CHILDREN'S UNDERSTANDING OF *YESTERDAY* AND *TOMORROW*

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ABSTRACT OF THE THESIS

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Children's understanding of temporal language is one indication of their understanding of time. This study used a picture-sentence matching paradigm to test children's understanding of *yesterday* and *tomorrow*. Children viewed two pictures of an object with a visible change of state (e.g., a carved pumpkin and an intact pumpkin) while listening to a sentence indicating the time of the action (e.g., "I carved the pumpkin yesterday"). They were asked to select one picture that matched the sentences. In Experiment 1, 69 3- to 5-year-old children completed this task, which included 12 sentences referred to the past and 12 referred to the future. Results showed that children performed better with past sentences than they did with future, suggesting they understand the temporal relation between past and present better than that between future and present. In Experiment 2, 41 4- to 5-year-old children completed the same task but with sentences containing conflicting tense and temporal adverb (e.g., "I carved the pumpkin tomorrow"). Results showed that children tended to select pictures that were the outcome of actions, regardless of when the action occurs, indicating their bias toward outcomes in temporal judgment. In Experiment 3, 25 adults completed the same task in Experiment 2 via computer. Their temporal judgments were mainly based on temporal adverbs, providing a maturity reference for this inconsistent situation.

Acknowledgements

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Introduction

Time is an essential component of our experience of reality. Almost everything existing in the world and everything that has happened in our life is carved into a point or an interval in time. We do not often think about the nature of time, but we can easily distinguish the past, present, and future. Our perception and intuition of time are so important that they guide our everyday decisions and behaviors. Scant evidence (Clifton, 1974) indicates that infants, even newborns, have an implicit sense of duration. However, the understanding of time develops very slowly from infancy into adulthood. When and how children understand different aspects of time becomes a very intriguing but complex question.

The complexity of the question comes from the abstractness of time itself. Unlike other concepts, time cannot be seen, heard, smelled, or touched. People communicate time using symbols, such as clocks, calendars, and so on. The most prevalent symbolic representation of time is temporal language. Examining the development of children's temporal language is one indication of how children form the concept of time. Researchers (Grant & Suddendorf, 2011; Weist, 1989) have emphasized the conceptual implications of temporal language development. They claimed that the emergence of temporal relations in child language is sufficient for us to infer changes in children's conceptual framework of time. It is even plausible that children's conceptualization of time develops in parallel, or at least intertwined, with their competence with temporal language. With this connection in mind, the rest of this paper focuses on the linguistic component of the development of temporal concepts.

There are two major models concerning children's development of time language. The first one is Cromer's (1968) de-centering model. He proposed that children's language is initially only here-and-now; later they are able to take a perspective other than present because they

develop the ability of "de-centering". Similar to Cromer's model, is Weist's (1986) four-system model. In this model, each system indicates a developmental stage, in which children show certain levels of competence using temporal language. The first system is the speech time (ST) system. Like Cromer's here-and-now, children's speech at this stage does not include tense, aspect or modality. Most 12- to 18-month-old children use this system in their talk. Later, until they are 24 months old, children develop the event time (ET) system, in which event time can be expressed separately from speech time. They begin to use past tense to mark an event anterior to speech time, and similarly, to use future tense to mark an event posterior to speech time. The third system is the restricted reference time (RT_r) system, which appears between 30 to 36 months. In this system, children start to use reference time to indicate when the event occurs. For example, a child may say "*Yesterday I was in Lodz*" (Weist, 1989, p.108). Both event time (i.e., past tense) and reference time (i.e., *yesterday*) exist in the RT_r system and both are formed in contrast to speech time. The last system is the free reference time (RT_f) system. This system emerges between 36 and 52 months. Children in this stage are capable of coordinating reference time, speech time and event time. Besides using temporal adverbs, they can also use one event to indicate the time of another event, for example, "While this one is playing [RT], that one will be playing [ET]" (Weist, 1989, p.105).

According to Weist's four-system model, the separation of event time from speech time indicates children's developing concept of time. This model is consistent with Nelson's (1991) proposal that language encodes temporal relations in two ways. One is grammaticization, such as tense and aspect, which corresponds to the ET system. The other is lexicalization, such as temporal terms, which corresponds to the RT_r system. Nelson (1989) pointed out that grammatical coding precedes and leads to semantic conceptualization. Research shows that

children begin to acquire temporal terms between 2 and 3 years old (Ames, 1946; Pawlak, Oehlrich, & Weist, 2006; Weist, 1989). Terms like *yesterday*, *today*, and *tomorrow* locate specific points in time. They are among the first set of temporal terms that come into appearance. Ames (1946) investigated the verbalized manifestation of children's sense of time. She observed 1.5- to 4-year-olds' spontaneous production of a range of temporal terms and also asked them a series of questions about various aspects of time. She found that terms representing the present tended to emerge first, so children produce *today* around 24 months. *Tomorrow* appears around 30 months, which is earlier than *yesterday* (around 36 months). Half of children in her study answered the t*omorrow* question (e.g., What will you do tomorrow?) correctly at 36 months and the *yesterday* question (e.g., What did you do yesterday?) at 48 months.

In accordance with Ames' (1946) observation data, Pawlak, Oehlrich, and Weist (2006) also found that *tomorrow* emerged earlier than *yesterday* in language for English-speaking children. They observed that *tomorrow* appeared approximately the same period (2;10) as *today* (2;11), whereas *yesterday* came several months later (3;3). Thus, the limited literature seems to reach a consensus that children spontaneously produce *tomorrow* before they are able to produce *yesterday*. Consistent with this interpretation, when Grant and Suddendorf (2011) asked parents to indicate their children's production and accurate use of a list of temporal terms, they found that parents rated their child using *tomorrow* more accurately than using *yesterday*.

However, evidence from language comprehension shows a different developmental trajectory of mastering *yesterday* and *tomorrow*. In a comprehension experiment, Harner (1975) found that children understand *yesterday* earlier than *tomorrow*. In her study, she invited 2- to 4-year-old children to play with different sets of toys on successive days. There were a set of toys children played with yesterday, a set of toys being used on the testing day, and a set of toys

saved for tomorrow. She asked children to "Show me a toy from yesterday" and "Show me a toy for tomorrow". Two-year-olds barely understood either *yesterday* or *tomorrow*. Three-year-olds understood the not-now nature of both terms but performed better on *yesterday* question. Four-year-olds understood both *yesterday* and *tomorrow* very well. These results are congruent with the research on children's representations of past events and future events. In general, older children are better at reporting information about both past and future events than are younger children (Busby & Suddendorf, 2005), but thinking about the future and using future events to infer a current state seems to be harder than thinking about the past and drawing inferences from past events (Grant & Suddendorf, 2010; Prabhakar, 2014; Suddendorf, 2010).

Nelson (1991) proposed that children's early event knowledge forms the foundation for children's initial understanding of time (Nelson, 1991). It is also fundamental in their understanding of temporal language. Once children grasp some temporal terms, such as *yesterday* and *tomorrow* mentioned above, temporal language in turn facilitates more developed event representations by specifying the exact time points where events occur. Children hear a great amount of discourse about events happening in their daily lives through everyday discourse with parents. To figure out whether a particular event locates in the past, the present, or the future, children have to use the temporal markers cued in discourse. In English, temporality is conveyed by both tense and temporal adverb. Children need to use this information to decide the temporal order and the temporal relation among events. To investigate how they utilize the linguistic cues to judge temporal relations, Weist (1991) used a two-choice sentence-picture matching task. He presented and described pairs of pictures to 2- to 6-year-old children; then a sentence was read to children, such as, "The girl threw the snow ball". Children had to pick out the picture that matched the sentence. Using this task, he tested sentences for each of his time

language development systems except the ST system. The results showed that children were able to parse out the temporal relation coded in the ET system (2;6) earlier than that in the RT_r system (5;6). This indicates that coordinating event time (expressed by tense) and reference time (expressed by temporal adverb) may not be as simple as it looks. Following this line of research, Grant and Suddendorf (2010) investigated preschoolers' ability to use the temporality of an event to infer the current state. Instead of pictures, they told children two short vignettes, one about a character who acquired an object (e.g., a balloon) or knowledge (e.g., a name) in the past and another vignette about another character acquiring that object or knowledge in the future. Then children were asked which character currently possessed the object or knew the fact. They tested 4- and 5-year-olds and found that 5-year-old children understood the causal changes cued by temporal terms and tense. Five-year-olds' performance was consistently better than chance across tasks, whereas 4-year-olds were less consistent.

Extracting temporality from linguistic markers and using temporal relation to make inferences would provide evidence for children's acquisition of temporal language and their conceptualization of time. Temporal terms such as *yesterday* and *tomorrow* are prevalent markers of events that children hear or talk everyday from or to their parents, teachers, and peers. However, the production data (Ames, 1946; Grant & Suddendorf, 2011; Pawlak, Oehlrich, & Weist, 2006) and comprehension data (Harner, 1975) indicate different trajectories of acquiring *yesterday* and *tomorrow*. Because children often use words productively before they fully understand word meanings (Nelson, 1991), comprehension tasks may be better tests of whether children understand the temporal meaning of the two words. Harner (1975) pioneered research in this direction and later, Weist (1991) and Grant and Suddendorf (2010) followed this line of investigation. However, limitations exist in their studies. Harner (1975) asked children to select a

toy from yesterday or for tomorrow. Correct responses could be based on successful categorization, with *yesterday* and *tomorrow* used as labels for certain set of toys rather than as temporal cues. The task did not require children to parse out temporal relation between events, which makes it hard to conclude whether children actually grasped the temporal referents of *yesterday* and *tomorrow* and how they relate to the present. Studies by Weist (1991) and by Grant and Suddendorf (2010) approached the more conceptual level. Unfortunately, Weist (1991) included a large number of temporal adverbs when testing sentences under the RT_r system. The results were averaged across many types of adverbs, which makes it hard to tell specifically how *yesterday* and *tomorrow* were understood. Grant and Suddendorf (2010) were more interested in the cognitive process of using causal and temporal relation to infer the present. They used vignettes, which were contextually rich, but made it harder to control the linguistic features. Furthermore, they asked children to infer the agent's current knowledge or possession depending on the vignettes, which would require other cognitive capacities, such as theory of mind.

The current study aims to present a clearer picture of how preschoolers understand temporal language and temporal relations. We focused on the commonly used temporal adverbs, *yesterday* and *tomorrow*. Three- to five-year-olds are the age groups of interest since it is a pivotal period for developments in both language and time concepts (Grant & Suddendorf, 2010; 2011). The first question addressed in this study is: Do children understand past events better than future events? That is, do they understand the temporal relationship between the present and past events before they understand the temporal relationship between the present and future events? Based on comprehension data (Harner, 1975) and research on children's on event representations (Grant & Suddendorf, 2010; Prabhakar, 2014; Suddendorf, 2010), we predict

children would understand the past better than the future. A second question concerns children's understanding of temporal relations with respect to the temporal adverbs, *yesterday* and *tomorrow*. Previous research (Herriot, 1969; Valian, 2006; Wagner, 2001) indicates that temporal adverbs help children distinguish present from the past and future when they are included in sentences using the past and future tense. These studies used a variety of different methodologies and focused on children's understanding of tense and aspect, but when temporal adverbs were included in tasks, there was some indication that the additional information provided by the adverbs helped children understand the meaning of past tense and future tense verb forms. In the current study, we also expect that *yesterday* and *tomorrow* will provide additional temporal cues besides tense to assist children to locate events in time.

To investigate these questions, a picture-sentence matching task was used in this study. Pairs of pictures depicting changes in objects based as a result of specific actions (e.g., opening a present) were presented to children. They also heard sentences describing the actions related to the objects shown in the pictures. Children's task was to select the picture that matched the sentence. Half of the sentences described past actions. Both simple past tense and past progressive tense were included since these two forms of past tense are common to children and they acquire them quite early (Weist & Zevenbergen, 2008). The other half of the sentences described future actions. We used the basic structure *will* [verb] as well as the structure *gonna* [verb] since these are the future tense forms that is most often used by children and parents (Harner, 1981; 1982a). To test the possible benefits of temporal adverbs in temporal specification, our past sentences varied on whether or not they included reference to *yesterday* and our future sentences varied on whether they included reference to *tomorrow*.

Experiment 1

Method

Participants

Participants were 69 children: 21 3-year-olds (*M* = 40.19 months, *SD* = 3.28; 11 boys and 10 girls), 28 4-year-olds (*M* = 54.04 months, *SD* = 4.13; 12 boys and 16 girls), and 20 5-year-olds (*M* = 64.20 months, *SD* = 2.98; 9 boys and 11 girls). Participants were all native English speakers. They were recruited from preschools near New Brunswick, New Jersey. Parents of the children in these schools provided consent for their children to participate, and children were given stickers for participation.

Materials

Materials included 24 pairs of pictures (see a complete list of test stimuli in the Appendix). A pilot study using a picture-naming task with 3- and 4-year-old children (N = 22) confirmed that all of the pictures were easily identified by preschool children. Each picture pair depicted the same object in two different states (see Figure 1). An action was indicated by visual changes of the object from the beginning state to the outcome state. The targeted actions and verbs used in describing each action included only regular verbs. A binder was used to display each pair of pictures one at a time. A recorder (Olympus WS-801) was used to present the test sentences, which described the action happening either in the past or in the future for each picture pair. A puppet was used to interact with children and deliver the test sentences to children.

Figure 1 *A pair of picture about a present. One picture depicts the present that was not opened; the other picture depicts the present that was opened. Each picture was presented on a 6" * 4" cm laminated card.*

Design and Procedure

Each child was tested individually. Children were invited to play a picture game. They were introduced to a puppet, and the experimenter explained the rule of the game before the test trials started. For each trial, the experimenter first presented the picture pair and asked children to identify what they saw in each picture. The identification question was included to draw children's attention to the pictures and to the difference between pictures. Children were not corrected if they misidentified the pictures or could not describe them. Four-year-olds and five-year-olds seldom misidentified or struggled with the pictures. Only 7 three-year-olds had trouble describing one or more pictures (out of all 48 pictures). However, failure to describe pictures was not considered a problem. The puppet referred to the objects in the picture pairs, for example, "I'll pick the flowers tomorrow" or "I opened the present," providing children with the correct information if they could not identify the objects at first. All of the sentences were pre-recorded by a native English-speaker and were consistent in pace, tone, and stress across sentences. During testing, the experimenter kept the recorder out of sight and pretended that the puppet was saying the sentences. Each testing sentence was played twice and the experimenter made sure that children paid attention to the sentences. If they became distracted, the sentence was played one more time. Then the experimenter asked children "What does it look like now?" Children needed to point to one of the pictures to answer the question.

To test for effects of past versus future tense (using two forms of each past and future tense) and presence or absence of temporal adverbs, eight types of test sentences were constructed (see Table 1). The total number of test trials (24) included three trials for each Sentence Type. Trials were administered in two blocks of 12 trials. The order of trials was pseudo randomized and counterbalanced between the two blocks. Children completed an unrelated activity, reading a picture book, for approximately 5 minutes between the two blocks. This interval was included to maintain children's attention and to avoid any fatigue. Children's choices for each test trial were recorded as correct or incorrect. The whole test session was videotaped for later scoring validation.

Table 1
Eight Sentence Types Used in Experiment 1 with examples.

Sentence Type			**Example**
Event Time	**Tense Type**	**Adverb**	
Past	**Simple Past**	***Yesterday***	*I **wrapped** the box **yesterday.***
		N/A	*I **folded** the clothes.*
	Past Progressive	***Yesterday***	*I **was carving** the pumpkin **yesterday**.*
		N/A	*I **was picking** the flowers.*
Future	**will [verb]**	***Tomorrow***	*I'**ll open** the present **tomorrow**.*
		N/A	*I'**ll dress** the bear.*
	be gonna [verb]	***Tomorrow***	*I'**m gonna** stack the chairs **tomorrow**.*
		N/A	*I'**m gonna** slice the watermelon.*

Results

Children's choice accuracy was calculated for each sentence type (i.e., the percentage of correct trials out of three). In the first set of of analyses, an Analysis of Variance (ANOVA) and multiple t-tests were conducted to determine differences between performance on past and future sentences and the possible benefit of having temporal adverbs. For these analyses, data from different tense types were collapsed within each event time (past and future). In the next set of analyses, a series of ANOVAs and t-tests were conducted to further investigate possible differences between tense types within each event time. Preliminary analyses found no effects of gender, so all analyses were collapsed across gender.

Overall analysis.

A 2 (Event Time: Past or Future) * 2 (Adverb: with or without) * 3 (Age group: 3, 4, or 5 years) ANOVA was performed on children's accuracy in selecting the correct picture. This analysis produced a significant main effect of Event Time, F (1,66) = 81.95, $p < .001$, $\eta^2 = 0.55$, and a significant interaction between Event Time and Age group, F (2,66) = 10.34, $p < .001$, $\eta^2 = 0.24$. The effect of adverb was not significant.

All age groups were more accurate in selecting the correct pictures for past events (M = 70.41%, SD = 20.04%) than for future events (M = 38.41%, SD = 22.74%). To further examine the interaction between Event Time and Age group, one-way ANOVAs on the effect of age group were performed on children's accuracy for past event and future events separately. The effect of age group was significant for past events, F (2,66) = 7.49, $p < .001$, $\eta^2 = 0.185$. Tukey's HSD tests showed that 5-year-olds were significantly more accurate than both 3- and 4-year-olds ($p < .05$) (see Figure 2), but there was no significant difference in accuracy between the two younger age groups. The effect of age group was also significant for future events, F (2,66) =

4.82, $p < .05$, $\eta^2 = 0.127$. Tukey's HSD tests showed that 5-year-olds were significantly *less* accurate than 3- and 4-year-olds ($p < .05$), but again, there was no significant difference in accuracy between the two younger age groups (see Figure 2).

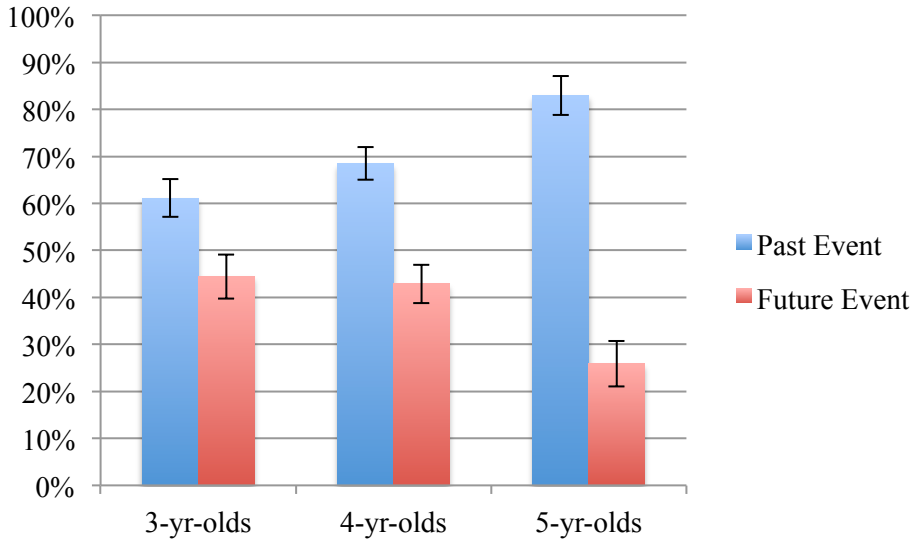

Figure 2 *Mean accuracy by age and event time. Error bars represent standard errors.*

A series of t-tests were also conducted to compare children's responses to chance level (50%) (see Table 2 for means and *SD*s). Three-year-olds' correct choices for past sentences were significantly above chance, for both sentences with adverbs, t (20) = 2.28, $p < .05$, and without adverbs, t (20) = 2.75, $p < .05$. However, 3-year-olds' correct choices for future sentences were around chance levels for both sentences with adverbs and without adverbs. Four-year-olds' response pattern was similar to 3-year-olds. Their correct choices for past sentences were above chance levels, for both sentences with adverbs, t (27) = 3.67, $p < .001$, and without adverbs, t (27) = 4.12, $p < 0.001$, while their correct choices for future sentences were around chance levels, for both sentences with adverbs and without adverbs. Five-year-olds' responses were similar to 3- and 4-year-olds', but the effects were even greater (see Figure 2 and Table 2). Their correct

choices for past sentences were significantly above chance levels, for both sentences with adverbs, t (19) = 8.31, $p < .001$, and without adverbs, t (19) = 6.09, $p < .001$, while their correct choices for future sentences were significantly below chance, for both sentence with adverbs, t (19) = -3.48, $p < .01$, and without adverb, t (19) = -7.37, $p < .001$.

Table 2
Mean accuracy rates (and standard deviations) for 3-, 4-, and 5-year-olds in Experiment 1.

Event Time	Adverb	3-year-olds	4-year-olds	5-year-olds
Past	***Yesterday***	60.32%(20.73%)	68.45%(26.58%)	83.33%(17.93%)
	No Adverb	61.90%(19.82%)	68.45%(23.72%)	82.50%(23.86%)
Future	***Tomorrow***	46.83%(17.97%)	47.02%(25.28%)	30.00%(25.71%)
	No Adverb	42.06%(24.51%)	38.69%(30.11%)	21.67%(17.18%)

Analyses separated by tense type.

Separate ANOVAs were performed on children's accuracy for past event and future event sentences respectively to investigate differences between tense types. A 2 (Past Tense Type: Simple Past or Past Progressive) * 2 (Adverb: with or without) * 3 (Age group: 3, 4, or 5 years) was conducted on children's choice accuracy for past sentences. As shown in Figure 3, this analysis yielded a significant main effect of age group, F (2,66) = 7.49, $p < .001$, $\eta^2 = 0.19$. Tukey's HSD tests showed five-year-olds were significantly more accurate than 3- and 4-year-olds ($p < .05$), but there was no significant difference in accuracy between the two younger age groups. There was no significant difference between choices for the two types of past tense sentences; children performed similarly on Simple Past sentences and Past Progressive sentences.

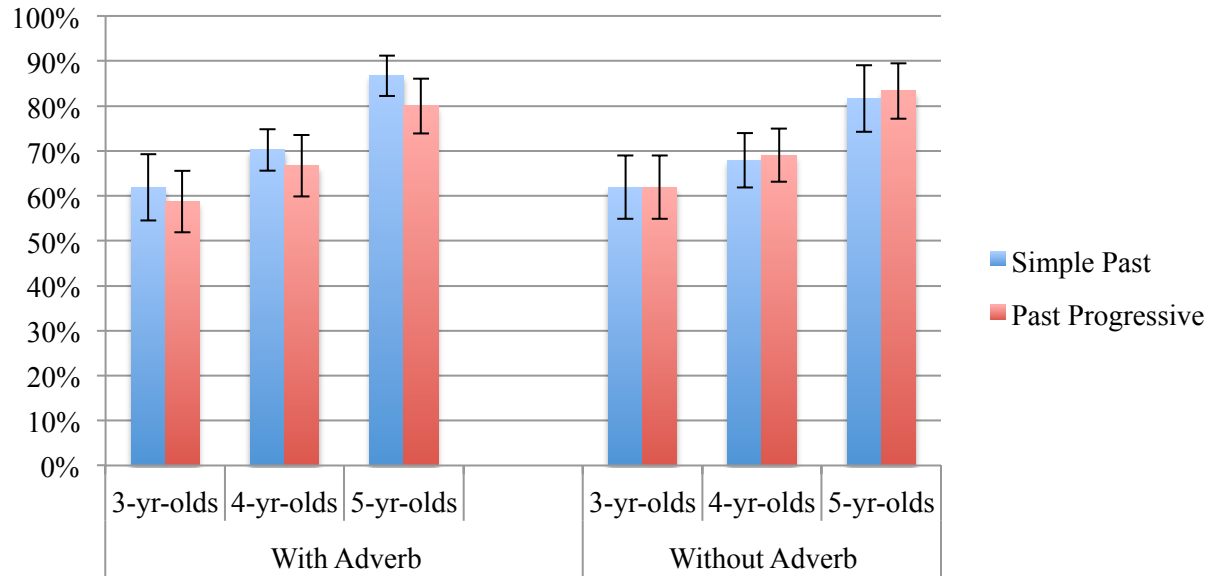

Figure 3 *Mean accuracy by Past Tense Type, adverb, and age group. Error bars represent standard errors*.

A 2 (Future Tense Type: *will* or *be gonna*) * 2 (Adverb: with or without) * 3 (Age group: 3, 4, or 5 years) was conducted on children's choice accuracy for future sentences. As shown in Figure 4, this analysis yielded significant main effects of adverb, F (1,66) = 6.69, $p < .05$, η^2 = 0.09, and age group, F (2,66) = 4.82, $p < .05$, $\eta^2 = 0.13$, as well as a significant three-way interaction among Future Tense Type, adverb, and age group, F (2,66) = 3.20, $p < .05$, $\eta^2 = 0.09$. In general, children were more accurate for future sentences with adverbs (M = 42.03%, SD = 24.36%) than future sentences without adverbs (M = 34.78%, SD = 26.31%). Tukey's HSD test showed that 5-year-olds were less accurate than 3- and 4-year-olds ($p < .05$), but there was no significant difference in accuracy between the two younger age groups.

Two separate 2 (Future Tense Type: *will* or *be gonna*) * 3 (Age Group: 3, 4, or 5 years) ANOVAs were conducted on accuracy for sentences with adverbs and sentences without adverbs to explicate the three-way interaction. For sentences with adverbs, the main effect of age group was significant, F (2,66) = 3.71, $p < .05$, $\eta^2 = 0.10$, but there were no significant main or

interaction effects for tense type. As shown in Figure 4, Tukey's HSD tests showed that 4-year-olds were significantly more accurate than 5-year-olds, $p < .05$, and 3-year-olds were slightly (marginal significance) more accurate than 5-year-olds, $p < .10$, and there was no significant difference between 4-year-olds and 3-year-olds. For sentences without adverbs, the effect of age group was also significant, $F\ (2,66) = 3.91$, $p < .05$, $\eta^2 = 0.11$. This effect was qualified by a significant interaction between Future Tense Type and age group, $F\ (2,66) = 4.21$, $p < .05$, $\eta^2 = 0.11$. Simple effect tests of this two-way interaction showed that 3-year-olds were significantly more accurate for future sentences using *will* than for future tense sentences using *be gonna* ($p < .05$) (see Figure 4). There were no significant difference between in accuracy for sentences using the two types of future tense for 4- and 5-year-olds.

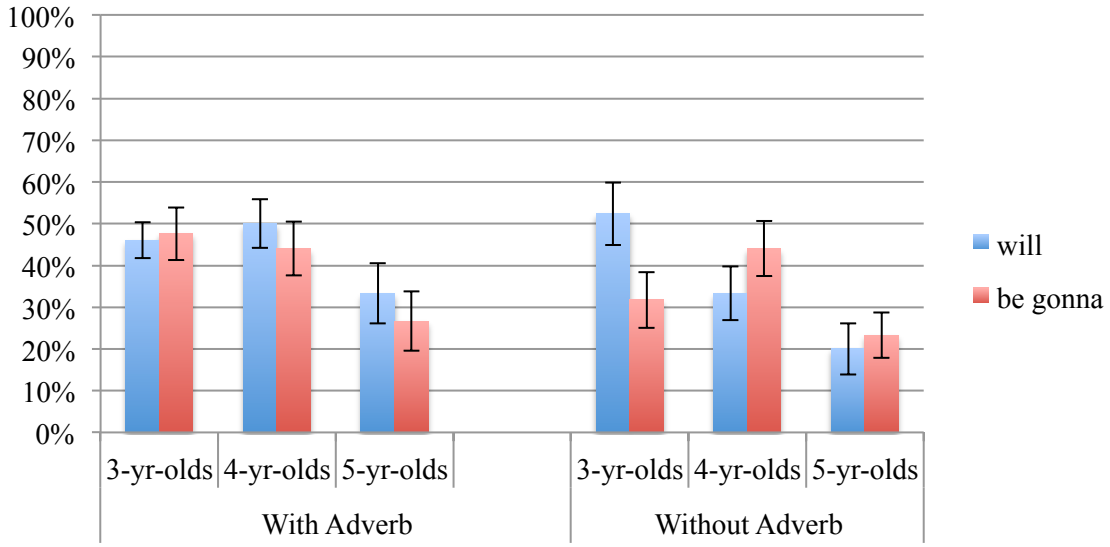

Figure. 4 *Mean accuracy by Future Tense Type, Adverb, and age group. Error bars represent standard errors.*

A series of t-tests were also conducted to compare children's responses to chance level (50%) on each tense type for past and future sentences, respectively (see Table 3 for means and *SD*s). Three-year-olds' accuracy across all the past and future sentence types was not

significantly different from chance level, except for future sentences without adverbs using *be gonna*, for which accuracy was significantly below chance, t (20) = -2.73, $p < .05$. Four-year-olds' accuracy for all four past sentence types was significantly above chance, *ts* (20) = 2.43 – 4.36, *ps* < .05. Their accuracy for future sentence types was not significantly different from chance levels, except that accuracy for future sentence without adverbs using *will* was significantly below chance, t (27) = -2.60, $p < .05$. Five-year-olds' accuracy on the four past sentence types was significantly above chance, *ts* (19) = 4.25 – 8.22, *ps* < .001, but their accuracy on the four future sentence types was significantly below chance, *ts* (19) = -4.90 – -2.30, *ps* < .05.

Table 3
Mean accuracy rates (and standard deviations) for 3-, 4-, and 5-year-olds in Experiment 1 by tense type.

Event Time	Tense Type	Adverb	3-year-olds	4-year-olds	5-year-olds
Past	**Simple Past**	***Yesterday***	60.90%(33.81%)	70.24%(24.58%)	86.67%(19.94%)
		No Adverb	61.90%(32.12%)	67.86%(32.05%)	81.67%(33.29%)
	Past Progressive	***Yesterday***	58.73%(31.46%)	66.67%(36.29%)	80.00%(27.36%)
		No Adverb	61.90%(32.12%)	69.05%(31.33%)	83.33%(27.57%)
Future	**will [verb]**	***Tomorrow***	46.03%(19.65%)	50.00%(30.77%)	33.33%(32.44%)
		No Adverb	52.38%(34.27%)	33.33%(33.95%)	20.00%(27.36%)
	be gonna [verb]	***Tomorrow***	47.62%(29.00%)	44.05%(34.01%)	26.67%(31.72%)
		No Adverb	31.75%(30.69%)	44.05%(35.20%)	23.33%(24.42%)

Discussion

Results showed that children in all three age groups performed better on past sentences than they did on future sentences. They could easily extract the pastness from the sentence and infer the causal changes due to the actions. This ability also increased with age; 5-year-olds performed significantly better than 3- and 4-year-olds in selecting the correct picture for past sentences. Results also showed that, in general, the types of tense format, i.e., simple past vs. past progressive or *will* vs. *gonna*, did not influence children's temporal judgment very much. Their performance did not differ across the two types of past tense, and the structure of future tense modified age differences and the adverbial benefit to some degree, but the difference caused by these tense types was not systematic.

In contrast, children's ability to understand future sentences and use the temporal cues to make inferences regarding the present was not well-developed. Three- and four-year-olds' responses were around chance, showing that they either did not understand the futurity conveyed by the temporal markers or they had trouble understanding the temporal relationship between future and present. As Grant and Suddendorf (2010) pointed out, the uncertainty of future makes it hard to infer current state because the future has not yet occurred and it may not eventuate the way it is supposed to. From this perspective, 3- and 4-year-olds' performances are quite understandable. However, our results showed 5-year-olds performed significantly *below* chance, which means they systematically picked the wrong pictures. For future sentences, such as "I'll open the present tomorrow", we asked children to "Show me what it looks like now" by selecting one of the pictures. The correct picture would be the unopened present, and the wrong picture would be the open one. Five-year-olds had a significantly strong tendency to pick the picture that shows the action has occurred, such as the open present in the previous example.

This tendency was even stronger in a pilot sample (N = 7) of 6- and 7-year-olds not included in this experiment. They picked the action outcome picture more frequently (*M* = 84.52%, *SD* = 14.77%, N = 7) than 5-year-olds in the current investigation (*M* = 74.17%, *SD* = 18.91%).

Considering 3- and 4-year-olds' chance-level performance on future sentences and 5-year-olds' good performance on past sentences, it is possible that older children did understand the task and both the past and future sentences, but they attended more to the action itself because they understand the verb better, as compared to 3- and 4-year-olds. When children hear a verb, such as "open", their representation of what the verb means becomes available and very salient. The semantic meaning of many verbs, and of all the verbs used in this experiment, can be easily accessed in terms of the effect of the action. Therefore, it could be that the better children encode the meaning of the verb, the more biased they are to represent the outcome of the action indicated by the verb.

As for the benefits of adding temporal adverbs, such as *yesterday* and *tomorrow*, when describing actions, there was no obvious advantage for children's performance of including adverbs. However, when past actions and future actions were analyzed separately, the inclusion of *tomorrow* did slightly improve children's accuracy for future actions. Considering their poor performances on future sentences, either around or below chance, this finding does not necessarily indicate that they understood the meaning of *tomorrow* sufficiently because its presence did not boost accuracy across chance levels. But it does suggest that when facing a difficult task, such as using a future action to infer the present, children may have to look for linguistic cues besides verb tense to help them make a decision. On the other hand, for past sentences, children could figure out which picture to pick by just attending to the verb. Verb tense may be the first marker they consider in such a temporal judgment task. This corresponds

to Weist's (2002) ideas on how first language learners and second language learners express temporal relations. He found that first language learners started to express temporal relations with verb morphology and then lexical means, i.e., temporal adverbs, whereas second language learners first express temporal relations with lexical means, especially conventional temporal terms. As for children, Weist pointed out that they incorporate morphological principles before understanding the meaning of temporal terms. Therefore, it suggests that for our English-native participants, verb morphology is a prioritized cue when parsing out temporal relations. Consistent with this interpretation, the findings from Experiment 1 showed that temporal adverbs generally did not help children very much, although in some conditions, they may have served as a secondary reference.

Experiment 2

If a bias to select pictures showing the outcome of a stated verb led 5-year-olds to systematically pick the wrong picture for future sentences in Experiment 1, this outcome bias should also be apparent or even more obvious when other temporal cues (e.g., adverbs) are totally unhelpful. To address this possibility, Experiment 2 tested children's performance in a similar picture-matching task using modified sentences such that the two temporal cues, i.e., tense and adverb, conflicted. For example, one such inconsistent sentence was "I'll open the present yesterday." As in Experiment 1, children were asked to select the picture that shows the current state of the object. If children are biased to select pictures based on the outcome of the verb, regardless of tense or adverb, this tendency should be evident even when tense and adverb conflict.

Results from Experiment 1 showed that youngest children struggled with the picture-matching task. Three-year-olds' performance on all past sentences and future sentences was close to chance. Therefore, only 4- and 5-year-olds were included in this experiment since responding to inconsistent sentences should be even harder than responding to the sentences used in Experiment 1.

Method

Participants

Participants were 41 children: 21 4-year-olds (M = 53.76 months, SD = 3.69; 5 boys and 16 girls) and 20 5-year-olds (M = 64.35 months, SD = 3.12; 10 boys and 10 girls). Participants were all native English speakers. They were recruited from preschools near New Brunswick as in Experiment 1. Parents of the children in these schools provided consent for their children to participate, and children were given stickers for participation.

Materials and Procedure

All the same pictures from Experiment 1 were used. The procedure was the same as in Experiment 1. The only difference was that the test sentences were semantically inconsistent sentences, which means that the tense of verb and the temporal adverb did not match; for example, "I'll open the present yesterday". As in Experiment1, sentences were delivered by a puppet. However, to avoid confusion, the experiment warned children at the beginning of the test session that "sometimes the puppet says silly things." In addition, semantically consistent sentences that did not include reference to either *yesterday* or *tomorrow* (e.g., "I sharpened the pencils today") were also included in the trials so that children heard a mixture of consistent and

inconsistent sentences. As in Experiment 1, children were asked to point to one of the pictures to show what the object looks like now after hearing the puppet deliver each of the test sentences.

The test sentences consisted of four types (see Table 2). There were three trials for each Sentence Type. Twenty-four trials in total were conducted in two blocks of 12 sentences, each consisting of six inconsistent test sentences and six consistent sentences (performance on these sentences was not analyzed for this report). (See the Appendix for a complete list of inconsistent test sentences and consistent sentences with *today*). The order of trials was pseudo randomized and counterbalanced between 2 blocks. Children participated in the same story-reading activity used in Experiment 1 between of the two test trial blocks. Since there was no correct or incorrect response to the inconsistent sentences, children's responses were recorded as consistent with the verb or consistent with the adverb. The whole test session was videotaped for later scoring validation.

Table 4
Four Sentence Types in Experiment 2 with examples.

Sentence Type		**Example**
Tense Type	**Adverb**	
Simple Past	***Tomorrow***	*I **picked** the flowers **tomorrow**.*
Past Progressive	***Tomorrow***	*I **was slicing** the watermelon **tomorrow**.*
will [verb]	***Yesterday***	*I'**ll carve** the pumpkin **yesterday**.*
be gonna [verb]	***Yesterday***	*I'**m gonna** erase the board **yesterday**.*

Results

In this experiment, if children chose a picture consistent with the verb tense, it was categorized as the verb choice; if they chose the picture consistent with the adverb, it was categorized as the adverb choice. The rate of adverb choice was calculated for each sentence type (i.e., the percentage of adverb choice out of three trials). The rate of verb choice was calculated for each sentence type by subtracting the rate of adverb choice from 1. In the first set of analyses, ANOVAs and t-tests were conducted to determine whether children's choices were based on verb tense or adverb. Since one score was the inverse of the other, all tests conducted on the rate of both adverb and verb choice necessarily yielded the same results, except the sign of the *t* or *F* value was opposite. For simplicity, only analyses conducted on the rate of adverb choice are reported. These data are shown in Figures 5 and 6.

In the second set of analyses, ANOVAs and t-tests were conducted to determine whether children showed the outcome bias. The percentage of choosing the *beginning* picture (e.g., the unopened present) was calculated for each sentence type as the rate of beginning choice. Similarly the percentage of choosing *outcome* picture (e.g., the opened present) was calculated for each sentence type as the rate of outcome choice. Because all tests conducted on the rate of beginning choice and the rate of outcome choice yielded the same results, except the sign of the *t* or *F* value was opposite, only analyses on the rate of outcome choice were reported here for simplicity. These data are shown in Figures 7 and 8. Preliminary analyses found no effects of gender, so analyses were collapsed across gender.

Analysis of adverb choices.

First, we collapsed sentence types of *Simple Past + tomorrow* and *Past Progressive + tomorrow* together as *Past + tomorrow*, and we collapsed sentence types of *will + yesterday* and *be gonna + yesterday* together as *Future + yesterday*. A 2 (Inconsistent Type: *Past + tomorrow* or *Future + yesterday*) * 2 (Age group: 4 or 5 years) ANOVA was conducted on children's rate of adverb choice. As shown in Figure 5, this analysis produced a significant main effect of Inconsistent Type, F (1,39) = 25.43, $p < .001$, $\eta^2 = 0.40$. Children made significantly more adverb choice on *Future + yesterday* sentences (M = 65.45%, SD = 25.66%) than on *Past + tomorrow* sentences (M = 30.49%, SD = 27.36%).

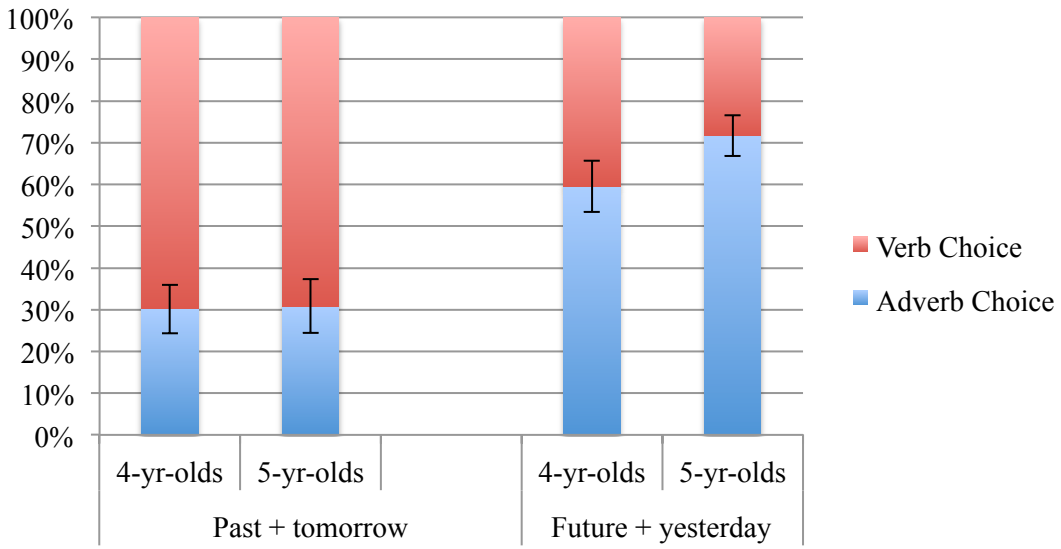

Figure 5 *Mean rates of adverb choice and verb choice by Inconsistent Type and age group. Error bars represent standard errors.*

A series of t-tests were computed comparing children's adverb choice to chances levels (50%) for both age groups. As shown in Figure 5, 4-year-olds made significantly fewer adverb choices for *Past + tomorrow* sentences than chance ($p < .01$), and their adverb choices for *Future + yesterday* sentences were not significantly different from chance level. Five-year-olds

made significantly fewer adverb choices on *Past + tomorrow* sentences than chance ($p < .01$) and significantly more adverb choices on *Future + yesterday* sentences than chance ($p < .001$).

Two separate 2 (Tense Type) * 2 (Age Group: 4 or 5 years) ANOVAs were conducted to determine whether tense type affected children's choice on *Past + tomorrow* sentences and *Future + yesterday* sentences respectively. As shown in Figure 6, no significant main or interaction effects were produced by either analysis. Children's responses did not differ between *Simple Past + tomorrow* sentences and *Past Progressive + sentences*; similarly their responses did not differ between *will + yesterday* sentences and *be gonna + yesterday* sentences. T-tests showed that 4-year-olds made significantly fewer adverb choices than chance on both *Simple Past + tomorrow* sentences, t (20) = 3.24, $p < 0.01$, and *Past + Progressive* sentences, t (20) = 2.58, $p < .05$. Their choices were not significantly different from chance level on both *will + yesterday* sentences and *be gonna + yesterday* sentences. Five-year-olds made significantly fewer adverb choices than chance on both *Simple Past + tomorrow* sentences, t (19) = 2.94, $p < .01$, and *Past Progressive + tomorrow* sentences, t (19) = 2.34, $p < .05$. They made significantly more adverb choice than chance on both *will + yesterday* sentences, t (19) = 2.46, $p < .05$, and *be gonna + yesterday sentences*, t (19) = 4.27; $p < .001$.

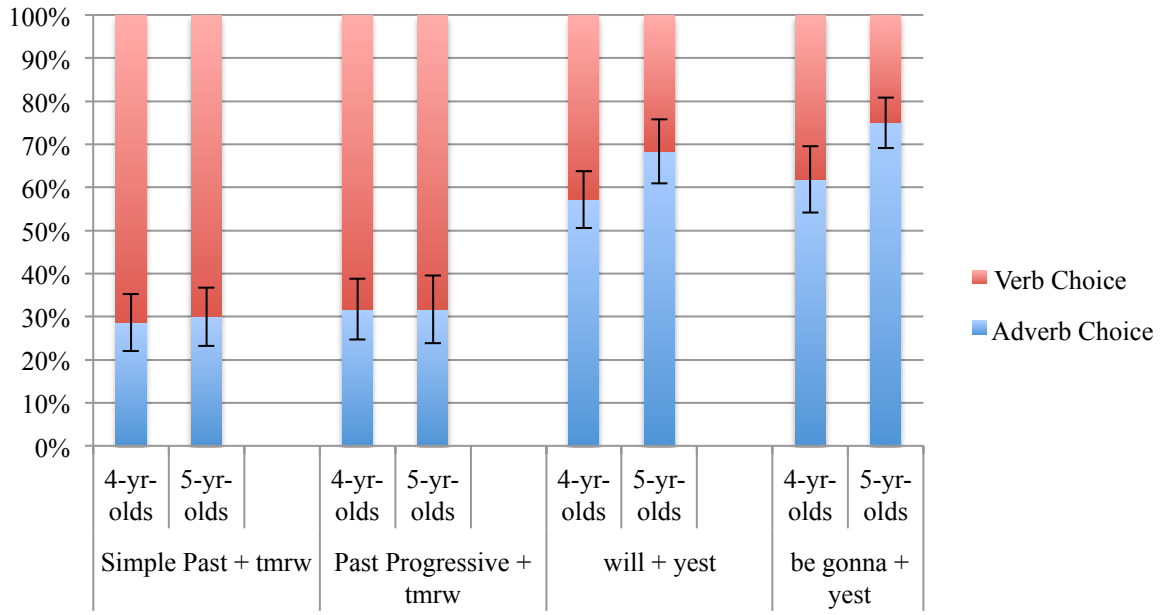

Figure 6 *Mean rates of adverb choice and verb choice by Inconsistent Tense Type and age group. Error bars represent standard errors.*

Analysis of outcome choices.

First, a 2 (Inconsistent Type: *Past + tomorrow* or *Future + yesterday*) * 2 (Age group: 4 or 5 years) ANOVA was conducted on children's rate of outcome choices. As shown in Figure 7, no significant main or interactions effects were found. Next, two separate 2 (Tense Type) * 2 (Age group: 4 or 5 years) ANOVAs were conducted to determine whether tense type affected children's selection of the outcome pictures for *Past + tomorrow* sentences and *Future + yesterday* sentences respectively. As shown in Figure 8, no significant main or interaction effects were produced by either analysis.

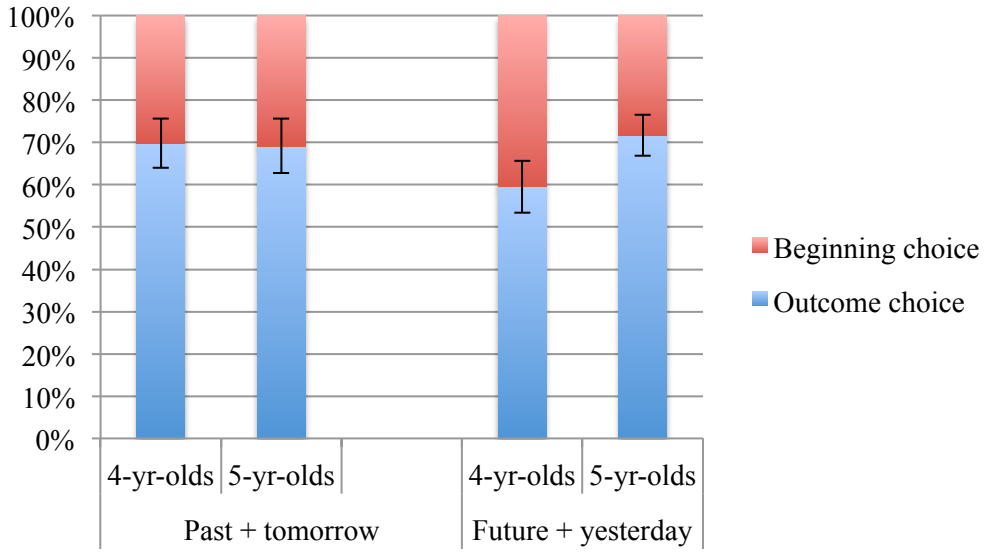

Figure 7 *Mean rates of outcome and beginning choices by Inconsistent Type and age group. Error bars represent standard errors.*

Finally, a series of t-tests were computed to compare children's outcome choices with chance level (50%) for both past and future verb sentences and for each type of past and future verb sentence. As shown in Figures 7, 4-year-olds were significantly above chance levels in their rates of outcome choices for *Past + tomorrow* sentences, t (20) = 3.41, $p < .01$, and as shown in Figure 8, this held for both *Simple Past + tomorrow* sentences, t (20) = 3.24, $p < .01$, as well as *Past Progressive + tomorrow* sentences, t (20) = 2.58, $p < .05$. Their choices for *Future + yesterday* sentences were not significantly different from chance levels; this was the case for both *will +yesterday* sentences and *be gonna + yesterday* sentences. In contrast, 5-year-olds made significantly more outcome choices than chance on both *Past + tomorrow* sentences, t (19) = 2.98, $p < .01$, and *Future + yesterday* sentences, t (19) = 4.47, $p < .001$, and this was the case for all verb forms, t (19) = 2.94, $p < 0.01$for *Simple Past + tomorrow* sentences; t (19) = 2.34, $p < 0.05$ for *Past Progressive + tomorrow* sentences; t (19) = 2.46, $p < .05$ for *will +yesterday* sentences; and t (19) = 4.27, $p < .001$ for *be gonna + yesterday* sentences.

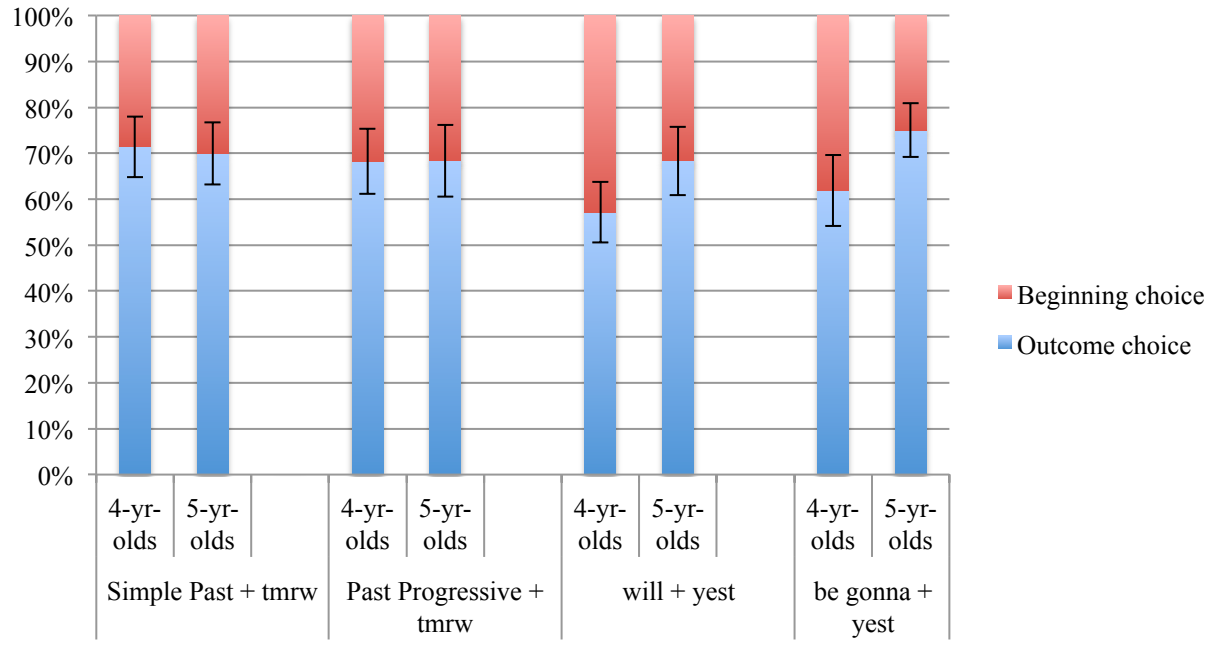

Figure 8 *Mean rates of outcome and beginning choices by Inconsistent Tense Type and age group. Error bars represent standard errors.*

Discussion

Results showed that 4- and 5-year-old children made temporal judgments consistent with the adverb for the inconsistent sentence structure of *Future + yesterday*, whereas their temporal judgments for *Past + tomorrow* were consistent with verb tense. However, looking into their choice patterns from the perspective of the implied sequence shown in the picture pairs, it appears that children's choices were directed by an outcome bias. Both selecting the picture consistent with the adverb for *Future + yesterday* (e.g., choosing the opened present after hearing "I'll open the present tomorrow.") and choosing the picture consistent with the verb tense for *Past + tomorrow* (e.g., choosing the opened present after hearing "I opened the present tomorrow") are indications of selecting the outcome picture regardless of verb tense and adverb. These results confirmed our speculation that an outcome bias exists in children's temporal

interpretations for many action verbs. When they heard a sentence describing an action, they focused more on what (the action) than when (in the past or future). That is, the temporality of an event was not coded as well as the content of the event. This is also congruent with research on early memory development. Infants certainly can hold information about the "what" of the event, but their memories of "where" and "when" become accessible until they are 2 years old (Reese, 2009). Meanwhile children's ability to date events accurately develops with their increasing time knowledge (Friedman, 2003). Based on the findings from Experiment 2, 5-year-olds' poor performance in Experiment 1 can be attributed to the outcome bias.

It is not clear from these data whether children's use of the outcome bias is based on their fragile understanding of how temporality is referenced by verb tense and adverbs or whether this is a more general characteristic of how action verbs are encoded. To address this question, in Experiment 3, adults were asked to select pictures to match the same inconsistent sentences presented to children in Experiment 2.

Experiment 3

Method

Participants

Participants were 25 English monolingual undergraduate students at Rutgers University (M = 19.50 years, SD = 1.54; 18 males, 7 females) who received research credits for their participation.

Stimuli and Procedure

All the same pictures from Experiment 1 were used. The same inconsistent sentences were tested as in Experiment 2 with a small number of consistent sentences (5 trials). The inconsistent sentence types were the same as in Experiment 2. There were 4 trials for each inconsistent sentence type, 21 trials in total including the consistent sentences. The order of the trials was randomized. Participants completed the picture-sentence matching task via a computer with an online program (Qualtrics).

Results and Discussion

In contrast to the children from Experiment 2, adults did not focus exclusively on the outcome of the actions referred to in the sentences, but based their temporal judgments on the temporal adverbs included in both *Past + tomorrow* sentences and *Future + yesterday* sentences (see Figure 9). T-tests showed adults made adverb choices significantly more than chance on *Past + tomorrow* sentences, $M = 85.00\%$, $SD = 26.02\%$, $t\ (24) = 6.73$, $p < .001$, and *Future + yesterday* sentences, $M = 82.50\%$, $SD = 26.02\%$, $t\ (24) = 6.25$, $p < .001$. ANOVAs on Inconsistent Sentence type showed no significant main effects.

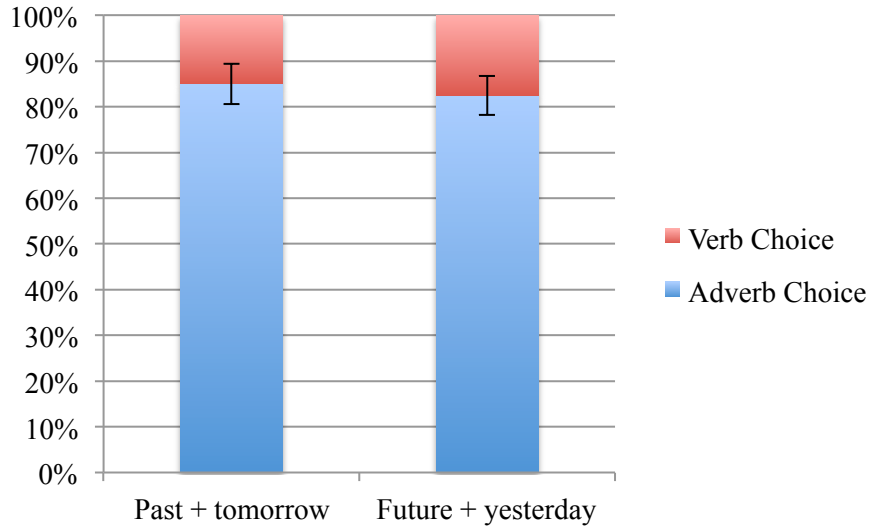

Figure 9 *Adults' mean rates of adverb choice and verb choice by Inconsistent Type. Error bars represent standard error.*

Why then are temporal adverbs more deterministic to adults than children in temporal judgments? First, adults likely have a clear idea of what *yesterday* and *tomorrow* mean. These adverbs designate a time period either 24 hours before now or 24 hours after now so are more precise than tense in temporal specification. Adults may therefore assume that when *yesterday* or *tomorrow* is pointed out specifically in an utterance, it is meant to be emphasized, even when it conflicts with the verb tense. In contrast, 4- and 5-year-old children's understanding of temporal adverbs such as *yesterday* and *tomorrow* is not as precise and consolidated as adults', so sentences including temporal adverbs may be more difficult to process, especially if the adverb information conflicts with verb tense. In this situation, the best understood information for children may be the action referred to in the verb, and they may rely on their understanding of how the action effects an outcome in determining which picture to select.

General discussion

This investigation examined whether young children understand language referring to the past before they understand reference to the future, and more specifically, whether they understand *yesterday* before they understand *tomorrow*. Results showed all three age groups performed better with past events than they did with future events in the sentence-picture matching task. This indicates that children understood references to the past and the temporal-causal relation between the past and the present better than they understood future references and the temporal-causal relation between the future and the present.

Comparing children's performance on sentences with temporal adverbs and their performance on sentences without temporal adverbs, no significant differences were obtained consistently. In general, the inclusion of the temporal adverbs *yesterday* and *tomorrow* did not help children in figuring out the temporal relations referenced in sentences framed in the past or future tense. Thus suggests that children do not yet understand *yesterday* and *tomorrow* to the extent that it would aid their temporal judgment.

Results of children's performance on future sentences showed that they were biased in to select pictures that displayed the outcome of actions. This outcome bias was augmented with age. Five-year-olds were more biased towards the outcome of the action, and this tendency became even more obvious when the available temporal cues did not make sense. Children may rely on the outcome of actions because of the salient information they obtain from the semantic meaning of the verb. The effect of action, derived from the verb meaning, becomes an efficient heuristic that directs them to a particular response, even it is wrong.

What makes the past easy but future hard for children to understand?

First, the future is uncertain. Future actions have not occurred yet and they may not eventuate in the way one can claim in the present. Saying "I'll open the present tomorrow" could only mean an intention or a desire, without any reliable truth-value until tomorrow actually comes. As pointed out by Grant and Suddendorf (2010), past events would causally affect the present state, but the causal effect from future to present is not very salient, sometimes even nonexistent. Therefore, it makes sense to use past information to infer information about a current state, whereas the present state only has the potential to influence the future. As Harner (1982b) suggested, certainty as well as immediacy are factors that contribute to children's understanding of future reference.

Second, the cognitive process of backward reasoning is in itself harder than forward reasoning. Inferring the present from the past requires reasoning forward along a mental time line, whereas inferring the present from the reference to the future requires backward reasoning. Processing backward seems to be generally hard in multiple cognitive domains (Friedman, 2005; Fuson, Richards, & Briars, 1982). Friedman (1986) tested children and teenagers with a day-of-the-week and month-of the-year task. In one condition, participants were asked to think forward, for example, "Does Saturday or Sunday come next after Monday?" In the other condition, participants were asked to think backward, for example, "Does Monday or Tuesday come next after Thursday?" He found that 9- and 10-year-olds could solve the forward tasks, only participants older than 15 years could solve the backward tasks. Although the task in Friedman's (1986) study was much more difficulty than the one used in the current investigation, it explicitly demonstrated how hard backward processing could be. Therefore, in our task, inferring present

with future actions can only be achieved with thinking backward, which would inherently impose extra cognitive demands on preschoolers.

Why didn't yesterday and tomorrow help children's temporal judgment?

We expected children to perform better for sentences with temporal adverbs; however, our data showed that is not the case. *Tomorrow* did help slightly but never raised children's accuracy above chance. One possibility could be that children have not developed a clear idea about what *yesterday* and *tomorrow* mean. Harner (1975) showed children first understand *yesterday* and *tomorrow* as *not today*. Younger children could interpret *yesterday* and *tomorrow* as any temporal displacement, rather than ones with specific direction and distance (Busby & Suddendorf, 2005). Because of this impoverished understanding of *yesterday* and *tomorrow*, when they heard the sentence, they may have paid more attention to the verb and their performance did not vary when the sentence dropped the adverb.

Another possibility could be that *yesterday* or *tomorrow* in a sentence provide a reference time to the event, which makes the sentence an utterance under the RT_r system of Weist's (1986) time language development model. Accordingly, our sentences without *yesterday* or *tomorrow* would be regarded as utterances under the ET system. As Weist (1986) proposed, the ET system emerges prior to the RT_r system, meaning that children produce utterances marked with tense before they are able to produce utterances marked with *yesterday* or *tomorrow*. Although this is a theoretical model of time language production, not comprehension, it does indicate that children acquire *yesterday* and *tomorrow* later than tense markers and underscores the first interpretation. If children cannot use the temporal information cued by *yesterday* or *tomorrow*, it could simply because they do not fully understand it. Moreover, the inferential nature of our task may also

decrease the possible benefits of referring to *yesterday* and *tomorrow*. Weist's (1991) study using similar paradigm also showed that children's comprehension of temporal language under the RT_r system, was no better than their understanding of language under the ET system.

Children's outcome bias

Results from both Experiments 1 and 2 showed that children exhibited an outcome bias when making temporal judgments. They paid more attention to the verb, especially the outcome of the action. It is actually somewhat common that children focus on the part of sentence, either verb or adjective, which is salient to them or they know more about. For example, in Valian's (2006) study, she showed children some props and asked them to "Show me the one that is/was happy." She noted that some children selectively attended to "happy" and picked the prop with a smile regardless of the tense. In our case, it is the meaning of verb that grabbed children's attention. They could just focus on the verb to make their choice without considering the tense and adverb. This non-syntactic strategy could be an alternative interpretation to the outcome bias.

Moreover, a recent study (Tillman, Cheung, Tulagan, & Barner, 2015) found the similar bias. They tested children's understanding of *yesterday* and *tomorrow* first by showing them some increasing events and also some decreasing events via images. An example of an increasing event could be a flower growing. The instruction accompanying the event was "Look, this is a flower. Every day, it grows taller". An example of a decreasing event could be a snowman melting. The instruction followed a similar style. Then in the testing phrase, they showed children an image of the object, for example the flower, and told them "This is a picture of another flower today". After this, they presented children two images of the flower, one in a bigger size and one in a smaller size, comparing each to the one showed previously. Children

were asked, “What did the flower look like yesterday?” Questions with *tomorrow* followed the same procedure. They found out children performed better with the *tomorrow* question than the *yesterday* question for the increasing events, but they did better with the *yesterday* question than the *tomorrow* question for the decreasing events. They claimed that this performance pattern might reflect children’s bias toward “bigger” items. Although their size bias is not quite identical to the outcome bias found in the current study, it does indicate that children are biased toward completeness, either completeness of object in terms of size/shape or the completeness of action. Linguistic research (Bronckart & Sinclair, 1973; Wagner, 2001) on tense and aspect also suggested that children might understand the completeness of an event earlier than the pastness of the event.

Conclusions

This study examined preschoolers’ understanding of *yesterday* and *tomorrow*, the developmental trajectory of their comprehension on temporal language, and their ability to extract temporal relations between the present, the past, and the future. Results suggest that children understand tense reference before they understand temporal adverbs and that their understanding of *yesterday* and *tomorrow* is still limited at five years of age. This is the first study in this field to directly test children’s sense of temporality under conflicting cues; testing this helped confirm the reliance on an outcome bias in children temporal judgment. Adults’ reliance on temporal adverbs compared to children’s perseveration with action outcome displayed a clear contrast, which could be interpreted as a gap of comprehension level of *yesterday* and *tomorrow* between adults and children.

One important limitation of this study is that the task tested future temporal judgment in a way that may be inherently hard because it depends on backward reasoning. Future research could modify the sentences and the question in a way that draws on forward reasoning in making future temporal judgment. For example, using the same picture pairs, children could be presented with sentences such as, “I carved the pumpkin today” and then asked questions such as, “What will the it look like tomorrow?” Moreover, the gap between adults and children casted in the current study posits the question: When children become more adult-like in making temporal judgment? When do they abandon the outcome bias and focus more on the temporal adverb? Future research with children older than 5 would help clarify when and how these linguistic as well as conceptual changes occur in understanding temporal terms, such *yesterday* and *tomorrow*, and in making temporal judgment with these cues.

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