The salience of temporal cues in the developing structure of event knowledge

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Two experiments used a novel method called Pathfinder to examine whether the salience of temporal cues embedded in event structure increases developmentally and whether people link event actions by simple adjacency relationships or embed them in an organized whole. A sequential format for eliciting knowledge was compared with a less structured format for dinner and bedtime events. Adults and their 8- and 10-year-old children demonstrated well-developed script organizations regardless of format, and organization improved across this age range. In Experiment 1, temporal cues were not a salient basis of comparison for 6-year-olds, but in Experiment 2 they could use temporal cues when instructed to do so. The results suggest that temporal salience increases between 6 and 10 years and that temporal knowledge of event actions is highly organized in this age range. Furthermore, children's event knowledge functions partly in the interaction between their developing event knowledge and the support provided by sequential constraints in the environment.

Children begin to represent event knowledge, or knowledge of activities that are causally or temporally ordered, very early in development (Bauer & Hertsgaard, 1993; Bauer & Mandler, 1989, 1992; Bauer & Shore, 1987; Bauer & Thal, 1990). Children as young as 13.5 months can act out novel event sequences consisting of two and three elements with the aid of props and verbal cues (Bauer & Hertsgaard, 1993). Furthermore, this knowledge endures over a 1-week delay, suggesting that young children are not merely imitating but instead have long-term memory of event sequences.

The fact that young children show some knowledge of events is not to say that they have fully developed event representations. Yet in many respects, when the quality of children's event representations is scrutinized, even preschool-aged children demonstrate a high degree of sophistication. For example, children between the ages of 13.5 and 30 months showed better recall for events with enabling relationships than for arbitrarily ordered events (Bauer, 1992; Bauer & Fivush, 1992; Bauer & Mandler, 1989; Bauer & Thal, 1990). Moreover, young children's
sensitivity to relationships between elements is not based merely on rote memory for the order of events (Fivush & Mandler, 1985). Additional studies show that young children learn logically ordered event sequences more easily than arbitrarily ordered event sequences, even when the logical relationships are variable and the arbitrary relationships are invariant (Fivush, Kuebli, & Clubb, 1992). Children also show less variability in their reports of logically ordered compared with arbitrarily ordered events (Bauer & Fivush, 1992; Fivush et al., 1992; Hudson & Nelson, 1983; Nelson, 1978; Nelson & Gruendel, 1981, 1986; Ratner, Smith, & Dion, 1986; Slackman, Hudson, & Fivush, 1986; Slackman & Nelson, 1984). Finally, the presence of conditional terms such as “if . . . then,” “when,” “before,” and “after” in 5-year-old children’s verbal protocols suggests that the structure of event knowledge is a temporal whole rather than a set of isolated elements (Fivush, 1984).

A number of procedural factors help eliminate differences that are observed between younger and older children’s event knowledge. Methods that do not rely on language skill show that the differences observed when older and younger age groups are compared can result from developmental differences in the ability to participate in a free verbal recall task rather than from less developed event knowledge (Farrar & Goodman, 1992; Fivush et al., 1992; Fivush & Mandler, 1985; Price & Goodman, 1990; Ratner et al., 1986; Smith, Ratner, & Hobart, 1987). One method substituted for verbal recall is behavioral reenactment. Children act out a sequence of events rather than verbally recalling the sequence. For example, age differences in recall and sequencing of events disappeared when 3- and 5-year-olds acted out the sequence (Fivush et al., 1992). In fact, behavioral reenactment and methods like it are essential for investigating event knowledge in preverbal children (Bauer, 1992; Bauer & Mandler, 1989, 1992; Bauer & Hertsgaard, 1993).

Context and retrieval cues also can help eliminate previously observed differences in event knowledge (Farrar & Goodman, 1992; Price & Goodman, 1990; Smith et al., 1987). Smith et al. (1987) showed that giving kindergarteners such cues greatly affects the amount of recall. Acting out a novel clay-making script with all the utensils and ingredients used during initial exposure resulted in 82% recall of events in contrast to 15% for verbal recall or 21% for verbal recall with props present. In contrast, adult behavior was not adversely affected by the absence of cues. Farrar and Goodman (1992) found similar developmental effects with the use of location cues. As Price and Goodman (1990) argued, such results are significant because they suggest that the ability to execute events in sequence is not solely a function of the representational structure of events. Rather, it is based on an interaction between support in the environment and the purported structure of this
knowledge, where available environmental cues make event knowledge more accessible to the child.

Despite their apparently high degree of sophistication of event knowledge, there is still room for growth. As children get older, they are able to report more of the elements of event structure than younger children, their reports are more complex and elaborated (Fivush, 1984; Fivush & Slackman, 1986; McCartney & Nelson, 1981; Nelson & Gruendel, 1986), and they are more easily able to learn new event sequences (Farrar & Goodman, 1992; Fivush et al., 1992; Fivush & Mandler, 1985; Price & Goodman, 1990). Furthermore, older children are not as dependent as younger children on the use of visual environmental cues in retrieving event memories (Price & Goodman, 1990). Thus, the developmental trend in children’s event memory shows increased elaboration of event representations, which become more accessible without the aid of visual retrieval cues.

The present study asks new questions about the developing structure of event knowledge. In particular, we focus on the dimension of event knowledge that best distinguishes these structures from other types of representations: the temporal dimension. Research cited earlier shows that temporal information is included in young children’s event knowledge (Fivush, 1984). However, previous research does not address the salience of temporal cues relative to other information in children’s event representations, including the objects, people, and specific actions performed by objects or people. For example, a young child may be certain that brushing one’s teeth involves the toothbrush and toothpaste and the activity of teeth brushing, yet the child may be uncertain of the placement of this activity in an event sequence of a bedtime routine. It might be expected that temporal cues linking component event actions would be acquired later than concepts associated with actions because temporal cues are derived from experienced activities. That is, looking at the behavior of the person eating across from you at the restaurant table will inform you when to signal the waiter for the check, but the knowledge that this is the next step in the event sequence must be internalized.

Many perceptual development studies have shown that some dimensions of information are more salient to children than others (Cook & Odom, 1992; Thompson, 1994). Dimensional salience is inferred when people use primarily one dimension for matching objects in perceptual classification tasks (Thompson, 1994) or consistently name a particular dimension first when looking for similarities and differences between objects (Cook & Odom, 1992). Cook and Odom’s (1992) differential sensitivity account of development argues that children form salience hierarchies of various perceptual dimensions. Through expe-
rience, the perceptual system detects more dimensional relationships between objects and becomes increasingly more sensitive to previously discovered dimensions. Thus, when a dimension is highly salient to a person, he or she is predisposed to activate it as a basis for comparing objects or events. Applying their account to the development of event representations, we hypothesize that temporal cues are lower in young children’s salience hierarchies than are specific person, object, and action cues associated with an action concept within an event sequence. Furthermore, the threshold for activation, or salience, of the temporal dimension becomes lower with development.

We are particularly interested in investigating potential differences between 6- and 8-year-old children because some theorists argue that these two age groups are at different stages (Piaget, 1970) or substages (Case, 1991) of cognitive development. In addition, the research on perceptual salience typically compares children in the age range from 6 to 10 years, showing developmental changes during this age range (Cook & Odom, 1992; Thompson & Markson, 1998).

**Inferring the structure of event knowledge**

Inferring the structure of event knowledge is challenging. Researchers in this area have remarked how verbal reports given by children are a sparser, less coherent reflection of the knowledge represented in memory (Fivush et al., 1992). Although we do not object to this belief, we suspect that the opposite also may be true. Several features of verbal recall and behavioral reenactment measures may be contributing to interpretations of knowledge structure that are more temporally organized, complex, or specific than what is represented. For example, the method of question asking (e.g., “What happens when . . .”, “What happens next?”) used to elicit children’s event knowledge may greatly influence the structure of organization reflected in recall by informing children that the temporal nature of the event is sought by the experimenter. If another basis of organization is more salient to the child, one would not discover this fact using verbal recall. In addition, verbal recall and behavioral reenactment are essentially cued recall tasks in which one event cues the next event in sequence. As a child progresses through the event sequence in recalling information, already-stated possibilities are eliminated and the memory search space is narrowed. Thus, loading the task with so many cues may give the appearance of a representational structure that is more temporally elaborated than that of actual memory. Bower (1978, p. 350) made similar cautions 20 years ago, arguing that the order with which events are mentioned is “neither a necessary nor a sufficient condition for inferring a temporally ordered memory structure.”
Our research addresses two questions about the developing structure of event knowledge. First, compared with other cues for event representations, how salient are temporal cues, and does children’s sensitivity to temporal information increase developmentally? Second, are young children’s event representations truly structured as an organized whole (Fivush, 1984), or are the links between event actions based primarily on adjacency relationships? We will return to this issue later.

The present study contrasts the organization of event knowledge that emerges when participants report information in a structured, sequential format (picture ordering) with an unstructured format (paired comparisons). In the picture-ordering condition, children were given pictures of dinner and bedtime event actions and were asked to order the pictures accordingly. In the paired comparison condition, children were asked to rate how well every pair of the pictures went together. Picture ordering is similar to techniques that are commonly used to elicit event knowledge, whereas the paired comparison task removes the constraints imposed by tasks that confine the organization of participants’ responses to a linear output. The salience of temporal cues in event knowledge should be reflected in comparisons between the two conditions. If temporal cues are salient, then paired comparisons should yield the same results as picture ordering, but if they are not, paired comparisons would be made on some other basis than sequential ordering information and the responses would thus be different from those obtained in the picture-ordering task.

An approach for understanding the structure of event knowledge

We used a technique called Pathfinder, which has been used to investigate knowledge structure in a number of domains, including adult memory (Cooke, 1992; Cooke, Durso, & Schvaneveldt, 1986; Cooke & Schvaneveldt, 1988), learning (Gomez & Schvaneveldt, 1994), and assessment of knowledge growth (Goldsmith, Johnson, & Acton, 1991; Gomez, Hadfield, & Housner, 1996). In the research reported here, Pathfinder is used to generate representations of common events involved in eating dinner and going to bed for children in three different age groups and their parents.

The Pathfinder network scaling algorithm generates empirically derived network representations of the associative structure among a set of concepts by taking psychological estimates of distance (e.g., relatedness ratings) as input and outputting a graphic representation of a person’s semantic network (Schvaneveldt, 1990; Schvaneveldt, Durso, & Dearholt, 1989). Each concept (actions in an event for eating dinner and going to bed) in the network is represented by a node, and the relationships between concepts are represented by links between nodes.
More specifically, assuming an ordinal scale, Pathfinder computes all possible alternative paths between two nodes. For example, an alternative path between the "brushing teeth" and "falling asleep" nodes would involve "brushing teeth" to "tucking in" to "falling asleep," where the distance value between the first two nodes is 2 and between the second two is 3. Each alternative path takes on the value of the shortest distance in the path, in this example, the value 2. For every pair of nodes, all alternative paths are compared to choose a winner, which is the path with the shortest distance. The winning alternative is then compared with the value directly linking the nodes (the direct path, or the relatedness estimate obtained from the participant). If the winning alternative has a shorter distance value than the direct path, it is chosen as the best route between the two nodes, and the direct path is discarded. Otherwise, the direct link is retained and the winning alternative value is discarded. Once produced, the networks for people in different age groups can be compared using a numerical index of structural similarity (see Schvaneveldt, 1990, for further technical details of the Pathfinder algorithm).

Readers familiar with work on cognition will recognize the relationship between Pathfinder networks and semantic networks (Collins & Loftus, 1975; Meyer & Schvaneveldt, 1976; Quillian, 1969). However, the primary method for constructing semantic networks is theoretical, whereas Pathfinder generates networks empirically from estimates of psychological distance. We assume that the resulting associative structures reflect knowledge of people, actions, or objects related to events. However, judgments about the relatedness of events could also be guided by thoughts about goals and causal relationships between them (Schank & Abelson, 1977). We investigated the extent to which relatedness ratings, in combination with techniques for determining the most salient relationships between concepts, might provide a useful means for comparing how children and adults mentally organize events.

**EXPERIMENT 1**

Two statistical approaches are used to contrast the organization of event knowledge that emerges when participants report information in a sequential format (picture ordering) compared with a less structured format (paired comparisons). The first approach uses comparisons of Pathfinder networks to provide a statistical measure of network similarity (NETSIM), or the proportion of shared links between event knowledge networks. If temporal salience is high, then NETSIM for paired comparison and picture-ordering data should be high. Furthermore, if tempo-
ral salience does not increase developmentally, the same pattern of
developmental differences should be reflected regardless of the meth-
odd used to elicit event knowledge. The second approach is an attempt
to investigate the conceptual glue that holds events together. We com-
pared the ideal distance between events and the actual ratings given for
such distances to determine whether events are related primarily by local
adjacency relationships or whether events are part of a larger associ-
tive structure. If event actions are associated primarily by local adjacency
relationships, then participants should see adjacent events as highly
related and all other events as equally unrelated. However, if events are
part of a larger structure, adjacent events should still be most highly
related, but ratings for events that are farther apart in sequence should
increase monotonically. The latter result would provide evidence in
favor of Fivush’s (1984) argument that event knowledge is organized in
terms of a temporal whole.

METHOD

Participants

Forty-five children from three age groups and one parent for each child
participated in Experiment 1. The 6-year-olds, 8 boys and 7 girls, ranged be-
tween 6.0 and 6.8 (M = 6.4). The 8-year-olds, 5 boys and 10 girls, ranged be-
tween 8.0 and 8.8 (M = 8.4). The 10-year-olds, 8 boys and 7 girls, ranged be-
tween 10.2 and 10.8 (M = 10.5). Most of the parents (33 women, 12 men) were
university students, although three were college professors. Their ages ranged
from 24 to 40 years (M = 32). Participants were of European-American and
Hispanic origin. On average, the parents spent 10 months out of the present
year living in the same home as their children. College students received course
credit and the children a small toy in return for participating in the study.

Apparatus and materials

Color photographs were used for the picture-ordering task. They measured
3 × 3 inches and were mounted in clear plastic. A sentence depicting an event
in the picture (e.g., “Stephen’s Dad ordered the food”) appeared in bold black
letters at the bottom of each photograph. There were nine photos of 5-year-
old Stephen and his dad ordering and eating in a McDonald’s restaurant for
the practice event sequence. There were 21 photos of a young girl (Rose) and
her mother and father for the dinner and bedtime event sequence (see Tables
1 and 2 for the exact wording of each event). These were chosen based on
dinner and bedtime events used by McCartney and Nelson (1981).

For the paired comparisons task, stimuli were presented on an Applecolor
high-resolution monitor (model MO401) driven by a Macintosh IICX computer.
A subset of event photos from the McDonald’s and dinner and bedtime stories
were scanned into digital format, producing a high-quality black-and-white
image from the color original. On every trial, two photos appeared side by side at the top portion of the screen, with the rating scale below them. On the screen, these photos were 8 × 9 cm in size.

**Design**

Two types of event actions were included in both tasks: common (C) and less common (LC). These are shown in Table 1. There were 9 McDonald's event action photos in the picture-ordering task to be sorted once by each participant, 7 C and 2 LC actions. For the dinner and bedtime event sequence, 21 photos were sorted, 8 C and 13 LC actions. These stimuli were presented in a randomized order. For the paired comparisons task, 7 of the McDonald's and 12 of the dinner and bedtime stimuli were included in the similarity rating sets, and each set contained all possible C event actions. For paired comparisons, participants received all possible pairs of event actions once, the order determined randomly for each participant, for a total of 21 McDonald's and 66 dinner and bedtime similarity ratings.¹

Children and adults were given the picture-ordering and paired comparisons tasks using the McDonald's event actions as practice before testing with the dinner and bedtime stimuli. Eight-year-old and 10-year-old children and their parents performed all tasks in one 90-min session of practice and testing. Because of their shorter attention span, 6-year-old children (and their parents) received the same amount of testing over two 45-min sessions, with a lag of no more than 5 days between sessions. In this group, picture-ordering and paired comparisons tasks using the McDonald's stimuli occurred in Session 1, dinner and bedtime picture ordering and paired comparisons in Session 2. Half of the participants in each age group (seven or eight) began with the paired comparisons task, the other half with the picture-ordering task.

**Procedure**

In the picture-ordering task, participants were given these instructions for the dinner and bedtime scenario: "I'm going to show you some pictures which

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**Table 1. McDonald's events used for the practice sessions in Experiment 1**

<table>
<thead>
<tr>
<th>Coding</th>
<th>McDonald's events</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC, PC</td>
<td>Stephen and his dad walked into McDonald's.</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Stephen looked at the Happy Meal toys.</td>
</tr>
<tr>
<td>LC</td>
<td>They stood in line.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Stephen's dad ordered the food.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Stephen's dad paid for the food.</td>
</tr>
<tr>
<td>C, PC</td>
<td>They ate their food.</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Stephen looked at the plants behind the table.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Stephen asked to play on the slide.</td>
</tr>
<tr>
<td>LC</td>
<td>Stephen's father said, &quot;Not now. You've got to eat your food first.&quot;</td>
</tr>
</tbody>
</table>

LC = less common event action; PC = paired comparisons task; C = common event action.

¹ Some participants were given McDonald's event actions for paired comparisons in Session 1, others for paired comparisons in Session 2.
Table 2. Dinner and bedtime events used in Experiments 1 and 2

<table>
<thead>
<tr>
<th>Coding</th>
<th>Dinner and bedtime events</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC</td>
<td>Rose was playing in the living room.</td>
</tr>
<tr>
<td>LC</td>
<td>Rose’s mother yelled, “Dinner time!”</td>
</tr>
<tr>
<td>LC</td>
<td>Rose ran into the kitchen.</td>
</tr>
<tr>
<td>LC</td>
<td>Rose asked, “What’s for dinner?”</td>
</tr>
<tr>
<td>LC</td>
<td>Rose’s father said, “We’re having your favorite, spaghetti.”</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Rose washed her hands.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Rose set the table.</td>
</tr>
<tr>
<td>LC</td>
<td>Rose’s father poured the milk.</td>
</tr>
<tr>
<td>LC</td>
<td>Rose’s mother served them each a dish of spaghetti.</td>
</tr>
<tr>
<td>C, PC</td>
<td>They all started eating their spaghetti.</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Rose said, “Please pass the salt.”</td>
</tr>
<tr>
<td>C, PC</td>
<td>They had chocolate cake for dessert.</td>
</tr>
<tr>
<td>LC</td>
<td>Soon they finished eating.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Rose asked to be excused from the table.</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Rose and her parents watched TV.</td>
</tr>
<tr>
<td>LC</td>
<td>Rose’s father said, “It’s bedtime Rose.”</td>
</tr>
<tr>
<td>C, PC</td>
<td>Rose brushed her teeth.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Rose put on her pajamas.</td>
</tr>
<tr>
<td>LC, PC</td>
<td>Rose read a book.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Rose’s father tucked her into bed.</td>
</tr>
<tr>
<td>C, PC</td>
<td>Soon Rose was asleep.</td>
</tr>
</tbody>
</table>

LC = less common event action; PC = paired comparisons task; C = common event action.

tell a story about Rose having dinner with her family and going to bed. On every picture card there is an event. For example, Rose ran into the kitchen. That’s an event. In what order do these events happen when Rose and her family eat dinner and Rose goes to bed? What order should the cards be in? There are no right answers.” For children who could not read, the experimenter read the caption on the card to the child and then asked the child to repeat the caption back. All participants placed the photographs on a table in the order they thought made the most sense. Positions were marked on the table by consecutive numbers, the number “1” on the left and numbering up to “21.” Participants could reorder the photographs until they were satisfied with the ordering. This task took no longer than 10 min to complete.

Instructions in the paired comparisons task were given with the first pair of stimuli appearing on the computer screen. They were told to “decide how well the two events go together. If they go very well together, put the marker at ‘best.’ If they don’t go together at all, you should put the marker at ‘worst.’ If they go together someplace in-between, press one of the other choices according to how well they go together.” The captions below the pictures were read to 6-year-old children over the first 20 trials. Participants indicated their choices by clicking a computer mouse at a rating bar on the screen with a label length coinciding
with the degree of relatedness of the two events. Upon each click, two stick-figure children appeared at the top of the screen and ran down, laughing audibly, ending up on opposite ends of the rating bar that was chosen. Responses could be changed by clicking on another rating bar. When satisfied with his or her response, the participant pressed the spacebar on the keyboard, bringing the next pair of events to the screen and causing the stick-figure children to disappear until the next trial. This task took no longer than 40 min to complete. Figure 1 depicts a screen from the paired comparisons task.

Everyone rested for several minutes between tasks. Parents and their children were tested on opposite sides of a large room and were not allowed to converse with each other if they finished before the other family member. Children played with toys while waiting to continue the experiment.

RESULTS AND DISCUSSION

Two approaches were taken to assessing developmental differences in event knowledge. First, in the NETSIM analyses, individual networks were generated from the picture-ordering and paired comparison data.

Figure 1. Visual display used for collecting paired comparisons
The individual networks were then compared with a reference network, which represented the adults' most common ordering of events using a measure of \textsc{netsim}, which reflects the proportion of links shared by two networks. \textsc{netsim} analyses address the temporal salience issue. Second, event structure analyses, based on the ideal distance between events and the actual ratings given for such distances, were conducted to determine whether events were related primarily by local adjacency relationships or were part of a larger associative structure. \(^2\)

\textbf{\textsc{netsim} analyses}

Picture-ordering data were converted to a format for analysis based on the distance between pictures. For instance, adjacent pictures were given a link distance of 1, pictures separated by one intervening picture were given a link distance of 2, and so on. In this analysis, only the event actions that the two tasks had in common were used in the analysis. The paired comparison data were converted from categorical labels to numerical distances by assigning all ratings of "best" as distance 1, "better" as 2, "good" as 3, "fair" as 4, "poor" as 5, and "worst" as 6. Pathfinder networks were generated for each participant, one from picture-ordering data and the other from paired comparison data. A referent network based on picture-ordering data was constructed by averaging z-transformed adult data and then submitting the averaged data to Pathfinder analysis (see Figure 2). A referent network based on the adult paired comparison data was constructed in the same manner. The resulting referent networks were identical to each other. Individual networks from all four age groups were then compared with the averaged adult network using the \textsc{netsim} index.

\textsc{netsim} is based on the expected similarity between networks and is computed in the following manner. First, the observed similarity is computed by dividing the number of links shared by both networks (those in the intersection) by the number of links in either network (those in the union). Next, the probability that two networks (e.g., a 6-year-old child network and the average adult network) will share a given number \((k)\) of links can be computed from the hypergeometric probability distribution. The probability that two networks will share \(k\) links can then be used to compute the expected similarity of two random networks. The expected similarity is subtracted from the observed similarity between two networks to get the \textsc{netsim} index, and this is compared with the chance level of similarity (\textsc{netsim} = 0). For instance: given eight event actions, if a 6-year-old child network contains 7 links and the average adult network contains 8 links and if 6 of the links are shared, then there are 9 links in the union (i.e., \(7 + 8 - 6 = 9\)). The probability of sharing 6/9 links is exactly 0.00047 (computed from the hypergeomet-
Figure 2. Referent network generated from adult picture-ordering data. Paired comparisons and picture ordering resulted in identical referent networks.

The referent network includes the following nodes:
- set-table
- eat-dinner
- eat-dessert
- excuse-from-table
- brush-teeth
- put-on-pajamas
- tuck-in
- fall-asleep

Probabilistic similarity analysis shows an observed similarity of 0.667 (i.e., 6/9), expected similarity of 0.162, and NETSIM is calculated as 0.667 - 0.162 = 0.505. A positive NETSIM value indicates a greater degree of similarity between two networks than that which is expected by chance. A negative NETSIM value means that the observed NETSIM is less than that expected by chance. Statistical significance can be used as a criterion for determining wheth-
er the NETSIM values exceed the degree of NETSIM expected by chance. Using this index, we might expect to find a higher degree of NETSIM between 10-year-olds and parents than between 6-year-olds and parents, for example.

Figure 3 shows the mean NETSIM values for each age group based on picture-ordering and paired comparison data. First, planned comparisons were conducted to determine whether NETSIM exceeded that expected by chance. Planned comparisons for picture ordering showed NETSIM values significantly above chance for all four age groups: $t(14) = 3.94, M = .33, SD = .32$ for 6-year-olds, $t(14) = 10.71, M = .61, SD = .22$ for 8-year-olds, $t(14) = 13.62, M = .71, SD = .20$ for 10-year-olds, and $t(44) = 23.32, M = .70, SD = .20$ for the adults ($p < .001$ unless otherwise noted). The paired comparison data showed a different pattern of results. NETSIM values were significantly above chance for 8-year-olds, $t(14) = 3.07, p = .008, M = .10, SD = .12$, for 10-year-olds, $t(14) = 4.78, M = .28, SD = .25$, and for adults, $t(44) = 18.12, M = .41, SD = .16$, but not for 6-year-olds, $t(14) = 1.74, p = .103, M = .03, SD = .12$.

A 4 (age) x 2 (task) ANOVA on NETSIM values resulted in main effects of age, $F(3, 86) = 27.03, p < .001, MSE = 0.04$, and task, $F(1, 86) = 155.10, p < .001, MSE = 0.04$. The main effects were mediated by an age x task interaction, $F(3, 86) = 3.00, p = .035, MSE = 0.37$. According to the picture-ordering data, NETSIM values increased significantly between 6 and
8 years of age, $t(28) = -2.78$, $p = .01$, but there were no differences in NETSIM values between 8-year-olds and 10-year-olds or between 10-year-olds and adults, $t < 1.33$, $p > .195$. In contrast, paired comparisons resulted in no differences in NETSIM values between ages 6 and 8, $t(28) = -.149$, $p = .147$, but there were significant increases in NETSIM values between ages 8 and 10, $t(28) = -2.49$, $p = .019$ and between 10-year-olds and adults, $t(58) = -2.36$, $p = .022$.

Interestingly, even though the NETSIM values exceeded chance in all but one case (6-year-olds’ paired comparisons), NETSIM values were higher for picture ordering than for paired comparisons in every age group. The lower NETSIM values for paired comparisons, even in the case of adult data, may suggest that relationships other than those specific to the ordering of event actions become salient when the task used for eliciting knowledge is not constrained by a linear format.

Taken separately, the developmental patterns for picture ordering and paired comparisons both fit the prediction that event knowledge should become more similar to adult knowledge with increasing age. However, the differences in the developmental patterns produced by the two tasks are noteworthy. Picture ordering placed 8-year-olds closer to 10-year-olds and adults in event knowledge, whereas paired comparisons placed 8-year-olds closer to 6-year-olds but significantly lower than 10-year-olds on event knowledge. Paired comparisons also showed a significant developmental increase in event knowledge from age 10 to adulthood.

An important difference between the paired comparison and picture-ordering tasks is that the latter constrains the number of links between events to $n - 1$. In contrast, the number of links resulting from paired comparison data is limited only by the number of salient relationships people see between comparisons. Thus, a central issue has to do with the proportion of event action links compared with all links in the networks produced from paired comparison data. Presumably, nonevent action links would have a semantic basis other than the temporal ordering of actions. For example, in the context of dinner and bedtime events, a relationship that occurs often in paired comparison data is “eat-dessert” and “brush-teeth,” where the relationship between these two event actions may have more to do with preventing cavities than with temporal ordering. One might hypothesize that younger children would be less likely to order event actions by temporal relationships than older children. That is, the proportion of event action links in the networks to all links might increase with age. This trend would result if, at later ages, the predominant associations between event actions are temporal in nature.

The proportions of event action relationships to all relationships, in increasing order for age group, were .36, .43, .60, and .71. An ANOVA
showed a significant developmental increase for the proportion of event action links to all links, $F(3, 86) = 23.79$, $MSE = 0.02$, $p < .001$. Post hoc $t$ tests showed significant increases between ages 8 and 10, $t(28) = -2.35$, $p = .026$, and between 10-year-olds and adults, $t(28) = -2.34$, $p = .023$. Six- and 8-year-olds did not differ significantly. Thus, there was an increasing tendency to use temporal relationships across age groups, demonstrating that temporal salience is continuing to develop at age 10.

**Event structure analyses**

The *NETSIM* analysis in the previous section was aimed at determining the presence or absence of local connections between event actions but did not address the issue of how these connections might be organized as a whole. To this end, event structure analyses were conducted to determine whether events are organized in memory based on a series of local adjacency relationships or whether the relationships between event actions are part of a larger associative pattern. If a holistic event structure dominates the relationships between actions, then there should be a linear relationship between the number of links intervening between event actions in the referent network and the average ratings for action pairs (as shown by the monotonically increasing line in Figure 4). This pattern would indicate that participants are rating ac-

![Figure 4](image-url)
tions that occur closer in the sequence as closer in distance than actions that are farther apart in sequence. However, if event sequences are structured primarily by local adjacency relationships, then adjacent actions should be rated as close in distance and all nonadjacent actions in the referent network (separated by two to six intervening links) should be rated as equally far apart in distance. Event structure, which is based predominantly on local adjacencies, should look like the bent line in Figure 4, where average ratings increase linearly from distance 1 to distance 2 but then remain constant for distances of two or more links. A final possibility is that participants would not make temporal distinctions between events occurring close in time but would cluster them into a group (e.g., the dinner group or the bedtime group) and consider the group to be temporally distinct from an event later in time.

The ratings for event action pairs in individual participants’ common event data were grouped according to the distances in the reference network (Figure 2, average adult network). Distances were converted to z-scores for each participant. Next, average distances were computed for each group (pairs with distance 1 through 5 and distances of 6 and 7), resulting in six distance categories. The results based on picture ordering are shown in Figure 5. Linear contrasts were used to determine whether there were significant increases in average ratings for items

![Figure 5](image-url)

Figure 5. Average distance in picture ordering as a function of distance in the referent network for all age groups in Experiment 1
separated by only one intervening link and items separated by two or more intervening links ($p < .001$ unless otherwise noted).

**Picture ordering**. There were significant increases for items separated by one versus two or more intervening links in all four age groups: $t(14) = 5.47$ for 6-year-olds, $t(14) = 18.55$ for 8-year-olds, $t(14) = 47.96$ for 10-year-olds, and $t(44) = 124.83$ for adults. Linear contrasts also were used to determine whether average ratings increased from distance 2 to distance 6. Again, there were significant increases in all four age groups: $t(14) = 6.52$ for 6-year-olds, $t(14) = 18.32$ for 8-year-olds, $t(14) = 127.40$ for 10-year-olds, and $t(44) = 263.26$ for adults. The results from the picture-ordering task suggest a pattern of associative relationships indicative of a temporal whole rather than one based on local adjacency relationships alone. There is a linear increase in ratings for items that are spaced farther apart in sequence compared with items separated by one link.

**Paired comparisons**. Rating analyses were conducted for the paired comparison data in the same manner described previously. The average distances are shown in Figure 6. There were significant increases in the average ratings given for event actions separated by one versus two or more intervening links for 8-year-olds, $t(14) = 5.28$, 10-year-olds, $t(14) = 6.79$, and adults, $t(44) = 30.96$, but not for 6-year-olds, $t(14) =

![Figure 6](image-url)

Figure 6. Average distance in paired comparisons as a function of distance in the referent network for all age groups in Experiment 1
1.31, \( p = .211 \). However, linear contrasts for determining whether average ratings increased from distance 2 to distance 6 showed significant increases for all four age groups: \( t(14) = 3.22, p = .006 \) for 6-year-olds, \( t(14) = 3.23, p = .006 \) for 8-year-olds, \( t(14) = 6.61 \) for 10-year-olds, and \( t(44) = 20.42 \) for adults. These results suggest a pattern of associative relationships indicative of a temporal whole for the older age groups, but events did not appear to be organized in terms of a script structure for the youngest age group. The results for 6-year-olds suggest that temporal distinctions are made between items far apart in distance but not for adjacent items. Post hoc inspections of 6-year-old data showed that dinner and bedtime events were grouped properly but not always in the correct order. For example, 6-year-olds grouped “put-on-pajamas,” “tuck-in,” and “fall-asleep” with bedtime events but some children ordered them incorrectly by placing “fall-asleep” between “put-on-pajamas” and “tuck-in.” Thus, the 6-year-olds’ paired comparison data did not support the hypothesis of a larger, temporally organized script structure, despite a wealth of evidence to the contrary suggesting that children have well-organized script knowledge by 6 years of age (e.g., Fivush, 1984; Fivush et al., 1992; Fivush & Mandler, 1985; McCartney & Nelson, 1981; Nelson & Gruendel, 1986; Price & Goodman, 1990). In contrast, the older age groups showed evidence of a representational structure based on a holistic pattern of associations rather than one based on local adjacency relationships.

The strong interpretation of the developmental trend uncovered in Experiment 1 is that the temporal cues are less salient to 6-year-olds than they are for older children and adults. However, two alternative explanations of the data must be examined. One alternative explanation for the paired comparisons versus picture ordering discrepancy found for 6-year-olds may be that children this young simply cannot make accurate judgments of relatedness. However, children clearly can discriminate perceptual differences in classification tasks involving comparisons of three or more objects (Cook & Odom, 1992; Smith, 1989; Thompson, 1994). Perhaps the memory requirements are too demanding because children would have to have some knowledge of their ratings across trials to make regularly ordered judgments. Therefore, we decided to ask 6-year-old children to make comparisons on a set of stimuli with more concrete relationships than those found in event structure. Thus, children in Experiment 2 participated in paired comparisons and picture ordering of objects related by size. If NETSIM values are still at chance for comparisons requiring knowledge of perceptual relationships, then this implies that young children simply cannot perform the paired comparison task. If NETSIM values are above chance for comparisons requiring knowledge of perceptual relationships, then this implies
that 6-year-olds can perform paired comparisons on items forming an
organized set of concepts.

An additional explanation for the results found in Experiment 1 is
that 6-year-olds are not sensitive to temporal relationships in the absence
of supportive contextual cues provided by the task context. In other
words, lacking the temporal constraints implied by linear ordering of
pictures, they must be explicitly reminded to make their comparisons
in the context of the time relationship. If children can base their paired
comparisons on temporal cues when their attention is directed to tem-
poral relationships, then we would have clear evidence that 6-year-olds’
event representations include temporal structure. Therefore, the chil-
dren in Experiment 2 also participated in paired comparisons and pic-
ture ordering using the dinner and bedtime events from Experiment 1
but with explicit instructions to focus on the temporal relationship.

EXPERIMENT 2

METHOD

Participants
Thirteen 6-year-old children attending a summer sports camp at New Mex-
ico State University participated in the study (M = 6.4; range = 6.0–6.11 years).
Six of the children were boys and seven were girls, and they came from Euro-
pean-American and Hispanic cultural backgrounds.

Materials
Seven white laminated cards with black circles of diameter varying from 0.5
to 3 in. were used in picture ordering and paired comparisons for determi-
ing whether 6-year-old children are able to give reliable relatedness judgments.
The dinner and bedtime events from Experiment 1 were also used, but instead
of all 21 photographs in the picture-ordering task, only 12 were used (the stim-
uli used in the paired comparisons task in Experiment 1).

Procedure
The children participated in two phases on the same day. Each phase con-
stituted of one task using the two sets of materials. The order of tasks was coun-
terbalanced across children so half of the children participated in picture or-
dering before paired comparisons and the other half participated in paired
comparisons first. All children performed the task with the same order of
materials, that is, circles followed by dinner and bedtime event actions.

Picture ordering. For picture ordering, the procedure was the same as in
Experiment 1. The general instructions were the same. Children were told to
order the event actions in terms of size or time depending on whether they were
sorting the circles or the dinner and bedtime event actions. The experiment-
er shuffled the cards, gave them to the participant, and then asked "What order do you think the cards should be in? Please place the cards in the order you think they should go in according to time (size)."

**Paired comparisons.** The same computer program used in Experiment 1 was used to display each of the event action (circle) pairs in Experiment 2. The children used the program to rate how well each pair of event actions went together on a six-item scale from best to worst (see Figure 1). Children participated in 21 trials using the circles and 66 trials using dinner and bedtime event actions. Again the primary difference in procedure was in the specificity of the instructions. The children were told, "You will see two events (circles) at a time. Decide how well these two events (circles) go together according to time (size)." The child used the computer mouse to select the rating that best reflected his or her judgment.

**RESULTS AND DISCUSSION**

**NETSIM analyses**

As in Experiment 1, picture-ordering data were converted to a format based on the distance between pictures of the common events during ordering. The paired comparison data were converted from categorical data to distances. Pathfinder networks were generated for each child. Preliminary t tests showed that NETSIM values for children who performed the picture-ordering task first were not significantly different from NETSIM values for those who performed paired comparisons first, so task order was not included as a variable in the analyses to follow (ps > .25). Individual networks for circle ordering were then compared with a reference network reflecting the correct ordering of circles according to size. Individual networks for the dinner and bedtime events were compared with the referent networks obtained in Experiment 1.

For the circle-ordering tasks, planned comparisons resulted in NETSIM values significantly above chance for both picture ordering, t(12) = 9.70, M = .75, SD = .28, and paired comparisons, t(12) = 8.29, M = .37, SD = .16 (ps < .001 unless otherwise noted). Although NETSIM values were higher for picture ordering than for paired comparisons, the high degree of NETSIM suggests that 6-year-old children can make ordered judgments of relatedness by comparing two objects at a time.

For the dinner and bedtime events, picture ordering also resulted in NETSIM values significantly above chance, t(12) = 7.06, p < .001, M = .48, SD = .24. The mean increase in NETSIM from Experiment 1 to Experiment 2 was .15. This difference did not result in a statistically significant improvement, t(26) = -1.35, p = .188. However, the significant differences in NETSIM values between ages 6 and 8 observed in Experiment 1 were no longer present when 6-year-olds from Experiment 2 were compared with 8-year-olds from Experiment 1, t(26) = 1.5, p = .145.
In contrast to the results found with paired comparisons in Experiment 1, where NETSIM values for 6-year-olds failed to exceed chance levels of similarity, NETSIM values in Experiment 2 were significantly higher than those expected by chance, \( t(12) = 4.66, M = .19, SD = .15 \). The mean increase in NETSIM from Experiment 1 to Experiment 2 was .16. This difference resulted in a statistically significant improvement, \( t(26) = -3.12, p = .004 \). Although the mean NETSIM score was higher for the 6-year-olds in Experiment 2 than for the 8-year-olds in Experiment 1 \( (M = .10) \), the difference did not reach significance, \( t(26) = -1.79, p = .08 \).

The proportion of script links to all links for networks generated from the paired comparison data in Experiment 2 were compared with those for 6-year-olds in Experiment 1. The proportion of script links to all links increased significantly, \( t(25) = 2.64, p = .014 \), from Experiment 1, \( M = .36 \), to Experiment 2, \( M = .54 \).

**Event structure analyses**

Event structure analyses for the circles and for the dinner and bedtime common events were conducted in the same manner as in Experiment 1.

**Picture ordering.** The results based on picture ordering are shown in Figure 7. Linear contrasts for determining whether there were signifi-

![Figure 7. Average distance in picture ordering of circles and dinner and bedtime events as a function of distance in the referent network for 6-year-olds in Experiment 2](image-url)
cant increases in average ratings for items separated by one link and items separated by two or more links showed significant increases for both circle ordering, $t(12) = 7.60$, and dinner and bedtime event actions, $t(12) = 14.26$. Linear contrasts for identifying increases in average ratings from distance 2 to distance 6 also resulted in significant increases for circle ordering, $t(12) = 8.82$, and dinner and bedtime event actions, $t(12) = 10.21$. Consistent with the results reported in Experiment 1 for picture ordering, these results suggest a pattern of associative relationships extending beyond local adjacency relationships to a temporal whole.

**Paired comparisons.** The results based on paired comparisons are shown in Figure 8. Linear contrasts comparing average similarity ratings for items separated by one link and items separated by two or more links showed significant increases for both circle ordering, $t(12) = 16.56$, and dinner and bedtime event actions, $t(12) = 6.66$. Linear contrasts for identifying increases in average ratings from distance 2 to distance 6 also resulted in significant increases for both circle ordering, $t(12) = 17.62$, and dinner and bedtime event actions, $t(12) = 5.09$. In contrast to the results reported in Experiment 1, the results for both circle ordering and dinner and bedtime event actions suggest that 6-year-olds organize information according to a pattern of associative relationships that extend beyond mere adjacency relationships. Circles of different sizes were

![Figure 8. Average distance in paired comparisons of circles and dinner and bedtime events as a function of distance in the referent network for 6-year-olds in Experiment 2.](image-url)
used in Experiment 2 to determine whether young children could reliably rate ordered stimuli in a paired comparisons task. Although the paired comparisons task is admittedly more difficult than is picture ordering, the paired comparison results reported for circle ordering demonstrate that 6-year-old children can indeed make the judgments necessary for a similarity rating task.3

The instructions also were altered in Experiment 2 in an attempt to encourage 6-year-olds to focus on time relationships. Although this additional cue did not result in great improvements for picture ordering, the additional information did make the salience of temporal relationships stronger in the paired comparisons task. This pattern of results across experiments suggests that 6-year-olds do internalize temporal cues for events, but these cues are not as salient to them as other bases of comparison. In contrast to their peers in Experiment 1, 6-year-olds in Experiment 2 showed greater NETSIM to the adult network and clear evidence of a temporally organized script structure for dinner and bedtime event actions. It is important to note that older children show significant degrees of NETSIM to the referent network as well as evidence of a larger structured pattern of temporal associations even in the absence of specific cues to focus on the time relationship.

GENERAL DISCUSSION

The present study investigated two questions about the salience of temporal cues in children’s developing event knowledge: Does the salience of the temporal nature of event knowledge increase between 6 and 10 years of age, and is the internalized structure of event knowledge organized as a temporal whole, or are the links between event actions based primarily on localized associations between pairs of events?

Temporal organization improves even in the picture-ordering task

The temporal nature of event knowledge was apparent in the picture-ordering data. For all age groups, network structures exhibited greater-than-chance similarity to a referent structure based on an idealized representation of the temporal ordering of events. Furthermore, relatedness ratings from the picture-ordering task suggested a pattern of associative relationships that was not based solely on local associations between pairs of events. Rather, the pattern of associative relationships suggested a coherent structure of the event represented as a whole. However, children’s ability to order event actions in the picture-ordering task is not particularly surprising for several reasons. Our youngest children were 6 years old, and even 3-year-olds can reenact (Fivush et
al., 1992) and explicitly verbalize (Slackman et al., 1986) scripts of familiar events. Thus, for the script generation task, there is no doubt that by 6 years of age, children can provide general cohesive and coherent accounts, especially those that have been experienced with great frequency in their lives.

What may be somewhat surprising, then, is that between ages 6 and 8 there was improvement in the degree to which network structures for picture ordering reflected the idealized referent structure. However, after age 8 network structures did not change. Thus we can conclude that in the context of a task that specifically asks children for temporally ordered responses and supplies them with event actions to be ordered, children's responses are temporally sequenced. Furthermore, our data show a small but significant improvement between ages 6 and 8 in the ability to sequence this knowledge.

**Temporal organization as a primary basis of organization**

Our main interest was whether aspects of event structure other than temporal or causal connections, such as perceptually noticeable commonalities between events, may serve as a primary basis of organizing event knowledge in younger children. For example, Ratner, Smith, and Padgett (1990) found that younger children's spontaneous sorting of events involved in clay making was organized according to object categories, whereas adults organized according to action categories. Ratner et al. suggested that as children gain increasing experience with events, they rely more on goals and actions to guide processing and less on the object information contained in events.

Two pieces of evidence from our study support this idea. We analyzed the paired comparison data from both experiments according to whether concepts were adjacent to each other in the network because of their high temporal relatedness or because semantic information other than temporal relatedness was used to organize event knowledge. Favoring Ratner et al.'s (1990) suggestion, the proportion of script links to all links increased significantly between age 8 and adulthood in Experiment 1. Furthermore, 6-year-olds in Experiment 1 not explicitly told to focus on the temporal dimension had a lower proportion of script links to all links than 6-year-olds in Experiment 2 (who were instructed to focus on time). Similarly, Ratner et al. (1990) found that young children could organize events in terms of their actions when asked yet did not spontaneously generate this type of organization. In the present research, older children and adults seemed to use the sequential ordering of events spontaneously as their primary basis of organization, whereas younger children did not. Thus, our evidence supports the position that the temporal nature of event knowledge develops later than aspects of
knowledge that can be ascertained from the immediate context of the event, such as the persons, objects, and actions characterizing event actions.

Finally, our results provide a strong, quantitative test of two possible forms of temporally related event structures. Specifically, one form describes the representation in terms of a series of localized associations between event actions, whereas the other form describes the representation in terms of temporal positions of event actions relative to actions further apart (forward or backward) in the sequence. The latter is a more advanced form of structure because temporal connections between event actions are represented in relation to all actions in the event sequence, not just adjacent actions. Fivush (1984) argued that the presence of conditional terms such as “if—then” or relational terms such as “before and after” are indicative of children’s holistic representational structure. However, this may be a weak form of evidence for holistic structure because the type of statements children make tend to link adjacent event actions, such as “We have rest and then we go outside to play” (Fivush, 1984, p. 1703). The ratings analyses conducted on the paired comparison data in the present study provided direct quantitative tests of both hypotheses, and the results supported the assumption that at least from the age of 6 years, children’s dinner and bedtime event representations are structured in the more advanced holistic form.

The interaction between contextual cues and representational structure

A child who has lived in the same family between the ages of 2 and 6 would have acquired approximately 1,500 experiences of eating dinner with the family and getting ready for bed. Presumably, the majority of common event occurrences should proceed in a temporally consistent manner. Thus, every evening experience should nudge the overall similarity of the structure of the child’s event representation closer to his or her parents’ structure. Yet the 6-year-olds in Experiment 1 did not produce temporally organized networks in the paired comparison task. How do we account for the fact that such prodigious experience did not yield event structure more closely paralleling that of adults?

Certainly part of the answer lies in our previous observation that younger children focus more on people, objects, and event actions than on the temporal relationships connecting them. In support, younger children’s relatedness judgments are more strongly influenced by non-temporal semantic information compared with older children and adults. But this does not wholly explain the discrepancy between 6-year-olds and the older age groups on this task. Recall that picture-ordering and paired comparison tasks used the same photographs of event occurrences, so the perceptual information was equivalent between tasks.
Yet 6-year-olds' networks were linearly organized for picture ordering but not for paired comparisons. A reasonable explanation for this discrepancy is that young children rely heavily on the available perceptual cues of event actions (i.e., people, actions, and objects) in the picture-ordering task to temporally structure their responses. The relative degree of disparity between picture-ordering and paired comparison networks thus can be construed as indicating the extent of internalization of the temporal characteristics of event knowledge: The greater the disparity, the less the knowledge is internalized. Younger children clearly show less internalization of temporality, whereas older children and adults show more.

Our results also are consistent with the hypothesis that temporal cues are lower in 6-year-old children’s salience hierarchies of representational dimensions (Cook & Odom, 1992) than are cues that can be derived from the immediate context. When the temporal dimension is more salient, the predisposition to activate it is high and will be used for event comparison even if not explicitly mentioned in the instructions. However, when the temporal dimension is less salient, the predisposition to activate it is low and will be used only for event comparison upon explicit instruction.

More broadly speaking, as children regularly participate in events in everyday life, they rely less on contextual cues for action as they gradually internalize temporal knowledge in memory. Thus, somewhat surprisingly, the transition to a sequentially organized adultlike representation may take longer than previously thought, even for highly experienced routines. Children’s reliance on external features of event structure as guides for appropriate behavior may serve as a crutch, allowing them greater opportunity to attend to and encode other meaningful facets of their complex world.

Notes

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1. Fewer pictures were used with paired comparisons than picture ordering to reduce the number of comparisons required of the participants, which is
Reducing the number of event actions from 21 to 12 resulted in 66 comparisons instead of 212. The reason for including four LC dinner and bedtime event actions in the set of similarity ratings was to weaken the salience of temporal cues. To the extent that children’s ratings are based on temporal relationships, this is even more powerful evidence of their tendency to select temporal cues as their basis for comparison.

2. Analyses using the maximum number of events specific to a task (e.g., 21 for picture ordering and 12 for paired comparisons) also were conducted. In an effort to simplify an already lengthy Results section, we have chosen not to report these findings. We also thought it more important to limit the network analyses to common events to make direct comparisons with the subsequent content and ratings analyses (analyses that make sense only for common events). Consistent with previous research, networks generated from ratings on common events resulted in significantly higher NETSIM scores than did networks generated from ratings on common plus less common events.

3. An additional study conducted in our laboratory shows that 6-year-olds can make similarity judgments on as many as nine pictures (36 comparisons) sharing perceptual relationships such as color, shape, and position of objects. Furthermore, NETSIM for these materials was almost identical to that for older age groups.

References


