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# Normative studies of sequence strength and scene structure of 30 scripts

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Subjective ratings of action-sequence strength and scene structure were collected for the 30 scripts documented by Galambos (1983). Subjects largely agreed on the location of the major scene boundaries. Ratings of action sequences indicated that some scripts possess stronger sequential properties than others, and if actions were from the same scene rather than from different scenes, the probability that subjects disagreed about their order was higher. We discuss the implications and importance of these results concerning modeling of script representation in memory.

A *script* has been defined as a "predetermined, stereotyped sequence of actions that define a well-known situation" (Schank & Abelson, 1977, p. 41). During the past two decades, much research has been devoted to the functional aspect of scripts, using a variety of tasks such as reading (e.g., Bellezza & Bower, 1981; Schank & Abelson, 197), making lexical decisions (e.g., Sharkey, 1986; Sharkey & Mitchell, 1985; Sharkey & Sharkey, 1987), answering questions (e.g., Lehnert, 1978), and retaining information (e.g., Graesser, Gordon, & Sawyer, 1979; Graesser & Nakamura, 1982; Graesser, Woll, Kowalski, & D. A. Smith, 1980; Locksley, Stangor, Hepburn, Grosovsky, & Hochstrasser, 1984; Nakamura, Graesser, Zimmerman, & Riha, 1985; D. A. Smith & Graesser, 1981). Consistent results have been obtained: Script activation allows subjects to interpret, form expectations, and draw inferences from input information. Consequently, comprehension of script-based stories is facilitated, even though memory of the original input may be distorted.

Research on structural aspects of scripts contrasts markedly with research on functional aspects of scripts. Fewer studies have been done and less consistent results have been reported on structural aspects. For several historical reasons, the few studies that have dealt with script structure have focused on how temporal information of actions is represented in a script. First, a script was originally defined

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as a "sequence of actions" that represents the typical content of an event (Schank & Abelson, 1977). Second, many researchers have been interested in the question of how spatial and temporal information is stored in memory (e.g., Polich & Potts, 1977; K. H. Smith & Foos, 1975; K. H. Smith & Mynatt, 1982). Third, at least since the time of John Locke, it has commonly been assumed that two things that are experienced as contiguous (spatially or temporally) are stored in memory as connected concepts (e.g., Anderson & Bower, 1973).

Three models that postulate that temporal information is either entirely, partly, or not represented structurally in scripts have been proposed to account for research findings pertaining to the issue. The first, the *sequential model*, postulates that actions are sequentially organized (temporally ordered) in the representation of a script. That is, temporal information is explicitly represented in the structure of a script. (Although Schank & Abelson, 1977, did not explicitly address the issue of script representation, in their discussion of script applier mechanism [SAM: a computer program that simulates script processing] a sequential representation was implied.) The second, the *hierarchical model*, postulates that scripts are organized into at least three hierarchical levels with a script title at the top, scene titles in the middle, and specific actions within scenes at the bottom (Abbott, Black, & Smith, 1985). In this model, temporal information is represented primarily at the scene level. The third, the *unstructured model*, postulates that temporal information is not represented structurally in scripts, but is represented by "code" tags on actions (Nottenburg & Shoben, 1980). Because the studies on script representation used different experimental paradigms (tasks) and property control of stimuli (e.g., action centrality), which almost surely involve different cognitive processes, it is difficult to evaluate the results of these studies unambiguously.

The literature shows that three kinds of experimental paradigms have been used to study script structure: action production (e.g., Barsalou & Sewell, 1985), memory (e.g., Abbott et al., 1985; Bower, Black, & Turner, 1979) , and priming (e.g., Bower et al., 1979, Exp. 4; Galambos & Rips, 1982; Nottenburg & Shoben, 1980).

Studies involving action production and memory have tended to support the notion that temporal information is at least partially represented in scripts, whereas priming studies have not. For example, Barsalou and Sewell (1985) asked subjects to produce actions from scripts, and examined the effects of instructions concerning the order in which actions were to be produced. Subjects were asked to produce script actions (a) in whatever order they came to mind, (b) from most to least central (reflecting the relative importance of an action to the performance of a script), (c) from first to last in terms of temporal ordering, or (d) from last to first. They found that more actions were mentioned for the first-to-last condition than for the other conditions. However, Nottenburg and Shoben (1980) employed a comparative judgment task in which subjects had to decide which of two actions from a script came earlier (or later) in the script. It is generally held that if script actions are sequentially arranged in scripts, the time needed to decide which of two actions comes earlier (or later) will be directly related to the number of normative actions between them, because of priming between the two actions. However, Nottenburg and Shoben found opposite results: The closer the temporal distance between two actions, the slower the subjects responded. These inconsistent results indicate that to study how temporal information is represented in scripts, it is necessary to control task demands.

Another factor that needs to be controlled is the centrality of actions. Because central actions are important in completing a script, the probability that these actions are included in script activities is high. Galambos (1983) showed that there is a high correlation between rated action centrality and standardness, where the standardness of an action is defined as the normative frequency with which the action is produced by subjects given the script title. In action production and memory studies, central actions are more readily retrieved but more poorly discriminated than peripheral actions (e.g., Bower et al., 1979; Graesser & Nakamura, 1982), and in priming studies, these actions are judged as members of scripts faster than peripheral ones (Galambos & Rips, 1982).

More intriguingly, central actions are expected to have strong associations among themselves. The E. E. Smith study (discussed in Abbott et al., 1985) showed a temporal priming effect for scene titles but not for scene actions. These results may have been obtained because the associations among scene titles (which are usually central actions to a script) are strong and include temporal information, whereas associations among scene actions may be weak if scene actions are associated primarily to scene titles.

Most important, to study how temporal information is represented in scripts, it is necessary to consider the sequence strength of a script. Actions in scripts with strong sequence strength cause or set up preconditions for the next action. For instance, the sequence of actions involved in a Japanese tea ceremony is a highly controlled ritual. For example, before putting tea leaves into a teapot, the teapot must have been warmed. The action "warming the tea pot" is a precondition for the action "putting tea leaves into the teapot." There are other scripts with weak sequence strength in which there is no fixed ordering for actions. For example, a typical circus performance presented trapeze artists, jugglers, lion tamers, and so on, and although some orders are more common than others (e.g., lion tamers often come last), there is no necessary order to the various acts (Abelson, 1981).

The strength of the association between two temporally adjacent actions would be stronger for a script with strong sequence strength than for a script with weak strength. Thus, it should be easier to find temporal priming for some scripts than others. Although the problem of sequence strength has been mentioned by some researchers (e.g., Abelson, 1981; Bower et al., 1979; Galambos & Rips, 1982; Haberlandt & Bingham, 1984), the review of previous studies on script representation revealed either no control for this variable or control procedures that were far from satisfactory. For example, one of the three criteria used by Haberlandt and Bingham for selecting scripts in their study was that "the scripts selected for this research had to be directional events, rather than events such as a circus performance" (p. 164). The stimuli used by them were the 30 scripts collected by Galambos (1983) which "were also judged to have relatively clear sequencing properties" (p. 164). No standard procedure was followed to select scripts and no operational definition of sequence strength was given.

In the present study, subjective judgments of the sequence strength of actions within 30 scripts were collected. The sequence strength of a script could be estimated in many ways. For example, as in measuring word familiarity (e.g., Seidenberg, 1985) and perceptual similarity of numbers (e.g., Shepard, Kilpatric, & Cunningham, 1975), it could be estimated simply by asking subjects to rate it. Sequence strength could also be estimated by asking subjects to reorder the actions of a script in as many ways as seems reasonable. The number of different arrangements of the actions is one index of the sequence strength of a script.

R. A. Smith and Houston (1985) used a paired-comparison method to measure sequence strength. This method involves presenting pairs of actions to subjects and asking them to decide which action occurs earlier in the script. After the ratings are collected, the results are tabulated in a matrix. If there is high agreement for the ordering of the actions, then the number of entries in the matrix below the main diagonal should be small.

There are no experimental data allowing us to decide which method is the best. The paired-comparison method was adopted for this experiment because it allows us to explore the second goal of this experiment, which is explained below.

According to the hierarchical model, scene titles are sequentially represented in scripts, and scene actions are grouped (unordered) within scenes. This hypothesis implies that the sequence strength at the scene level will be stronger than at the action level. There should be more disagreements among subjects with respect to the orders of actions within scenes than between scenes. Scene boundaries were determined (as in Bower et al., 1979) by asking subjects to segment actions presented in their normatively correct order into chunks by putting slash marks between actions to indicate natural scene boundaries.

## EXPERIMENT

### METHOD

#### Subjects

Subjects were 126 undergraduates at the University of Texas at Arlington who participated to satisfy a course requirement. The paired-comparison sequence rating task had 96 subjects, and the scene boundary determination task had 30. Subjects were tested in groups of 10 to 20.

#### Materials

We selected 30 scripts, each containing 12 actions, from the Galambos (1983) script norms. For example, the script for cashing a check consisted of the following 12 actions: go to bank, write down date, write down amount, write your signature, record the amount, stand in line, go to window, endorse the back, give to teller, show your identification, receive the money, and count the money.

#### Procedure

**Scene boundary determination.** Each subject received a booklet containing 30 scripts. In the booklet, the title of a script was listed at the top of a page followed by the actions presented in the order specified by the Galambos (1983) norms. Subjects were asked to segment actions within each script into scenes by placing slashes to mark scene boundaries. They were given no hint as to how many slashes to place in a script. The instructions of the task were as follows:

> On each page of this booklet, you will find a list of 12 actions describing the activity listed on the top of the page. Many people feel that the actions in each activity can be divided into several parts or subactivities. Please imagine that you will perform each activity. As you do so, decide whether or not the actions form natural groups; if so, identify these groups by placing a line between two actions marking the boundary of each group.

**Sequence rating.** Each subject received a booklet containing instructions followed by five scripts randomly selected from the script pool with the restriction that each script was assigned once to 16 subjects. Each action within a script was paired with all other actions. That is, there were 66 pairs of actions for each script. In the booklet, the title of a script was listed at the top of a page followed by the 66 action pairs in random order. Subjects were asked to mark the action of a pair that they believed would occur earlier in the script. The instructions of the task were as follows:

> You will receive five booklets, each consisting of three pages. On the top of each page, the name of an activity and pairs of actions which people generally do when they perform the activity are listed. Many people feel that the actions in each activity have a sequencing property. That is, in performing an activity, some actions are usually engaged in earlier than other actions. Please imagine that you will perform each activity. As you do so, decide which action of a pair occurs earlier in the activity by placing a line under the action.

## RESULTS

### Scene boundary data

For each script, the number of subjects placing a slash between each pair of actions was tabulated (Table 1). Agreement among subjects was computed for each script by dividing the subjects in half and then correlating the frequencies from the two halves. These correlations (.52 to .97, mean correlation = .80) are shown in Table 1. For most scripts there was substantial agreement among subjects as to where the major scene boundaries were.

To determine the major scene boundaries of a script, the distributions of the number and locations of boundaries selected were examined. All scripts yielded a skewed distribution of the number of slashes at each boundary point, with less than 10% of the boundaries selected by more than 20 subjects and more than 60% of the boundaries selected by 8 or fewer subjects. In most scripts, the point where 50% (15) of the subjects did or did not make a slash fell in a natural gap in the slash distribution, so this was adopted as the cutoff point. By this criterion, a mean of 3.10 scenes was generated for the scripts. Scene boundaries are underlined in Table 1.

### Sequence rating data

One subject who did not complete the experiment was replaced. For each script, the sequence rating data were tabulated in a 12 × 12 matrix, where the rows and the columns corresponded to the 12 actions ordered according to the Galambos (1983) norms.

The number of entries above the main diagonal was computed for each script and converted to a proportion by dividing by 1,056, the total number of entries in the matrix. This score was used to indicate the sequence strength of a script (second column of Table 2).

Table 1. Number of subjects who placed a scene boundary between Action $i$ and $i + 1$, and reliability correlations between subjects for 30 scripts

| Script title | Action number 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Reliability |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barbecuing a Steak | 0 | 3 | 1 | 0 | <u>29</u> | 0 | <u>18</u> | 7 | 6 | 7 | <u>15</u> | | .92 |
| Brewing Some Tea | 3 | <u>18</u> | 6 | 10 | 4 | 2 | 5 | <u>24</u> | 6 | 7 | 9 | | .91 |
| Buying a Car | 11 | <u>19</u> | 4 | <u>16</u> | 8 | 5 | <u>17</u> | 5 | 8 | 12 | 7 | | .54 |
| Cashing a Check | 12 | 0 | 0 | 4 | <u>17</u> | 2 | 7 | 6 | 4 | 14 | 3 | | .83 |
| Catching a Plane | <u>19</u> | 7 | 10 | 4 | 6 | 9 | 8 | 14 | 8 | 10 | 0 | | .52 |
| Changing a Tire | 14 | 0 | <u>22</u> | 6 | 3 | 7 | 5 | <u>17</u> | 3 | 14 | 6 | | .76 |
| Changing the Bed | 4 | <u>28</u> | 1 | 8 | 0 | 9 | <u>18</u> | 3 | 9 | 13 | 6 | | .91 |
| Checking Out Books | 3 | 1 | 3 | <u>23</u> | 4 | 5 | <u>25</u> | 1 | 2 | 12 | 6 | | .97 |
| Cleaning Your Clothes | 2 | <u>22</u> | 4 | 6 | 7 | 0 | 0 | <u>26</u> | 7 | 0 | <u>28</u> | | .95 |
| Doing the Dishes | 9 | 9 | 4 | 5 | 4 | 13 | <u>19</u> | 1 | 1 | <u>19</u> | <u>16</u> | | .82 |
| Getting a Suntan | 13 | 1 | 14 | <u>18</u> | 1 | 3 | 5 | 13 | 7 | <u>17</u> | 0 | | .64 |
| Going on Vacation | 2 | 4 | 7 | 8 | 12 | <u>26</u> | 7 | 13 | 5 | <u>18</u> | 1 | | .82 |
| Going to Movies | 0 | 0 | <u>25</u> | 4 | 2 | <u>18</u> | 4 | 12 | 11 | 13 | 13 | | .94 |
| Going to Restaurant | <u>20</u> | 2 | 6 | 5 | <u>20</u> | 5 | 13 | 8 | <u>21</u> | 5 | 1 | | .90 |
| Making a Campfire | 5 | 13 | 0 | 1 | <u>25</u> | 1 | 11 | 5 | <u>15</u> | 10 | 2 | | .90 |
| Making New Clothes | 8 | 2 | <u>30</u> | 0 | 2 | <u>19</u> | 2 | <u>27</u> | 14 | 2 | 14 | | .96 |
| Painting a Room | <u>18</u> | 2 | 0 | <u>19</u> | 0 | <u>23</u> | 3 | 0 | <u>24</u> | 4 | 5 | | .93 |
| Pitching a Tent | 4 | <u>15</u> | 9 | 3 | 3 | <u>18</u> | 2 | 3 | 8 | 14 | 5 | | .78 |
| Playing Tennis | 12 | 14 | 11 | 10 | <u>16</u> | 5 | 2 | 1 | <u>15</u> | 5 | <u>15</u> | | .68 |
| Sending a Gift | 4 | 0 | 7 | 11 | 2 | <u>17</u> | 14 | 0 | 2 | 4 | 9 | | .83 |
| Serving Good Wine | <u>16</u> | 2 | 3 | <u>17</u> | 2 | 12 | 1 | 2 | <u>15</u> | 8 | 8 | | .63 |
| Shopping for Groceries | <u>23</u> | 3 | 7 | 3 | 4 | 0 | <u>21</u> | 7 | 8 | 7 | 4 | | .85 |
| Smoking a Pipe | 7 | 4 | 2 | 13 | 13 | 7 | 7 | 5 | 13 | <u>18</u> | 4 | | .68 |
| Starting a Car | 0 | 2 | <u>15</u> | 2 | 11 | 2 | 11 | 11 | <u>17</u> | 4 | 2 | | .90 |
| Taking a Photograph | 3 | 14 | 8 | 0 | 1 | <u>21</u> | 2 | 1 | 6 | 8 | 3 | | .95 |
| Taking the Subway | 3 | 14 | 13 | 7 | 6 | <u>16</u> | 8 | 3 | 8 | <u>17</u> | 1 | | .55 |
| Throwing a Party | 0 | 8 | 5 | <u>27</u> | 0 | <u>18</u> | 2 | <u>18</u> | 8 | 6 | 13 | | .89 |
| Washing Your Hair | 7 | 6 | 12 | <u>17</u> | 1 | 3 | 14 | <u>24</u> | 13 | 6 | 6 | | .70 |
| Writing a Letter | 13 | 0 | 11 | 3 | 10 | <u>23</u> | 1 | 4 | 6 | 2 | 5 | | .89 |
| Xeroxing a Page | 12 | 4 | <u>15</u> | 7 | 1 | 1 | 8 | 7 | 3 | 9 | 8 | | .55 |

*Note.* Actions in each script are ordered according to the Galambos (1983) norms. Scene boundaries are underlined.

Table 2. Sequence strengths, new sequences that maximize sequence strength, and Spearman rank-order correlations between the new sequences and those suggested in the Galambos (1983) norms for 30 scripts (data from Experiment 1 sequence-rating task)

| Script title | Sequence strength | New sequence | | | | | | | | | | | | New sequence strength | $r$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shopping for Groceries | .98 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .98 | 1.00 |
| Sending a Gift | .94 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 10 | 12 | .95 | .99 |
| Going to Restaurant | .93 | 1 | 3 | 5 | 2 | 4 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .94 | .97 |
| Making New Clothes | .93 | 1 | 2 | 3 | 4 | 6 | 5 | 7 | 8 | 10 | 9 | 11 | 12 | .95 | .99 |
| Catching a Plane | .93 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .93 | 1.00 |
| Painting a Room | .92 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .92 | 1.00 |
| Playing Tennis | .92 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 10 | 12 | .93 | .99 |
| Changing a Tire | .91 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .91 | 1.00 |
| Writing a Letter | .91 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 9 | 11 | 12 | .91 | .99 |
| Going to Movies | .90 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 11 | 9 | 12 | .91 | .98 |
| Buying a Car | .89 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 11 | 10 | 12 | .90 | .99 |
| Cleaning Your Clothes | .89 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .89 | 1.00 |
| Changing the Bed | .89 | 1 | 2 | 3 | 4 | 7 | 8 | 5 | 6 | 10 | 9 | 12 | 11 | .93 | .93 |
| Xeroxing a Page | .89 | 1 | 2 | 3 | 4 | 6 | 7 | 5 | 8 | 9 | 10 | 11 | 12 | .90 | .98 |
| Pitching a Tent | .89 | 1 | 2 | 3 | 5 | 4 | 8 | 6 | 7 | 9 | 10 | 11 | 12 | .90 | .97 |
| Barbecuing a Steak | .88 | 1 | 2 | 6 | 4 | 5 | 7 | 3 | 8 | 10 | 11 | 9 | 12 | .93 | .89 |
| Checking Out Books | .88 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 8 | 11 | 10 | 12 | .90 | .99 |
| Getting a Suntan | .88 | 1 | 2 | 4 | 5 | 3 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .88 | .97 |
| Brewing Some Tea | .87 | 2 | 1 | 3 | 5 | 4 | 6 | 7 | 8 | 10 | 11 | 9 | 12 | .90 | .97 |
| Making a Campfire | .87 | 1 | 2 | 3 | 4 | 6 | 7 | 5 | 8 | 9 | 10 | 12 | 11 | .87 | .97 |
| Starting a Car | .87 | 1 | 2 | 3 | 4 | 6 | 5 | 9 | 7 | 8 | 10 | 12 | 11 | .89 | .97 |
| Throwing a Party | .87 | 2 | 1 | 3 | 4 | 8 | 5 | 6 | 7 | 10 | 9 | 11 | 12 | .89 | .94 |
| Taking the Subway | .86 | 2 | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | .87 | .99 |
| Doing the Dishes | .85 | 1 | 2 | 3 | 4 | 5 | 7 | 6 | 8 | 9 | 10 | 11 | 12 | .85 | .99 |
| Serving Good Wine | .85 | 1 | 4 | 2 | 3 | 5 | 6 | 8 | 7 | 9 | 11 | 10 | 12 | .87 | .97 |
| Going on Vacation | .84 | 2 | 1 | 3 | 4 | 5 | 6 | 8 | 7 | 9 | 11 | 10 | 12 | .86 | .97 |
| Smoking a Pipe | .84 | 1 | 2 | 5 | 3 | 4 | 8 | 6 | 7 | 9 | 10 | 12 | 11 | .86 | .95 |
| Cashing a Check | .82 | 1 | 6 | 2 | 7 | 3 | 4 | 8 | 9 | 5 | 10 | 11 | 12 | .85 | .82 |
| Taking a Photograph | .81 | 1 | 4 | 3 | 6 | 5 | 2 | 7 | 10 | 8 | 9 | 12 | 11 | .84 | .89 |
| Washing Your Hair | .81 | 2 | 3 | 1 | 5 | 6 | 8 | 7 | 10 | 4 | 11 | 9 | 12 | .92 | .84 |

*Note.* Numbers correspond to the action order from the sequence norms collected by Galambos (1983).

A sequence strength of 1.00 means that the subjects agreed entirely with the action sequence in the Galambos (1983) norms and that the script possesses strong sequential properties. A sequence strength of .50 indicates that the actions of a script did not possess sequential properties. The sequence strengths of the 30 scripts were .81 to .98, with a mean of .88, which was significantly greater than .50, $t(29) = 52.97$.

Inspection of the rating matrices revealed that a reordering of the actions would yield higher sequence strengths for most scripts. A computer program was developed to find the action sequence that yielded the highest sequence strength for each script. Twenty-five of the scripts could be reordered to yield a higher sequence strength (see column 3 of Table 2 for the new sequences, and column 4 for the new sequence strengths), with a mean of 4.23 actions per script reordered. The mean of the new sequence strengths was .90. Of these shifts, 83% involved a move of an action to a new position in the same scene. The Spearman rank-order correlation between the new sequence and the sequence suggested in the Galambos (1983) norms was computed for each script. These correlations, .82 to 1.00, are shown in column 4, Table 2 (a correlation of 1.00 indicates that the script was not reordered).

### Tests of the hierarchical model

The number of entries located below the main diagonal and the proportion of these below-diagonal entries that were located within scenes were calculated for each script. The mean percentage of the below-diagonal entries located within scenes was 56%. Because a mean of 35% of the action pairs in the paired-comparison questionnaires had both actions sampled from the same scene, this was used as a "chance" baseline. A matched $t$ test was used to compare the observed and base probabilities for below-diagonal within-scenes judgments. The probability that below-diagonal entries were located within scenes was significantly above chance, $t(29) = 7.66$.

## DISCUSSION

The results of the sequence rating task have several implications. First, some scripts have stronger sequence strength than others. Second, all scripts tested possess moderately strong sequential properties. Third, although some modification for the action sequences listed in the Galambos (1983) norms is suggested, by and large their sequences agree with our data.

In some scripts, confusion of ordering between actions may be caused by ambiguity. For example, in the script "Washing Your Hair," the action *get a towel* can occur either before or after the action *turn on water.* In such cases, "misorderings" indicate weak sequence structure. However, ambiguity sometimes results from restricting descriptions of actions to three words. For example, in the script "Changing the Bed," the actions *tuck in corners* and *tuck in sides* can occur after any one of the following actions: *spread bottom sheet, spread top sheet, straighten top sheet,* or *put on blankets.* If the sentences were changed to *tuck in bottom sheet corners* or *tuck in blanket corners,* there would have been less confusion about the ordering of these actions. In these cases, scripts with strong sequence properties may be misidentified as having weak sequence strengths. (A stronger sequence strength for a script could also be obtained by deleting these ambiguous actions.)

The hierarchical model postulates that script actions are organized into scenes and that sequential information is primarily stored at the scene level. An objection has been raised by Mandler and Murphy (1983) concerning a basic assumption of the hierarchical model. Because the model postulates that actions are organized within scenes, it is necessary that the scene be a stable memory construct. However, Mandler and Murphy found that this is not the case. They varied the surface structure of a script-based story (e.g., story length, phrase length, sentence structure, and punctuation) and found that such changes greatly influenced subjects' judgments of scene boundaries.

In the present research, the location of scene boundaries showed substantial agreement among subjects, a result that is incompatible with the conclusion of Mandler and Murphy (1983). Furthermore, the scene structure of a script can be used to predict subjects' sequence ratings. The probability that subjects disagree about the order of actions selected from the same scene is higher than for actions selected from different scenes. Also, when the actions of the scripts were reordered to obtain the maximum sequence strengths, most of the switches between actions were made within scenes. This result agrees with the hierarchical model which as A. C. Graesser noted (personal communication, February 2, 1990) predicts that within-scene orderings of actions are less constrained than between-scene orderings of actions. In conclusion, the results of the present research seem to support the concept that the structure of scripts in memory is a combination of sequential and hierarchical representation, with scenes organized in temporal order and scene actions having a weaker sequential structure.

## Notes

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## References

Abbott, V. A., Black, J. B., & Smith, E. E. (1985). The representation of scripts in memory. *Journal of Memory and Language, 24,* 179–199.

Abelson, R. P. (1981). Psychological status of the script concept. *American Psychologist, 36,* 715–729.

Anderson, J. R., & Bower, G. H. (1973). *Human associative memory.* Washington, DC: Winston.

Barsalou, L. W., & Sewell, D. R. (1985). Contrasting the representation of scripts and categories. *Journal of Memory and Language, 24,* 646–665.

Bellezza, F. S., & Bower, G. H. (1981). The representation and processing characteristics of scripts. *Bulletin of the Psychonomic Society, 18,* 1–4.

Bower, G. H., Black, J. B., & Turner, T. J. (1979). Scripts in comprehension and memory. *Cognitive Psychology, 11,* 177–220.

Galambos, J. A. (1983). Normative studies of six characteristics of our knowledge of common activities. *Behavior Research Methods & Instrumentation, 15,* 327–340.

Galambos, J. A., & Rips, L. J. (1982). Memory for routines. *Journal of Verbal Learning and Verbal Behavior, 21,* 260–281.

Graesser, A. C., Gordon, S. E., & Sawyer, J. D. (1979). Recognition memory for typical and atypical actions in scripted activities: Tests of script pointer + tag hypothesis. *Journal of Verbal Learning and Verbal Behavior, 18,* 319–332.

Graesser, A. C., & Nakamura, G. V. (1982) The impact of a schema on comprehension and memory. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 16, pp. 59–109). New York: Academic Press.

Graesser, A. C., Woll, S. B., Kolwalski, D. J., & Smith, D. A. (1980). Memory for typical and atypical actions in scripted activities. *Journal of Experimental Psychology: Human Learning and Memory, 6,* 503–515.

Haberlandt, K., & Bingham, G. (1984). The effect of input direction on the processing of script statements. *Journal of Verbal Learning and Verbal Behavior, 23,* 162–177.

Lehnert, W. G. (1978). *The process of question answering.* Hillsdale, NJ: Erlbaum.

Locksley, A., Stangor, C., Hepburn, C., Grosovsky, E., & Hochstrasser, M.

(1984). The ambiguity of memory tests of schema theories. *Cognitive Psychology, 16,* 421–448.

Mandler, J. M., & Murphy, C. M. (1983). Subjective estimates of script structure. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 534–543.

Nakamura, G. V., Graesser, A. C., Zimmerman, J. A., & Riha, J. (1985). Script processing in a natural situation. *Memory & Cognition, 13,* 140–144.

Nottenburg, G., & Shoben, E. J. (1980). Scripts as linear orders. *Journal of Experimental Social Psychology, 16,* 329–347.

Polich, J. M., & Potts, G. R. (1977). Retrieval strategies for linearly ordered information. *Journal of Experimental Psychology: Human Learning and Memory, 3,* 10–17.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, goals, and understanding.* Hillsdale, NJ: Erlbaum.

Seidenberg, M. S. (1985). The time course of phonological code activation in two writing systems. *Cognition, 19,* 1–30.

Sharkey, N. E. (1986). A model of knowledge-based expectation in text comprehension. In J. A. Galambos, R. P. Abelson, & J. B. Black (Eds.), *Knowledge structure* (pp. 49–70). Hillsdale, NJ: Erlbaum.

Sharkey, N. E., & Mitchell, D. C. (1985). Word recognition in a functional context: The use of scripts in reading. *Journal of Memory and Language, 24,* 253–270.

Sharkey, N. E., & Sharkey, A. J. C. (1987). What is the point of integration? The loci of knowledge-based facilitation in sentence processing. *Journal of Memory and Language, 26,* 255–276.

Shepard, R. N., Kilpatric, D. W., & Cunningham, J. P. (1975). The internal representation of numbers. *Cognitive Psychology, 7,* 82–138.

Smith, D. A., & Graesser, A. C. (1981). Memory for actions in scripted activities as a function of typicality, retention interval, and retrieval task. *Memory & Cognition, 9,* 550–559.

Smith, K. H., & Foos, P. W. (1975). Effect of presentation order on the construction of linear orders. *Memory & Cognition, 3,* 614–618.

Smith, K. H., & Mynatt, B. T. (1982). Construction and representation of ordering in memory. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 16, pp. 111–151). Hillsdale, NJ: Erlbaum.

Smith, R. A., & Houston, M. J. (1985). A psychometric assessment of measures of scripts in consumer memory. *Journal of Consumer Research, 12,* 214–224.