Tuesday, Threesome, Foursday: Chinese names for the days of the week facilitate Chinese children's temporal reasoning

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Abstract
In this study we show that there is a significant difference in the pace at which Chinese and English-speaking children acquire a working knowledge of names of the days of the week (DOW). Anecdotal evidence from classroom observation claims that Chinese and English speaking children acquire the names of the DOW at different rates (Chinese speakers at age five, English speakers at age six to nine) and that English-speaking children produce the DOW before they are able to comprehend their abstract structure or meaning. We investigate this differential in an experiment using a story and problem-solving format. Two groups of children, Chinese and English monolinguals between the ages of three and seven, were shown picture cards pertaining to a story about cartoon characters during the seven days of a week. They were then asked questions aimed at assessing what level of mastery they had attained in comprehending and using the DOW. Our results show that Chinese speaking children reach advanced levels of mastery at an earlier age than English speaking children. The study shows a strong link between the early mastery of specific nomenclature systems, such as simple numeric sequences and the subsequent acquisition of more cognitively complex systems, such as time-related schema. This research sheds light on the constructional nature of human knowledge whereby more complex abstract systems are acquired on the basis of less complex, more concrete systems.

Keywords: Chinese; English; children; acquisition; time; linguistic relativism.

Introduction
It has been a long held axiom of developmental linguistics that children learn their native language in stages (Gentner, 1982; Columbia Encyclopedia, 2004). Acquisition of basic number words has been shown to follow this same stage-like development (Wynn, 1992). Specific language dealing with abstract systems, such as time, is not expected to be different. In our own observations it is generally considered that children before the age of three do not exhibit an ability to engage in dialogue using the names of the days of the week (DOW), while children older than eight not only comprehend and use these terms, but can usually compute elapsed time in days and solve problems involving incremental parts of a week, an abstract concept. Also, they can verbalize these concepts using the accepted terminology both forward and backward in time. Somewhere between these two ages children not only acquire the vocabulary but also achieve a working knowledge of the abstract time units that this vocabulary symbolizes. What’s more, they probably acquire this knowledge, like all aspects of language, through stages or levels of proficiency.

It has been noted that even though children may be familiar with the names of the DOW, these words are actually “meaningless” at first (Pollman, 2003). The acquisition of number words and time sequence such as the DOW are different from the acquisition of other words. Instead of mapping meaning-to-form for each word, children learn these words by “rote a list of at first meaningless word forms and detect in this list a repetitive structure that enables the learner to produce other items of the list…” (Pollman, 2003, p. 3) Thus, children demonstrate the ability to speak knowledgeably about them at a later age. Additionally, there is anecdotal information that English speaking children are able to use the DOW in problem solving in a classroom setting only after the age of six, but Chinese speaking children can do so by the age of five. In this experiment we set out to determine to what extent this observation is justified, and we offer an explanation for such a difference in acquisition and performance. In his article, “Some Principles Involved in the Acquisition of Number Words”, Thijs Pollman (2003) claims that the principles that govern a child’s acquisition of numbers are the same as those which drive acquisition of the DOW. Also, numbers closely parallel what Horn (1972) calls “scalar” terms, or sets of words that can be arranged in an ordinal relationship. This quite sufficiently describes the sequence of names used for the DOW.

If it is true that mastery of abstract time sequences, such as DOW and MOY (month of the year), is so closely related to mastery of numerical sequences, then it is likely that, if the two sequences are linked semantically, acquisition of numbers could facilitate early acquisition of the DOW. We suspect that this is the very process underlying the alleged fast-track time-word acquisition by Chinese speakers.

All dialects of Chinese use a simple numbering sequence to designate the names of the DOW. This system begins with Monday as the first day of the week. Thus, xīngqì yī, “weekday one”, is Monday, xīngqì ēr, “weekday two”, is Tuesday, xīngqì sān, “weekday three”, is Wednesday, following the Chinese numeric sequence where yī is one, ēr is two, sān is three, and so on. The only exception is Sunday, the last day of the week, which is xīngqì rì in Mandarin Chinese and translates to “weekday of sun”. Nevertheless, the terminological system used for naming the DOW in Chinese is basically the same used for simple counting and learned by children at a very early age somewhere between ages two and three (Brown, 1973).
Table 1: Description of complexity levels and sample questions (five questions per level for a total of 25)

<table>
<thead>
<tr>
<th>Level of Complexity</th>
<th>Description</th>
<th>Sample Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Basic Composition</td>
<td>Knowledge of the week as an entity of time which has parts</td>
<td>How many days are there in a week?</td>
</tr>
<tr>
<td>2 Name Recognition</td>
<td>Knowledge of and the ability to distinguish the specific names of the days of the week</td>
<td>On what day does Winnie the Pooh go Swimming?</td>
</tr>
<tr>
<td>3 Adjacency Relationships</td>
<td>Knowledge that days are sequentially related with the ability to solve problems that involve days which occur next to each other</td>
<td>Today is Tuesday and Winnie goes swimming. What will he do tomorrow?</td>
</tr>
<tr>
<td>4 Within-week Proxemics</td>
<td>Ability to recognize, compute and verbalize about the proxemics relationship of days that are not simply adjacent, but are still within the scope of the same target week</td>
<td>Today is Sunday and Winnie eats some honey. On Tuesday he will fly a balloon. How many days must he wait to fly a balloon?</td>
</tr>
<tr>
<td>5 Cross-week Proxemics</td>
<td>Ability to recognize, compute and verbalize about the proxemics relationship of days that cross the boundaries of a conventional 7-day week as configured in the speaker’s native language</td>
<td>Today is Friday and Winnie goes swimming. Next Monday he will ride in a boat. How many days must he wait to ride in a boat?</td>
</tr>
</tbody>
</table>

Contrastingly, the names of the DOW in English are derived from mythical terms and, thus, are arbitrary symbols and not at all systematically related to time or numeric sequences. Also, they have no recognized sequential relationship with each other.

It is our conjecture that these contrasting naming systems, the Chinese reliance on numerosity compared to the English use of arbitrary symbols, is manifested in a differential in the rate of acquisition of the abstract realm of time words associated with the notion of a week. Our ultimate objective is to demonstrate this empirically. First, however, we need to establish that there is a genuine difference in the Chinese versus English speakers’ acquisition rate. Before designing an experiment to test for the differential in acquisition rate by these two populations, we determined a means of measuring proficiency. This brings us back to the notion of staged development. We propose that the general ability to understand and use the DOW can be broken down into five increments of increasing proficiency level. We will hereafter refer to these as the five levels of DOW acquisition. They are described in Table 1.

With these five definitions, we designed and conducted an experiment consisting of a child’s story and a list of stimulus questions per level for a total of 25 questions aimed at assessing at what ages children in our two language populations reach the various proficiency levels.

Method

Participants

Seventy-seven children of various ages between three and seven participated in this study. They were divided into two groups according to their native language. The Chinese group consisted of 34 Chinese monolingual children from Jiangsu province, China. The other 43 participants are English monolingual children living in the State of Hawai’i of the United States. Their native language is English and will be referred to as the English group. All participants were rewarded at the end of the experimental procedure with a parchment certificate of completion and some candy or a coupon for ice cream.

Materials

The experiment was conducted using two types of materials: a set of story cards and a list of stimulus questions. The story cards consisted of seven 4.5 inch by 3.5 inch laminated cards, each with a picture of the cartoon character Winnie the Pooh engaged in some activity easily recognizable to a child. Each card was also associated with one of the seven days of the week (see Appendix A for a graphic representation of the actual picture cards). Together, these cards formed a story involving Winnie the Pooh’s activities on each day of the week.

The stimulus questions consisted of short questions in either Chinese or English. Each question was designed to assess how well a participant understood the words used for the names of the DOW and how proficient they were at using them to solve problems involving time. Also, each question was designed to illicit a short (usually one- or two-word) response from the participant. These questions were further divided into five groups representing the five levels of proficiency regarding time words as outlined in the Introduction above. The following are sample questions from each of the five levels (see Appendix B for a full listing of questions by proficiency level).

Procedure

The researcher guided each participant through three experiment phases. In stage one, the researcher laid out the story cards in front of the participant one card at a time while telling the story of Pooh’s week of activities. The researcher began with the Sunday card (in the case of English speakers) or the Monday card (in the case of
Chinese speakers) accordingly. Each card was revealed as the story unfolded. The researcher, making sure that the child was paying attention, would verbally relate what the activity was by saying, for instance, “On Sunday Winnie the Pooh eats some honey.” The story phase was finished when all seven cards were spread out before the child and each day’s activity had been verbalized in the child’s native language.

In phase two the researcher left the cards spread out in front of the participant in the order they were introduced and asked fifteen questions from the list of questions. These questions were taken from the questions included in levels one, two and three and randomly ordered. Thus, while the cards are still visible in DOW order, the researcher would ask, for instance, “On what day does Winnie the Pooh go swimming?” The child was given some leeway in providing an answer to the question. In case a child could not answer immediately or give an unrelated response, such as “Swimming in the lake!”, the researcher would repeat the question if necessary until the child gave an appropriate response or it was determined that the child could not respond to the question, at which time the next question was asked.

Phase three was conducted similarly to phase two with two exceptions. First, the story cards were randomly mixed up in front of the child so that they were still visible, but no longer in DOW order. This was done so that the child could not answer the next set of questions by simply counting the number of cards between two days. Secondly, the questions asked in this phase were taken from the sets of stimulus questions in levels 4 and 5, both of which require the child to solve time-related problems that involve non-adjacent days. As in phase two, the researcher waited until it was clear that the participant had provided an appropriate answer or could not answer the question.

In order to score the overall performance by a participant, one point was assigned for each correct answer to the two sets of questions from phases two and three. Since there was a total of 25 questions, five each for the five graduated levels of proficiency, the maximum possible score was 25. In this way, the degree of overall understanding by a given participant of how to use the DOW and the ability to accurately verbalize about time related problems was reflected in their numeric score, the higher the score, the greater the degree of time-word proficiency.

Results

Two subjects were excluded from data analysis because they were not concentrating in the experiment and failed to respond to the experimenter. The data is represented graphically in Figure 1.

As we can see, the Chinese-speaking group scored higher in the experiment than the English-speaking group, as predicted.

According to our data, at about age five Chinese-speaking children demonstrate a proficiency that is commensurate with the level three proficiency rating, that is, ability to handle adjacency relationships using time-words (accumulated more than 15 points in the test). On the other hand, most English speaking children are at about level two (name recognition) at the same age (obtained less than 15 points). The highest scores among Chinese monolingual children are near maximum and imply the attainment of full proficiency. These are reached shortly after the age of six, while no English speakers achieved scores beyond what would be expected for level three.

Table 2: Mean score in each language and age group.

<table>
<thead>
<tr>
<th></th>
<th>3yrs</th>
<th>4yrs</th>
<th>5yrs</th>
<th>6yrs</th>
<th>7yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG</td>
<td>5.5</td>
<td>7.55</td>
<td>8.75</td>
<td>15.5</td>
<td>21.88</td>
</tr>
<tr>
<td></td>
<td>(N=4)</td>
<td>(N=10)</td>
<td>(N=9)</td>
<td>(N=10)</td>
<td>(N=8)</td>
</tr>
<tr>
<td>CHI</td>
<td>14.5</td>
<td>15.15</td>
<td>19.91</td>
<td>22.86</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>(N=4)</td>
<td>(N=10)</td>
<td>(N=10)</td>
<td>(N=7)</td>
<td>(N=3)</td>
</tr>
</tbody>
</table>

To get a more precise picture, the data was submitted to SPSS and ran a two-way ANOVA, with Language and Age as independent variables and score as the dependent measure. The age variable was coded categorically instead of continuous. The result shows that there is a large main effect for Age, \( F(4, 71) = 38.60, p < 0.01 \). Not surprisingly, with increasing age, the scores are significantly higher. Language also shows a large main effect, \( F(1, 73) = 18.89, p < 0.01 \) suggesting that there is a significant difference in scores; in other words, there is an acquisition pace difference between the two language groups. However, there is no interaction between age and language \( F(3, 71) = 1.86, p = 0.14 \), which means the scores of one language group are consistently higher than that of the other group. In sum, this analysis shows that there is a significant difference between the time-word proficiency scores accumulated by children in the two target populations.

Discussion

There seems to be evidential support for the notion that children who learn Chinese as a native language are able to comprehend and use, in verbal context, terminology for the DOW developmentally before children who learn only English as a native language. As can be seen from the above results, age-for-age, the Chinese monolinguals reached a more advanced degree of proficiency.

We are convinced that the different systems for naming the DOW are at the root of this language-specific acquisition differential. Chinese children, like their English speaking counterparts, acquire the basic numeric sequence terms at an early age (Brown, 1973). We have no specific evidence at this time that such acquisition is achieved at different times for these languages. There is a general lexical learning pattern—for example, nouns before verbs or concrete before abstract. The same process is at work here. Acquisition of basic numeric terminology and the ability to count from one to ten precedes acquisition of time-words such as the DOW and the ability to solve time-related problems. However, the use of number words to refer to the
DOW in Chinese forms a link between the two acquisition processes and provides the Chinese speaking child with an advantage in achieving time-word proficiency. Let us call this phenomenon lexical leveraging. This leverage takes effect somewhere between the age of three and four and explains why Chinese and English speaking children begin to diverge at about that age in their linguistic development regarding the DOW and their ability to solve time-related problems involving them.

Pollmann (2003) claims that in order to acquire number words and their meanings, a child must first learn a list of speech forms that is meaningless and then, following a set of principles of rhythm and coordination, advance to further “mathematical thinking”. He also shows that the same process governs the acquisition of “sequences of the names of the days of the week”. It is our contention that while English speakers must follow this procedure twice, once for numbers and once again for the DOW, Chinese speakers do not since the two sequences are already linked.

To add to the discussion we would like to inventory a few interesting phenomena we noticed while conducting this study. First, there seems to be earlier development regarding the word “tomorrow” than “yesterday”. It is possible that these two words follow a radically different frequency of exposure for young listeners. Also, it became clear to the author that the initial segmentation of the five levels of DOW acquisition, as described in the Introduction, may not be an accurate depiction of the actual phases that a child goes through. Examining the pattern of answers the experimenter received for the stimulus questions, it was evident that children were often able to answer later level questions with accuracy even when they were stumped by so-called earlier level questions. It is for this reason that the dependent variable time-word proficiency was decided to be coded as an overall point score and not convert it to a proficiency level as originally defined.

For further study we intend to pursue this line of research by extending this study with some modifications to other languages. This extension offers some interesting possibilities. For instance, Japanese and Korean represent a set of what might be called “hybrid” languages with respect to the numerosity-time sequence connection. Both these languages are similar to the English system of using arbitrary, that is non-numerically sequenced, terms for referring to the DOW; however, both also follow the Chinese system for referring to the months of the year in which numbers are used for names. It would be instructive and provide further support for the theory proposed in this paper if, for speakers of Japanese and Korean, time-word proficiency followed a Chinese-like fast track for the months of the year, but an English-like acquisition pace for days of the week.

References

Horn, L. (1972). On the semantic properties of the logical operators in English. Doctoral dissertation, UCLA, Los Angeles, CA. Distributed by IULC, Indiana University, Bloomington, IN.
Appendix A

Phase 1: The following are the pictures on the story cards used with English speaking participants:

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pooh eats</td>
<td>Pooh rides</td>
<td>Pooh flies</td>
<td>Pooh goes</td>
<td>Pooh reads</td>
<td>Pooh goes</td>
<td>Pooh climbs</td>
</tr>
<tr>
<td>some honey</td>
<td>in a boat</td>
<td>a balloon</td>
<td>swimming</td>
<td>a book</td>
<td>swimming</td>
<td>a tree</td>
</tr>
</tbody>
</table>

Appendix B

Phase 2 Levels 1-3:
1. How many days are there in a week?
2. How many days in a week do you go to school?
3. How many days in a week do you stay home?
4. How many days in a week do your parents go to work?
5. How many days of the week do you know the names of?
6. On what day does Winnie the Pooh go swimming?
7. On what day does Winnie the Pooh ride in a boat?
8. On what day does Winnie the Pooh fly a balloon?
9. On what day does Winnie the Pooh Read a book?
10. On what day does Winnie the Pooh climb a tree
11. Today is Thursday and Winnie the Pooh goes dancing. What will he do tomorrow?
12. Today is Monday and Winnie the Pooh rides in a boat. What did he do yesterday?
13. Today is Tuesday and Winnie the Pooh flies a balloon. What will he do tomorrow?
14. Today is Saturday and Winnie the Pooh climbs a tree. What did he do yesterday?
15. Today is Sunday and Winnie the Pooh eats some honey. What will he do tomorrow?

Phase 3 Levels 4-5:
16. Today is Tuesday and Pooh flies a balloon. On Friday Pooh goes swimming. How many days must he wait to go swimming?
17. Today is Monday and Pooh rides a boat. On Wednesday Pooh reads a book. How many days must he wait to read a book?
18. Today is Friday and Pooh goes swimming. On Wednesday Pooh read a book. How many days ago did Pooh read a book?
19. Today is Saturday and Pooh climbs a tree. On Thursday Pooh went dancing. How many days ago did he go dancing?
20. Today is Sunday and Pooh eats some honey. On Tuesday Pooh flies a balloon. How many days must he wait to fly a balloon?
21. Today is Friday and Pooh goes swimming. Next Sunday Pooh eats some honey. How many days must he wait to eat some honey?
22. Today is Wednesday and Pooh reads a book. How many days must he wait to read a book again?
23. Today is Saturday and Pooh climbs a tree. Next Monday Pooh rides in a boat. How many days must he wait to ride in a boat?
24. Today is Thursday and Pooh goes dancing. Next Tuesday Pooh flies a balloon. How many days must he wait to fly a balloon?
25. Today is Friday and Pooh goes swimming. Next Monday Pooh rides in a boat. How many days must he wait to ride in a boat?
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