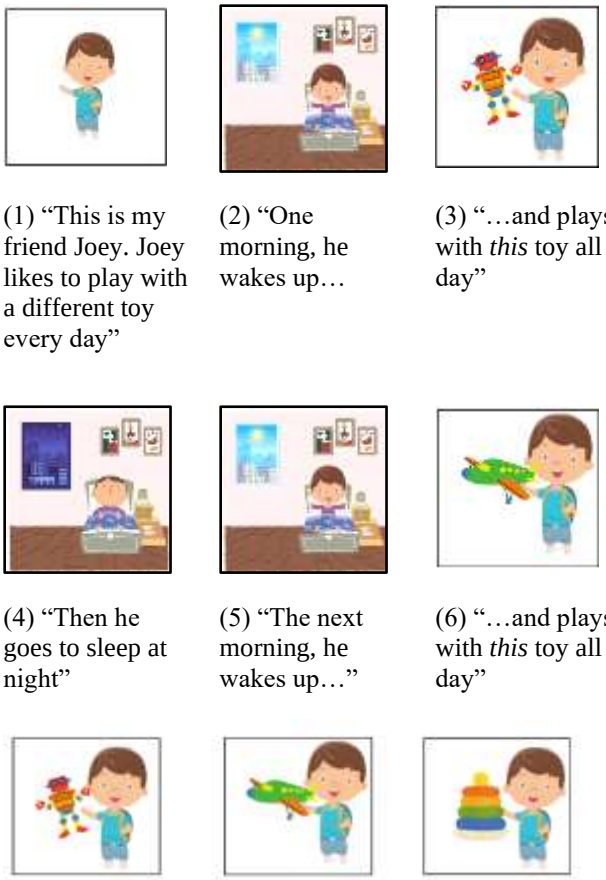
(1) … जिनसे तुम **कल** खेले थे
… jinse tum **kal** khele the
… which you **yesterday** play.PST.2SG
[Show me the toys] you *played with yesterday*.

(2) … जिनसे तुम **कल** खेलोगे
… jinse tum **kal** kheloge
… which you **tomorrow** play.FUT.2SG
[Show me the toys] you *will play with tomorrow*.

Questions were divided across six trials with each toy (i.e., ball, block, car) presented twice. Children were asked to identify the toy associated with 'yesterday' on half the trials and the toy associated with 'tomorrow' on the other half. Children always saw red toys on Day 1 (yesterday's toys), yellow toys on Day 2 ( today's toys), and blue toys were reserved for Day 3 and presented only at test (tomorrow's toys).

**One-Day Hypothetical Events Task.** This task was used to test children's reasoning about yesterday and tomorrow for hypothetical events. On the second day, children were told a

story about a character playing with different sets of toys. They were then asked to identify the toy associated with 'yesterday' and with 'tomorrow' (see Figure 1).



(1) "This is my friend Joey. Joey likes to play with a different toy every day"

(2) "One morning, he wakes up…

(3) "…and plays with *this* toy all day"

(4) "Then he goes to sleep at night"

(5) "The next morning, he wakes up…"

(6) "…and plays with *this* toy all day"

Test: "Show me the toy *for tomorrow* (no tense) / *he will play with tomorrow* (tense)*"*

Figure 1. Story used in the One-Day Hypothetical Events Task. Events were presented sequentially from (1) to (6).

## Results

To test whether children's early meanings of deictic time words differed across linguistic groups (English tense, English no-tense, or Hindi), we first constructed a base generalized linear mixed model, with age and language group as fixed factors, and participant as a random factor with Performance on Two-Day Real Events as the dependent variable (see Figure 2). Age was a significant predictor of performance ($\beta = 0.45$, SE = 0.11, $t(107) = 3.85$, $p < 0.001$). Children in the Hindi group performed significantly better than children in the English no-tense group ($\beta = 0.58$, SE = 0.21, $t(107) = 2.75$, $p = 0.006$) and English tense group ($\beta = 051$, SE = 0.20, $t(107) = 2.46$, $p = .04$). These data suggest that Hindi children were not delayed in learning 'kal', and even outperformed their English-speaking peers, compatible with a strong role for syntactic bootstrapping early in learning. However, we also found no significant difference in performance between the English tense and no-tense groups ($\beta = 0.07$, SE = 0.22, $t(107) = .31$, n.s.), suggesting that although children used tense information early in learning, the explicit presence of tense information during the task was not necessarily critical to performance for English-speaking children (though see post hoc analyses below for evidence it might still play some small role). To assess differences in children's acquisition of 'yesterday' and 'tomorrow' we added a term for lexical item (yesterday / tomorrow) to our base model, and found a significant effect of item ($\chi^2(1) = 4.35$, $p < 0.03$). Children understood reference to yesterday better compared to reference to tomorrow ($\beta = .12$, SE = 0.06, $t(554) = 2.08$, $p = .03$).

We also constructed a three-way interaction model (Performance ~ Age (binned) * Language group (English no-tense / English tense / Hindi) and Item (yesterday / tomorrow) + (1|PID)). Overall, 5-year-olds performed significantly better than 3-year-olds ($\beta = 1.04$, SE = 0.36, $t(125.99) = 2.85$., $p = .005$) and 4-year-olds ($\beta = .48$, SE = 0.19, $t(102) = 2.47$., $p = .04$), but there was no significant difference between 3- and 4-year-olds ($\beta = 0.56$, SE = 0.34, $t(125.99) = 1.64$, n.s.). Follow-up pairwise comparisons revealed that 4-year-olds in the English tense group performed significantly better on yesterday compared to tomorrow trials ($\beta = .90$, SE = 0.18, $t(546) = 4.89$, $p = .0002$), while no such differences were found among the 3- and 5-year-olds in the English tense groups. Moreover, no significant differences in item-based performance were found among children in the English no-tense and Hindi groups at any age. These results are consistent with the idea that English-speaking children used past tense marking during the task to facilitate comprehension of 'yesterday', but that they did not show similar benefits for 'tomorrow'.

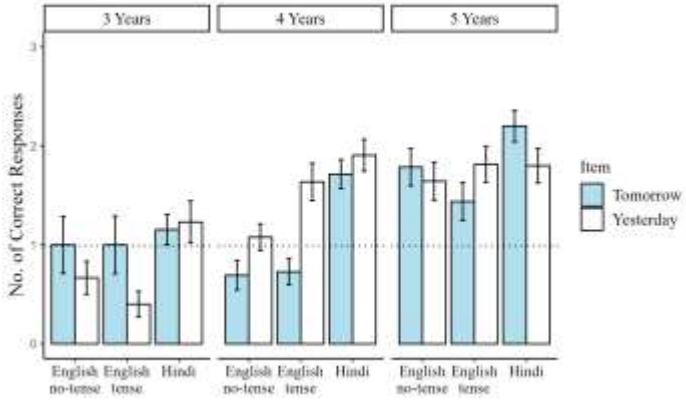



Figure 2. Children's Performance on the Two-Day Real Events Task across language groups.

We next assessed children's use of deictic time words to reason about hypothetical, non-autobiographical events in the One-Day Hypothetical Events task. To do so, we constructed a base generalized linear mixed model with age and language group as fixed factors, and participant as a random factor, with Performance on One-Day Hypothetical Events as the dependent variable. There was a significant effect of age ($\beta = 0.22$, SE = 0.09, $t(107) = 2.50$, $p = 0.013$). However, there

were no significant differences between the three language groups, perhaps because the task was not as sensitive to children's early knowledge, as reported below. Similar to the Two-Day Real Events task, we added a term for Item to the base model, which significantly improved model fit ($\chi^2(1) = 6.12$, $p < 0.01$) See Figure 3.

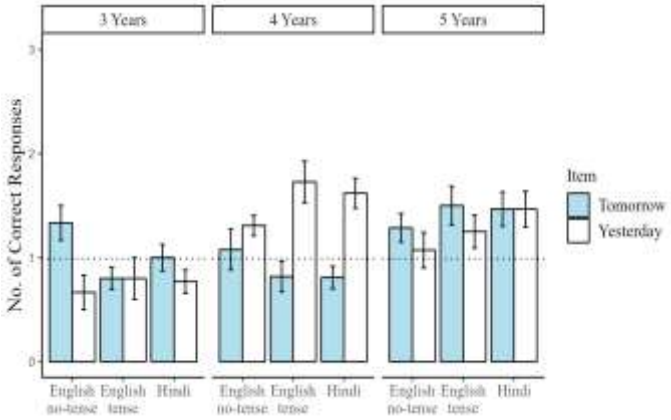



Figure 3: Children's Performance on the One-Day Hypothetical Events Task across Language Groups

As with the Two-Day task, we constructed an exploratory interaction model with the following formula: Performance on One-Day Hypothetical Events ~ Age * Language Group * Item + (1|PID). Four-year-olds in the English tense group understood yesterday significantly better than tomorrow ($\beta = 0.90$, $SE = 0.19$, $t(546) = 4.55$, $p = .001$), whereas no such difference was observed among the 3- and 5-year-olds in the English tense group. Similarly, 4-year-olds, but not 3- and 5-year-olds in the Hindi group, appeared to understand reference to yesterday better than reference to tomorrow ($\beta = 0.80$, $SE = 0.14$, $t(546) = 5.61$, $p < .0001$). In contrast to the Two-Day task, which found some success by age 4, the results of the One-Day task suggest that children begin to comprehend the use of deictic time words to refer to hypothetical events sometime between 4 and 5 years of age.

In a final set of analyses, we compared children's performance across the One-Day and Two-Day tasks by constructing models with age, language group, item, and task as fixed factors and participant as a random factor, with overall performance across both tasks as the dependent variable. A model with Age x Task x Item x Language Group interaction best fit the data ($\chi^2(11) = 27.37$, $p = 0.004$). Children demonstrated significantly better performance overall on the Two-Day task compared to the One-Day task ($\beta = 2.53$, $SE = 0.91$, $t(1203) = 2.78$, $p = .005$). There was also a significant Age x Task interaction ($\beta = 0.58$, $SE = 0.20$, $t(1203) = 2.85$, $p = .004$), suggesting that as children get older, their performance on the Two-Day task showed a greater increase, compared to the One-Day task. Follow-up pairwise comparisons found that across languages, 5-year-olds performed better on the Two-Day task relative to the One-Day task ($\beta = 0.43$, $SE = 0.07$, $t(1194) = 5.73$, $p < .0001$). In addition, 4-year-old Hindi speakers also performed significantly better on the Two-Day task ($\beta = 0.59$, $SE = 0.11$, $t(1194) = 5.31$, $p < .0001$), though no significant differences in performance on the two tasks were found among 3-year-old Hindi speakers ($\beta = 0.30$, $SE = 0.14$, $t(1194) = 2.16$, n.s.). In contrast to Hindi speakers, there was no significant difference in 4-year-olds' performance on the two tasks within the English tense group ($\beta = 0.09$, $SE = 0.15$, $t(1194) = 0.58$, n.s.), nor within the English no-tense group ($\beta = 0.30$, $SE = 0.14$, $t(1194) = 2.16$, n.s.). These results suggest that the differences between these tasks may become more pronounced as children begin to acquire the meanings of these deictic time words, and are compatible with the idea that the Two-Day autobiographical measure being more sensitive to children's early knowledge.

## Discussion

The present research examined how 3- to 5-year-old children learn the meanings of 'yesterday' and 'tomorrow' by testing Hindi and English learners in India. Children were tested on their knowledge of time words on autobiographical events and hypothetical events. We found that children's performance improved with age across groups, but that Hindi learners exhibited an earlier comprehension of 'yesterday' and 'tomorrow' relative to their English counterparts, when the events in question were autobiographical. This was despite the fact that Hindi learners used only one word to refer to both 'yesterday' and 'tomorrow', suggesting that children can use tense information alone to differentiate these words. By contrast we found no differences between the different language groups when the events were hypothetical, and children performed worse overall.

These results have potentially important consequences for understanding the sources of information that children use to acquire abstract words like 'yesterday' and 'tomorrow'. Previous studies have proposed two sources of information that children might use to acquire such words. According to the event mapping hypothesis, children might learn the meanings of time words by mapping them onto different events, such as through memory for past events (e.g., Friedman, 2000; 2003) or conversations about future events (e.g., Hudson 2002; Zhang & Hudson, 2018). In contrast, according to syntactic bootstrapping, children might begin the acquisition of these words by leveraging the linguistic context in which they are embedded (e.g., Gillete et al., 1999; Gleitman, 1990; Tillman et al., 2017; Williams et al., 2021).

We reasoned that if children begin the acquisition of deictic time words like 'yesterday' and 'tomorrow' solely by mapping them to events, then we should expect a delayed developmental trajectory for acquiring word meanings in the Hindi group, relative to the two English groups. In Hindi, because the same word 'kal' is used for both yesterday and tomorrow, event mapping would predict the creation of conflicting associations between the word in both past and future events. An event mapping view would predict that children in the English groups should acquire these words earlier than children learning Hindi. By contrast, if children rely more on syntactic cues like tense marking than on event

mapping, then Hindi learners might perform as well or possibly even better than English learners, since for 'kal', these cues are necessary to disambiguate between reference to past and future events. We found that children in the Hindi group succeeded on the Two-Day Real Events task earlier than their English-speaking counterparts, in support of the latter hypothesis.

We also explored differences in children's understanding of references to 'yesterday' and 'tomorrow'. On the event mapping account, children might comprehend reference to 'yesterday' before 'tomorrow' because they depend on access to memory traces of past events, but lack such access to future events. Therefore, differences in acquiring the meaning of yesterday relative to tomorrow would be predicted across all language groups, since children would similarly rely on memory traces for past, but not future events. On the syntactic bootstrapping account, if children bootstrap the meanings of these lexical items from tense markings, then acquiring the meaning of 'tomorrow' should be harder in English relative to 'yesterday', which does not have a clear future tense, but there should be no differences in performance in Hindi, because Hindi features a robust marking of both past and future tense. Our data suggest that children in the English tense group performed better on 'yesterday' trials than on 'tomorrow' trials, but that no such differences were found in the English no-tense group, once again lending support to the hypothesis that children use syntactic cues to infer the meanings of deictic time words.

Finally, data from our study reveal differences in children's performance between the Two-Day Real Events, and One-Day Hypothetical Events tasks: 5-year-olds but not 3- and 4-year-olds performed better on the Two-Day task overall. Four-year-old Hindi speakers also performed better on the Two-Day task compared to the One-Day task, though English-speaking children did not show similar differences at this age. While the lack of difference between tasks among younger English speakers could reflect their still-developing comprehension of time words, results in 5-year-olds suggest that the Two-Day Real Events task may be more sensitive to their knowledge. This result is potentially important, because previous studies that test time concepts largely rely on tasks that describe hypothetical events on imaginary timelines, rather than events that actually occurred. Consequently, it is possible that children's failures on these tasks reflect an inability to reason about hypothetical events as much as they indicate a failure to comprehend temporal concepts. In particular, such tasks may rely on complex conditional inference (Markovits et al., 2016), counterfactual reasoning (McCormack et al., 2018; Rafetseder et al., 2013), or reasoning about possibilities (Turan-Küçük & Kibbe, 2024)

Although we find early comprehension of 'kal' in Hindi-speaking children – compatible with the use of syntactic bootstrapping – it is important to note that event mapping may still have played a role in English-speaking children, and might also play a role later in acquisition for children learning Hindi. First, it remains possible that English-speaking children used this strategy. Under such a scenario, however, we might expect that English-speaking children would outperform Hindi-speaking children, by drawing on two compatible sources of information – event mapping and syntax – rather than tense alone. Because we did not find such an advantage, our data suggest that if event mapping was used by English-speaking children, it played only a weak role. Second, event mapping may also be critical for learning remoteness information. Although grammatical tense communicates whether events occurred in the past or future, it cannot alone communicate that 'yesterday' refers to the day before it is uttered, but not earlier (Williams et al., 2021). Previous studies suggest that children often use 'yesterday' to refer to events in the distant past Busby & Suddendorf, 2005; Friedman, 1990, Nelson, 1998, Tillman et al., 2017; Weist, 1989). Given this, it's possible that children must use some form of event mapping to associate words like 'yesterday' and 'tomorrow' with distances of one day from today. However, our data suggest that syntactic cues must play an important role in word learning, especially when other cues may not be readily available to the child learner, for example, when the events of tomorrow are hypothetical and do not have memory traces (Friedman, 2003; Hudson & Mayhew, 2011).

Because the data reported in this study were collected in India, it remains possible that the developmental trajectory we report here is unique to this context. Although details of her study are hard to glean, it appears that children in Harner's (1975) study understood 'yesterday' and 'tomorrow' earlier in development relative to English speakers in this study. This could be due to differences in SES, formal training, and parent interactions, which might in turn be related to differences in vocabulary learning, training with formal temporal symbols, and amount of exposure to English in children's day-to-day environment. However, our within-culture approach to comparing English and Hindi learners allows a relatively powerful assessment of the role that linguistic cues play in learning, since many of the cultural differences that exist between cultures like India and the US are reduced or eliminated in our design.

In summary, we found evidence that Hindi learners acquired meanings of the deictic time words 'yesterday' and 'tomorrow' earlier, when asked about autobiographical events, relative to English learners in India, in support of the hypothesis that children rely chiefly on syntactic cues in language to bootstrap the meanings of time words like 'yesterday' and 'tomorrow'. We also found evidence in favor of the hypothesis that tasks designed to test children's autobiographical experience of time might be a more sensitive measure of children's knowledge of specific time words. By testing children on consecutive days, and across two languages in a non-western culture, this project also addresses some limitations in literature. Future research on children's temporal cognition should devise new methods for testing children's conceptual knowledge of the past and future.

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