This paper presents the detailed propositional analyses of the text employed in a study that compared the contents of recall protocols of high knowledge (HK) and low knowledge (LK) groups. The paper also includes the propositional analyses of the recall protocols of the HK and LK individuals, as well as detailed analyses of the results. (Author/FL)
TEXT PROCESSING OF DOMAIN-RELATED INFORMATION
FOR INDIVIDUALS WITH HIGH AND LOW DOMAIN KNOWLEDGE:
METHODOLOGICAL CONSIDERATIONS

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The paper entitled "Text Processing of Domain-Related Information for Individuals with High and Low Domain Knowledge" (Spilich, Vesonder, Chiesi, & Voss, in press) presented the results of an experiment which involved use of textual material. A one-half inning account of a baseball game was presented to individuals with either high (HK) or low (LK) baseball knowledge, and subsequently the individuals were asked to recall the contents of the account. The purpose of the study was, of course, to compare the contents of the recall protocols of the HK and LK groups by assessing both quantitative and qualitative differences in recall. The results indicated that HK recall was quantitatively and qualitatively superior to that of LK recall, and the findings were considered in terms of the superiority of HK individuals to relate game actions and sequences of such actions to the goal structure of the game. In order to provide a reasonable analysis of protocol differences, it was necessary to perform a number of detailed analyses. However, because of length, the details of these analyses were not contained in the aforementioned paper. It is therefore the purpose of this paper to present such analyses in detail. More specifically, this paper presents the procedures used to analyze the text employed in the aforementioned study and also presents in detail the procedures used in the scoring of the recall protocols.
The Propositional Analysis of the Text

Table 1 presents the text that was used in the Spilich, Vesonder, Chiesi, and Voss (in press) paper. The text is a one-inning account of a fictitious baseball game.

Table 1

Baseball Text

The Ridgeville Robins are playing the Center City Cougars. The Robins are leading 5-3 with the Cougars at bat in the last half of the fifth inning. The sky is getting darker, and the rain that has started is becoming heavier. The Cougars' first batter, Harvey Jones, is taking his time coming to plate. The umpire steps back from behind the plate and tells him to step into the batter's box.

Jones, the hitter, is left-handed, and has a batting average of .310. Claresen, the pitcher, has allowed only four hits, has walked one, and has struck out six. This performance is about average for Claresen since this left-hander has an earned-run average of 6.00 and typically strikes out quite a few batters.

Claresen now adjusts his cap, touches his knee, begins his wind-up, and delivers a high fast ball that the umpire calls "Ball One." The Robins’ catcher, Don Postman, returns the ball, and Claresen takes the sign. The next pitch is swung on and hit to centerfield. Maloney comes in and catches it for the first out.

The Robins’s catcher, Don Postman, returns the ball, and Claresen takes the sign. The next pitch is swung on and hit to centerfield. Maloney comes in and catches it for the first out.

The next batter is the powerful hitter, Fred Johnson, who leads the league in home runs with 23. Claresen no doubt is glad to face him with no one on base. Claresen is now getting his sign from the catcher, begins his windup, and throws a curve ball breaking into the right-hand batter at the knees. The umpire calls it for a strike. Claresen is now getting ready again, winds up and throws, and Johnson hits it off to right and into the stands, a foul ball. The count is now 0 and 2. Claresen rubs up the new ball, takes his sign, and throws a fast ball which just misses the bill of Johnson's cap. Johnson took one step toward the mound, but then came back. Johnson stepped out of the batter's box and put some resin on his hands; the bat is no doubt slippery from the rain. Claresen is ready again, winds up and throws a slider which breaks inside, making the count 2-2. Once more Johnson steps out of the batter's box and gets some resin on his hands. He steps back in and Claresen starts his motion and throws. Johnson swings and has a line drive down the left field line. Ferraro runs over to get the ball as Johnson rounds first and goes toward second. Ferraro's throw is late and Johnson is safe on second with a double.

2
Beck, the left-handed relief pitcher, is warming up in the bullpen. The next hitter for the Cougars is the right-hand hitting Carl Churniak, a .260 hitter who is known to hit well in the clutch. Claresen takes his sign, delivers, and Churniak takes the pitch for a ball. Claresen again is ready and pitches, and Churniak swings and hits a slow bouncing ball toward the shortstop. Haley comes in, fields it, and throws to first, but too late. Churniak is on first with a single; Johnson stayed on second.

The next batter is Whitcomb, the Cougars' left-fielder. He is a left-hander hitting .255. Claressen wipes his forehead with his sleeve and takes his sign. Claressen looks toward first, where Manfred is holding the runner. He stretches, looks at second, and throws a high fast ball for a strike. The catcher returns the ball and Claressen once more gets ready. Claressen throws a low curve ball. It bounces into the dirt and past the catcher. Johnson moves to third and Churniak to second before the catcher can retrieve the ball. The ball is returned to Claressen. He gets the sign and winds up, and throws a slider that Whitcomb hits between Manfred and Roberts for a hit. Dulaney comes in and picks up the ball. Johnson has scored, and Churniak is heading for the plate. Here comes the throw, and Churniak is out. Churniak argues, but to no avail. The batter reached second on the throw to the plate.

The next batter is Rob Williams, the Cougar's catcher. He is hitting .230. Claressen is rubbing up the ball and now is ready to pitch. The rain is coming down in sheets. Claressen delivers and Williams takes a curve over the inside corner for a strike. Working rapidly, Claressen again delivers and Williams takes a ball, low and outside. Claressen again gets the sign, stretches, and throws a fast ball, which Williams swings at and misses. The catcher returns the ball and Claressen is ready. The pitch is a curve ball which Williams swings at and misses for his third strike.

The umpires now are meeting and they signal that the game is being called.

Table 2a presents the propositional analysis that was performed on the text. The method of analysis was essentially that developed by Kintsch (1974) and Turner and Greene (in press). The traditional propositional notation was not employed, however, although each proposition could readily be expressed in terms of its predicate and argument(s). Table 2b presents the propositions in the more traditional notation.
Table 2a
Propositional Structure of Baseball Passage and Classification of Propositions According to Baseball Knowledge Structure

<table>
<thead>
<tr>
<th>#</th>
<th>Proposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>There exists a baseball game</td>
</tr>
<tr>
<td>SG</td>
<td>Team - Ridgeville Robins</td>
</tr>
<tr>
<td>SG</td>
<td>Team - Center City Cougars</td>
</tr>
<tr>
<td>G2</td>
<td>Score - 5-3</td>
</tr>
<tr>
<td>G2</td>
<td>Team ahead - Robins</td>
</tr>
<tr>
<td>SG</td>
<td>Team batting - Cougars</td>
</tr>
<tr>
<td>SG</td>
<td>Inning - fifth</td>
</tr>
<tr>
<td>SG</td>
<td>Half Inning - last (of the fifth)</td>
</tr>
<tr>
<td>SG</td>
<td>Weather - sky dark, rain, heavy rain (not &quot;sheets,&quot; that is later)</td>
</tr>
<tr>
<td>E</td>
<td>(First) batter comes up to bat</td>
</tr>
<tr>
<td>SSI</td>
<td>First batter - name is Jones</td>
</tr>
<tr>
<td>NAI</td>
<td>Batter is slow to come to plate</td>
</tr>
<tr>
<td>NAI</td>
<td>Cause - 11, stalling (to try to get game called, Score, Rain, etc.)</td>
</tr>
<tr>
<td>NAI</td>
<td>Umpire - tells batter to get in batter's box</td>
</tr>
<tr>
<td>SSR</td>
<td>Batter - left-hand hitter</td>
</tr>
<tr>
<td>SSR</td>
<td>Batter - average is .310</td>
</tr>
<tr>
<td>SSR</td>
<td>Batter - a good hitter</td>
</tr>
<tr>
<td>E</td>
<td>Pitcher acknowledged (assume for team in field)</td>
</tr>
<tr>
<td>SSI</td>
<td>Pitcher's name is Claresen</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher is left-handed</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's record in game - given up 4 hits</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's record in game - given up 1 walk</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's record in game - 6 strikeouts</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's record - quite a few strikeouts</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's record in game - typical</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's E.R.A. - 6.00</td>
</tr>
<tr>
<td>SSR</td>
<td>Pitcher's E.R.A. is high</td>
</tr>
<tr>
<td>SSR</td>
<td>Because 26, pitcher is not good</td>
</tr>
</tbody>
</table>
NAI 28. Pitcher adjusts cap
NAI 29. Pitcher touches knee
A4A 30. Pitcher winds up and pitches
A4A 31. Pitch is fast ball
A4 32. Umpire calls "Ball" (pitch is ball)
G4 33. Ball 1
SSI 34. Robins' catcher is Postman
NAI 35. Postman returns ball to pitcher (after pitch)
NAR 36. Claresen gets sign
A4A 37. Claresen pitches
A3A 38. Batter (Jones) hits ball
A3A 39. Ball goes to center field
A3A 40. Ball is caught
SSI 41. Caught by Maloney
SSI 42. Maloney is Robins' centerfielder
A3 43. First batter (Jones) is out
G3 44. 1 out
E 45. Next batter is up
SSI 46. Batter's name is Johnson
SSI 47. Batter is second batter
SSR 48. Batter has hit 23 home runs
SSR 49. Batter leads league in home runs
SSR 50. Batter is power hitter
SSR 51. Batter's ave. (not in text)
SSI 52. Pitcher is glad no one is on base when Johnson (this batter) is batting
NAR 53. Pitcher (Claresen) gets sign
A4A 54. Pitcher throws pitch
A4A 55. Pitch is curve ball
A4A 56. Pitch breaks into batter at knees
SSR 57. Batter is right-handed (inference)
A4 58. Pitch is strike
G4 59. Strike 1
A4A 60. Claresen pitches
A4A 61. Batter hits ball
A4A 62. Batter (Johnson) hits foul
63. Foul is to right
64. Strike 2
65. Claresen rubs ball
66. Claresen gets sign
67. Claresen (pitcher) throws
68. Pitch is fast ball
69. Pitch is high
70. Pitch just misses batter
71. Pitch just misses bill of batter's cap
72. Pitch is brushback pitch
73. Pitch is Ball
74. Ball 1
75. Count is Ball 1 - Strike 2
76. Batter (Johnson) steps toward mound
77. Cause 76, 72
78. Batter (Johnson) comes back
79. Batter steps out of batter's box
80. Batter gets resin bag
81. Batter puts resin on hands
82. Cause 81, bat slippery due to rain
83. Pitcher (Claresen) is ready
84. Pitcher winds up
85. Pitcher delivers pitch
86. Pitch is slider
87. Slider breaks inside
88. Pitch is "Ball"
89. Ball 2
90. Count is 2-2
91. Batter (Johnson) again steps out of batter's box
92. Batter again gets resin bag
93. Batter again puts resin on hands
94. Pitcher (Claresen) starts motion
95. Pitcher throws
96. Batter (Johnson) hits ball
97. Hit ball is line drive
98. Ball goes to left field
99. Ball goes down line of left field
100. Left fielder runs to get ball
101. Ferraro is Robins' left fielder
102. Batter (Johnson) is safe at second
103. Batter gets double (Credit given for 102)
104. Runner at second base (Cougars)
105. Left fielder's (Ferraro) throw late
106. Pitcher in bullpen (Assume Robins)
107. Warming up in bullpen
108. Pitcher's name is Beck
109. Pitcher is left-handed
110. Pitcher is relief pitcher
111. Current pitcher (Claresen) is in trouble
112. Cause 111, 104
113. Next batter comes up
114. Next batter is third batter
115. Next batter's name is Churniak
116. Batter is right-handed
117. Batter's batting average is .260
118. Batter is fair hitter
119. Batter known as c - h hitter
120. Pitcher (Claresen) takes sign
121. Pitcher pitches
122. Batter (Churniak) takes pitch
123. Pitch is a ball
124. Ball 1
125. Pitcher (Claresen) is ready
126. Pitcher pitches
127. Batter (Churniak) hits ball (Omitted batter swings)
128. Ball hit is slow ground ball
129. Ground ball goes toward shortstop
130. Shortstop comes in (for ball)
131. Shortstop fields ball
132. Shortstop throws to first base
Throw is late
Batter (Churniak) is safe at first base (Credit given for getting hit)
Batter (Churniak) has single
Runners on first and second base (Cougars)
Runner on second stayed at second base
Runner on second was Johnson
Cause 136, ball hit to left side of infield
Shortstop's name is Haley
Next batter comes up
Batter is fourth batter
Batter's name is Whitcomb
Batter is Cougars' left fielder
Batter bats left-handed
Batter's average is .255
Batter is fair hitter (or poor)
Pitcher (Claresen) wipes forehead with sleeve
Pitcher (Claresen) takes sign
Pitcher (Claresen) looks toward first base
First baseman is holding runner (keeping him close to first)
First baseman's name is Manfred
Pitcher (Claresen) stretches
Pitcher (Claresen) looks at second base
Pitcher (Claresen) pitches
Batter takes pitch
Pitch is high
Pitch is fast ball
Pitch is strike
Strike 1
Catcher returns ball to Claresen (pitcher)
Pitcher (Claresen) gets ready
Pitcher (Claresen) pitches
Pitch is curve ball
Pitch is low (pitch is ball)
Pitch bounces in dirt
Ball bounces past catcher

Runner from second goes to third

Runner is Johnson

Runner from first goes to second

Runner is Churniak

Pitch was wild pitch (defined by 164, 166, 168)

166, 168 before catcher could get ball

Runners on second and third

Pitch was ball

Ball 1 - Strike 1

Catcher returns ball to pitcher

Pitcher (Claresen) gets sign

Pitcher (Claresen) winds up

Pitcher pitches

Pitch is slider

Batter hits pitch

Ball goes between two players

Ball goes between first and second

Batter (Whitcomb) gets a hit (single) - safe at first base

Ball is hit to outfield (right field)

Two players (183) are Manfred and Roberts

Name of second baseman is Roberts (Inference since 150)

Right fielder comes in to field ball

Name of right fielder is Delaney

Right fielder picks up ball

Runner on third scores

Runner is Johnson

Score - 5-4

Runner from second goes toward home plate

Runner is Churniak

Throw comes (from Delaney)

Runner is out at home plate

Second out of half-inning

Runner out at home argues
NAI 202. Runner loses argument (to no avail)
SSI 203. Runner arguing is Churniak
A3 204. Batter advances to second base
SSI 205. Batter is Whitcomb
A3A 206. Cause of 202 - throw to home plate (196)
G3 207. Runner on second base
E 208. Next batter comes up
SSI 209. Name of next batter is Williams
SSI 210. Batter is fifth batter
SSI 211. Batter is Cougars' catcher
SSR 212. Batter is hitting .230
SSR 213. Batter is poor hitter
NAI 214. Pitcher (Claresen) rubs ball
NAI 215. Pitcher is ready
SG 216. It is raining hard (sheets)
A4A 217. Pitcher pitches
A4A 218. Batter takes pitch
A4A 219. Pitch is curve
A4A 220. Pitch is over inside corner (of plate)
A4 221. Pitch is strike
G4 222. Strike 1
NAI 223. Pitcher works rapidly
NAI 224. Inference - 223 (because it is raining hard, etc.)
A4A 225. Pitcher pitches
A4A 226. Batter takes pitch
A4 227. Pitch is a ball
G4 228. Ball 1
G4 229. Count - Ball 1 - Strike 1
A4A 230. Pitcher pitches (Inference)
A4A 231. Pitch is low
A4A 232. Pitch is outside
A4 233. Pitch is ball
G4 234. Ball 2
G4 235. Count - Ball 2 - Strike 1
NAR 236. Pitcher gets sign
NAI 237. Pitcher stretches
A4A 238. Pitcher throws
A4A 239. Pitch is fast ball
A4A 240. Batter swings
A4A 241. Batter misses
A4 242. Pitch is strike
G4 243. Strike 1
G4 244. Ball 2 - Strike 2
NAI 245. Catcher returns ball to pitcher
NAR 246. Pitcher is ready
A3A 247. Pitcher pitches
A3A 248. Pitch is curve
A3A 249. Batter swings
A3A 250. Batter misses
A3 251. Batter strikes out
G4 252. Ball 2 - Strike 3
G3 253. Out 3
SG 254. Half-inning over (side retired)
SG 255. Inning 6
NAR 256. Umpires meet
SG 257. Umpires signal game is called (terminated)
SG 258. Cause, 257 - rain (inferred)
G2 259. Team ahead when game is called
G2 260. Score when game is called
G1 261. Robins win
G1 262. Cougars lose
G1 263. Game official (5 innings)
SSR 264. Claresen was winning pitcher
Table 2b
Propositional Structure (Traditional Notation)

0. (EXIST, BASEBALL GAME)
1. (ISA, TEAM PLAYING, RIDGEVILLE ROBINS)
2. (ISA, TEAM PLAYING, CENTER CITY COUGARS)
3. (QUALITY, SCORE, 5-3)
4. (QUALIFY, 9, TEAM AHEAD, ROBINS)
5. (QUALITY, TEAM AT BAT, COUGARS)
6. (QUALITY, INNING, 5TH)
7. (QUALIFY, 6, LAST HALF)
8. (QUALITY, WEATHER, DARK, RAINY)
9. (COME, FIRST BATTER, TO BAT)
10. (QUALIFY, 9, JONES)
11. (QUALIFY, 9, SLOWLY)
12. (CAUSE, 11, STALL)
13. (TELL, UMPIRE, BATTER, 9)
14. (QUALITY, 10, LEFT-HANDED BATTER)
15. (QUALITY, 10, AVERAGE OF .310)
16. (IMPLY, 15, BATTER GOOD)
17. (EXIST, PITCHER)
18. (QUALIFY, 17, CLARESEN)
19. (QUALIFY, 17, LEFT-HANDED)
20. (QUALIFY, 17, 4 HITS IN GAME)
21. (QUALIFY, 17, 1 WALK IN GAME)
22. (QUALIFY, 17, 6 STRIKEOUTS IN GAME)
23. (IMPLY, 22, MANY STRIKEOUTS)
24. (QUALIFY, 20, 21, 22, TYPICAL)
25. (QUALIFY, 17, E.R.A. IS 6.00)
26. (IMPLY, 25, HIGH)
27. (IMPLY, 26, PITCHER NOT GOOD)
28. (ADJUST, 17, CAP)
29. (TOUCH, 17, KNEE)
30. (WINDS AND PITCHES, 17)
31. (QUALITY, PITCH, FAST BALL)
32. (CALL, UMPIRE, "BALL")
33. (QUALITY, "BALL," 1)
34. (NAME, CATCHER, POSTMAN)
35. (RETURN, BALL, CATCHER, PITCHER)
36. (OBTAIN, PITCHER, SIGN)
37. (PITCHES, PITCHER)
38. (HITS, BATTER, BALL)
39. (MOVE, BALL, CENTER FIELD)
40. (CATCH, BALL)
41. (QUALIFY, 40, MALONEY)
42. (QUALIFY, MALONEY, CENTER FIELDER)
43. (QUALITY, BATTER, OUT)
44. (QUALITY, "OUT," 1)
45. (COME, NEXT BATTER, TO BAT)
46. (QUALIFY, 45, JOHNSON)
47. (QUALIFY, 45, SECOND BATTER)
48. (QUALIFY, 45, 23 HOME RUNS)
49. (CAUSE, 48, LEADS LEAGUE)
50. (IMPLY, 48, POWER HITTER)
51. (QUALIFY, 46, AVERAGE)
52. (QUALITY, PITCHER, GLAD, NO ONE ON BASE)
53. (GETS, PITCHER, SIGN)
54. (THROW, PITCHER, PITCH)
55. (QUALITY, PITCH, CURVE)
56. (BREAK, PITCH, BATTER'S KNEES)
57. (QUALITY, BATTER, RIGHT-HANDED)
58. (QUALITY, PITCH, STRIKE)
59. (QUALITY, "STRIKE," 1)
60. (PITCHES, PITCHER)
61. (HIT, BATTER, BALL)
62. (HIT, BALL FOUL)
63. (LOC., FOUL, RIGHT)
64. (QUALITY, "STRIKE," 2)
65. (RUB, PITCHER, BALL)
66. (GET, PITCHER, SIGN)
67. (THROW, PITCHER, BALL)
68. (QUALITY, PITCH, FAST BALL)
69. (QUALITY, PITCH, HIGH)
70. (MISS, PITCH, BATTER, BARELY)
71. (QUALITY, 70, BILL OF CAP)
72. (IMPLY, 70, BRUSHBACK PITCH)
73. (QUALITY, PITCH, "BALL")
74. (QUALITY, BALL, 1)
75. (QUALITY, COUNT, BALL 1, STRIKE 2)
76. (STEP, BATTER, PITCHER)
77. (CAUSE, 76, 72)
78. (COME, BATTER, BACK)
79. (STEP, BATTER, OUT OF BOX)
80. (GET, BATTER, RESIN BAG)
81. (PLACE, 80, HANDS)
82. (CAUSE, 80, RAIN)
83. (QUALITY, PITCHER, READY)
84. (WIND, PITCHER)
85. (DELIVER, PITCHER, PITCH)
86. (QUALITY, PITCH, SLIDER)
87. (BREAK, SLIDER, INSIDE)
88. (QUALITY, PITCH, "BALL")
89. QUALITY, "BALL," 2)
90. (QUALITY, COUNT, BALL 2, STRIKE 2)
91. (STEP, BATTER, OUT OF BOX, AGAIN)
92. (GET, BATTER, RESIN BAG, AGAIN)
93. (PLACE, 92, AGAIN)
94. (START, PITCHER, MOTION)
95. (THROW, PITCHER, BALL)
96. (HIT, BATTER, BALL)
97. (QUALITY, HIT, LINE DRIVE)
98. (MOVE, BALL, LEFT FIELD)
99. (MOVE, BALL, LEFT FIELD LINE)
100. (RUN, LEFT FIELDER, BALL)
101. (QUALIFY, LEFT FIELDER, FERRARO)
102. (QUALITY, BATTER, SAFE, SECOND BASE)
103. (GET, BATTER, DOUBLE)
104. (QUALITY, RUNNER, SECOND BASE)
105. (THROW, LEFT FIELDER, LATE)
106. (EXIST, PITCHER, BULLPEN)
107. (QUALIFY, 106, WARMING UP)
108. (QUALIFY, 106, BECK)
109. (QUALIFY, 106, LEFT-HANDED)
110. (QUALIFY, 106, RELIEF PITCHER)
111. (QUALITY, PITCHER, TROUBLE)
112. (CAUSE, 111, 104)
113. (COME, NEXT BATTER, TO BAT)
114. (QUALIFY 113, THIRD BATTER)
115. (QUALIFY, 113, CHURNIAK)
116. (QUALIFY, 113, RIGHT-HANDED)
117. (QUALIFY, 113, AVERAGE .260)
118. (IMPLY, 117, FAIR HITTER)
119. (QUALITY, BATTER, CLUTCH HITTER)
120. (GET, PITCHER, SIGN)
121. (PITCH, PITCHER)
122. (TAKE, BATTER, PITCH)
123. (QUALITY, PITCH, "BALL")
124. (QUALITY, BALL, 1)
125. (QUALITY, PITCHER, READY)
126. (PITCH, PITCHER)
127. (HIT, BATTER, BALL)
128. (QUALITY, 127, SLOW GROUND BALL)
129. (MOVE, BALL, SHORTSTOP)
130. (MOVE, SHORTSTOP, BALL)
131. (FIELD, SHORTSTOP, BALL)
132. (THROW, SHORTSTOP, BALL, FIRST BASE)
133. (QUALITY, THROW, LATE)
134. (QUALITY, BATTER, SAFE, FIRST BASE)
135. (GET, BATTER, SINGLE)
136. (QUALITY, RUNNERS, FIRST AND SECOND BASES)
137. (QUALITY, RUNNER, SECOND BASE)
138. (QUALIFY, 137, JOHNSON)
139. (CAUSE, 136, 129)
140. (QUALIFY, 129, HALEY)
141. (COME, NEXT BATTER, TO BAT)
142. (QUALIFY, BATTER, FOURTH BATTER)
143. (QUALIFY, BATTER, WHITCOMB)
144. (QUALIFY, BATTER, LEFT FIELDER)
145. (QUALIFY, BATTER, LEFT-HANDED)
146. (QUALIFY, BATTER, AVERAGE .255)
147. (IMPLY, 146, FAIR BATTER)
148. (WIPE, PITCHER, FOREHEAD, SLEEVE)
149. (TAKE, PITCHER, SIGN)
150. (LOOK, PITCHER, FIRST BASE)
151. (HOLD, PITCHER, RUNNER)
152. (QUALIFY, FIRST BASEMAN, MANFRED)
153. (STRETCH, PITCHER)
154. (LOOK, PITCHER, SECOND BASE)
155. (PITCH, PITCHER)
156. (TAKE, BATTER, PITCH)
157. (QUALITY, PITCH, HIGH)
158. (QUALITY, PITCH, FAST BALL)
159. (QUALITY, PITCH, STRIKE)
160. (QUALITY, STRIKE, 1)
161. (RETURN, CATCHER, BALL, PITCHER)
162. (GET, PITCHER, READY)
163. (PITCH, PITCHER)
164. (QUALITY, PITCH, CURVE)
165. (QUALITY, PITCH, LOW)
166. (BOUNCE, PITCH, DIRT)
167. (BOUNCE, BALL, CATCHER)
168. (GO, RUNNER, SECOND, THIRD)
169. (QUALIFY, RUNNER, JOHNSON)
170. (GO, RUNNER, FIRST, SECOND)
171. (QUALIFY, RUNNER, CHRENTAK)
172. (IMPLY, 164, 166, 168, WILD PITCH)
173. (MOVE, 166, 168, CATCHER, BALL)
174. (QUALITY, RUNNERS, SECOND, THIRD)
175. (QUALITY, PITCH, BALL)
176. (QUALITY, BALL, 1)
177. (QUALITY, COUNT, BALL 1, STRIKE 1)
178. (RETURN, CATCHER, BALL, PITCHER)
179. (GET, PITCHER, SIGN)
180. (WIND, PITCHER)
181. (PITCH, PITCHER)
182. (QUALITY, PITCH, SLIDER)
183. (HIT, BATTER, PITCH)
184. (MOVE, BALL, TWO PLAYERS)
185. (QUALIFY, 184, FIRST AND SECOND BASE)
186. (HIT, BATTER, SINGLE)
187. (HIT, BATTER, BALL, RIGHT FIELD)
188. (QUALIFY, 1, MANFRED, ROBERTS)
189. (IMPLY, 188, 150)
190. (MOVE, RIGHT FIELDER, BALL)
191. (QUALIFY, RIGHT FIELDER, DELANEY)
192. (PICKUP, RIGHT FIELDER, BALL)
193. (SCORE, RUNNER, THIRD BASE)
194. (QUALIFY, 193)
195. (QUALITY, SCORE, 5-4)
196. (GO, RUNNER, SECOND BASE, HOME PLATE)
197. (QUALIFY, 196, CHERNIAK)
198. (COME, THROW, RIGHT FIELDER)
199. (QUALITY, RUNNER, OUT, HOME PLATE)
200. (QUALITY, OUT, 2)
201. (ARGUE, RUNNER, HOME PLATE)
202. (LOSE, RUNNER, ARGUMENT)
203. (QUALIFY, 201, CHERNIAK)
204. (GO, BATTER, SECOND BASE)
205. (QUALIFY, RUNNER, WHITCOMB)
206. (CAUSE, 202, 196)
207. (QUALITY, RUNNER, SECOND BASE)
208. (COME, NEXT BATTER, TO BAT)
209. (QUALITY, BATTER, WILLIAMS)
210. (QUALITY, BATTER, FIFTH)
211. (QUALITY, BATTER, CATCHER)
212. (QUALITY, BATTER, AVERAGE .230)
213. (IMPLY, 212, POOR HITTER)
214. (RUB, PITCHER, BALL)
215. (QUALITY, PITCHER, READY)
216. (RAINING, SHEETS)
217. (PITCH, PITCHER)
218. (TAKE, BATTER, PITCH)
219. (QUALITY, PITCH, CURVE)
220. (QUALITY, PITCH, INSIDE CORNER)
221. (QUALITY, PITCH, STRIKE)
222. (QUALITY, STRIKE, 1)
223. (WORK, PITCHER, RAPIDLY)
224. (CAUSE, 223, 216)
225. (PITCH, PITCHER)
226. (TAKE, BATTER, PITCH)
227. (QUALITY, PITCH, BALL)
228. (QUALITY, BALL, 1)
229. (QUALITY, COUNT, BALL 1, STRIKE 1)
230. (PITCH, PITCHER)
231. (QUALITY, PITCH, LOW)
232. (QUALITY, PITCH, OUTSIDE)
233. (QUALITY, PITCH, BALL)
234. (QUALITY, BALL, 2)
235. (QUALITY, COUNT, BALL 2, STRIKE 1)
236. (GET, PITCHER, SIGN)
237. (STRETCH, PITCHER)
238. (THROW, PITCHER, BALL)
239. (QUALITY, PITCH, FAST BALL)
240. (SWING, BATTER)
241. (MISS, BATTER, BALL)
242. (QUALITY, PITCH, STRIKE)

18
One point about the propositional analysis is that some propositions could be derived from the text which are not included in the analysis of Table 2a. These primarily are not important to the account and in some cases are somewhat arbitrary. For example, Proposition 52, which is concerned with the assertion that the pitcher was glad that he was facing a particular batter when no runners were on base, could be divided into at least two propositions, but this was not done because the basic content of the assertion could be contained in a single proposition. A second point is that a few propositions were placed in the structure because the recall protocols necessitated their inclusion.
While the propositional structure was by no means data driven, it was necessary to include those few propositions because of the contents of one or two protocols. For example, Proposition 27 states that the pitcher, based upon his record, was not a good pitcher. This is a conclusion that is implied by the text information. It should be reiterated, however, that there were only a few such propositions included in the text.

The most important aspect of the propositional structure involves the classification of the propositions that is presented in the left column of Table 2a. The text propositions are classified according to a baseball knowledge structure, and this structure is presented in Table 3. The structure pertains to the knowledge that is involved in the play of the game and not to all baseball knowledge. (Specific leagues, teams, and players, for example, are not considered.)

The uppermost part of the structure depicted in Table 3 is setting information. There is general setting information which refers to the teams playing, the inning (or half-inning) of the game, and any general information that could influence the play of the game. The specific setting information pertains to information that involves a particular team, player, or some other component of the game. There are two types of specific setting information, relevant and irrelevant. The first includes information that is of some relevance to the game but not involved in the game per se. For example, a player's batting average indicates the general success of that player in getting hits, and, while this statistic has no direct bearing on what a person does when at bat, it is relevant in the sense of providing an idea of how good a hitter the individual is. It also states the probability of that person getting a hit (other things being equal). Thus, the specific setting information that is relevant includes most of the statistics kept for particular
Table 3

Baseball Knowledge Structure

**Setting**

**General:** Teams Playing, Team at Bat, Team in Field, Inning, Miscellaneous Conditions

**Specific:** Relevant—Teams' Records as Related to Goal Structure, Players' Records as Related to Goal Structure

Irrelevant—Team Attributes, Player Attributes

**Enabling:** Batter at Bat and Pitcher Ready to Pitch

---

**Goal Structure**

<table>
<thead>
<tr>
<th>Team at Bat</th>
<th>Level</th>
<th>Variables</th>
<th>Values</th>
<th>Team in Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winning game</td>
<td>1</td>
<td>Game outcome</td>
<td>Win-lose</td>
<td>Winning game</td>
</tr>
<tr>
<td>Scoring runs</td>
<td>2</td>
<td>Score</td>
<td>Domain of game scores</td>
<td>Preventing runs from scoring</td>
</tr>
<tr>
<td>Getting runners on base and advancing runners</td>
<td>3</td>
<td>Pattern of base runners, Outs</td>
<td>Eight possible patterns, 0, 1, 2, 3</td>
<td>Preventing runners from getting on base or advancing by making outs</td>
</tr>
<tr>
<td>Having &quot;balls,&quot; avoiding &quot;strikes&quot;</td>
<td>4</td>
<td>&quot;Balls,&quot; &quot; Strikes&quot;</td>
<td>0, 1, 2, 3, 4</td>
<td>Getting &quot;strikes,&quot; avoiding &quot;balls&quot;</td>
</tr>
</tbody>
</table>

---

**Non-game Actions**

---

Relevant non-game actions

Irrelevant non-game actions
teams and individual players. The irrelevant specific setting category includes information that does not relate to the play of the game. Examples of this type of information include the color of the uniforms and the numbers worn by the players. The enabling setting information category consists of the information pertaining to game activity initiation. Examples of this information include the members of one team being in the field with the pitcher being ready to pitch and the batter at bat.

In the list of propositions of Table 2a, general setting propositions are denoted SG, and specific setting propositions are denoted SSR and SSI, depending upon whether they are relevant or irrelevant, respectively. The enabling propositions are denoted E.

The next category of the knowledge structure of Table 3 is that of the goal structure. It is assumed that baseball has a hierarchical goal structure involving four levels. The highest level consists of winning the game. The remaining levels consist of subgoals which are related to winning the game. The second-level goal is scoring runs (team at bat) and preventing runs from being scored (team in field). The third level is getting a batter on base and advancing runners (team at bat) and making batters out and preventing runners from advancing by making them out (team in field). The fourth level involves events connected with a batter getting on base; the batter (team at bat) tries to get "Balls" called in order to get to first base, while the pitcher (team in field) tries to get " Strikes" on the batter.

Related to each level of the goal structure is a set of actions, each of which may take place during the play of a baseball game. These actions are too numerous to consider in any exhaustive sense, but Table 4 presents a list of typical actions. (Table 4 also presents information typical of
the other types of information of the baseball knowledge structure presented in Table 3.

Table 4
Classification System for Propositions of a Baseball Knowledge Structure

I. Setting Information
   A. General (G)
      Propositions
      Team(s) playing
      Team at bat
      Team in field
      Inning
      Inning half
      Relevant setting information

   B. Specific (S)
      1. Relevant (SSR)
         Propositions
         Batter information
         Batter's batting average
         Batter's number of at-bats
         Batter's number of hits
         Batter's number of doubles
         Batter's number of triples
         Batter's number of home runs
         Batter's speed
         Batter's runs batted in
         Batter's tendency to hit into double play
         Batter's general quality
         Batter's bunting ability
         Batter's lef—right handedness
         Batter's clutch-hitting reputation
         Batter—pull hitter, straightaway hitter, opposite field hitter
         Batter power hitter
         Batter "spray" hitter

         Pitcher information
         Pitcher's earned run average
         Pitcher's strike-out record
         Pitcher's walk record
Pitcher's left- or right-handedness
Pitcher's run record
Pitcher's inning record
Pitcher's hit record
Pitcher's hit record
Pitcher's type of best pitch (fast ball, curve ball, etc.)
Pitcher's ability to prevent stolen bases from occurring
Pitcher's type (starter, relief, long relief)
Pitcher's win-lost record
Pitcher's special characteristics
Pitcher's general quality

Fielder's information
Fielder's position
Fielder's quality at fielding position
Fielder--at specific position -- error record
Fielder--at specific position -- throwing arm
Fielder--at specific position -- ability to field ground balls
Fielder--at specific position -- ability to field fly balls
Quality of double-play combination
Fielder's place to play specific batter
Fielder--specific position -- specific characteristics

Managerial and coaching information
Tendency to replace pitcher
Tendency to use pinch hitter
General quality and reputation
Tendency to use steal and hit-run
Change-of-state of potential relevance

Pinch hitter
New pitcher
New runner
New fielder
Manager (or coach) expelled

2. Irrelevant (33%)

Propositions

Baseball information in game context general non-relevant
Information pert. to pitcher
Information pert. to batter
Information pert. to runner
Information pert. to fielder
Information pert. to manager or coach
Information pert. to umpire
Name of player
Name of player at position
Propositions

Batter comes to bat
Pitcher on mound
Team takes field
Umpires come on field

Listed below are auxiliary actions which would be classified according to the outcome of the play.

Pitcher's actions while pitching
- Pitcher throws curve ball
- Pitcher throws fast ball
- Pitcher throws change of pace
- Pitcher throws slider
- Pitcher throws knuckle ball
- Pitcher throws screw ball
- Pitcher throws pitchout
- Pitcher throws brushback (ducks)
- Pitcher throws to first base
- Pitcher throws to second base
- Pitcher throws to third base
- Pitch is low
- Pitch is high
- Pitch is outside
- Pitch is inside
- Pitch is in the dirt
- Pitch is wild
- Pitch breaks inside
- Pitch breaks outside
- Pitch breaks down
- Pitcher jams batter
- Pitcher commits balk

Batter's action
- Batter swings
- Batter takes pitch
- Batter misses
- Batter hits ball
- Batter's batted ball direction
- Ball hit on ground
- Fly ball hit
- Line drive hit
- Ball hit bouncing
- Ball hit toward position X (Pk is filled with TB, SS, 3B, FB, P, RF, CF, LF).
Ball hit between positions PS filled with TS
(3rd base - SS) SS (SS - 2B), (SF) 2B. 1B
LC (left-center) CR (center-right) Batter hits ball down line (X = Left or right)
Batter hits foul ball
Batter bunts
Batter drags bunt
Batter arrives at base safely on single, double, triple, or home run
Batter out at base (X = F, S, T, H)
Batter safe on error
Batter safe on walk
Batter safe on passed ball
Batter safe on fielder's choice
Batter reaches base on throw

Runner's information
Runner leads off base
Runner attempts steal
Runner starts running in hit-and-run play
Runner reaches base safely (X = F, S, T, H)
Runner out at base (F, S, T, H) on particular play
Runner goes toward base

Fielder's movements
Fielder's movement to field GB
X = position of fielder, filled in
Fielder catches fly ball (or line drive) successfully
Fielder fields ground ball successfully (Substitute position for F when appropriate.)
Fielder throws ball (to first base, etc.)
Fielder misses fly ball
Fielder misses ground ball
Fielder misses thrown ball
Fielder's throw arrives late

II. Goal Structure and Related Action

A. Level 1

1. Goal Structure Level 1 (G1)
   Team won or lost

2. Action Information Level 1 (A1)
   Action of winning or losing

3. Auxiliary Action Information Level 1 (A1A)
   Action leading to play winning or losing
B. **Level 2**

1. **Goal Structure Level 2 (G2)**
   - Score
   - Score differential
   - Team ahead

2. **Action Information Level 2 (A2)**
   - Action involving change in score

3. **Auxiliary Action Information Level 2 (A2A)**
   - Action leading to scoring of a run

C. **Level 3**

1. **Goal Structure Level 3 (G3)**
   - Number of outs
   - Location of (any) runners (X designates base, 1, 2, 3)

2. **Action Information Level 3 (A3)**
   - Action in which out is made
   - Action in which batter gets on base safely or runner safely advances to another base

3. **Auxiliary Action Information Level 3 (A3A)**
   - Actions leading to making an out
   - Actions leading to batter reaching base safely and/or runner reaches base safely

D. **Level 4**

1. **Goal Structure Level 4 (G4)**
   - Number of balls on batter
   - Number of strikes on batter
   - Count (ball - strike)

2. **Action Information Level 4 (A4)**
   - Pitch is ball
   - Pitch is strike

3. **Auxiliary Action Information Level 4 (A4A)**
   - Pitcher delivers ball
   - Pitch is curve
   - Pitch is fast ball
   - Pitch is slider
   - Pitch is change of pace
   - Pitch is screwball
   - Pitch is knuckleball
   - Pitch is spit
   - Pitch is pitchout
   - Batter takes pitch
Another aspect of the action classification is the inclusion of a category at each level called auxiliary actions. These are actions which are part of a play leading to a goal action but not the action itself. For example, the text may state, "The batter hit a fly ball to left field. The left fielder took three steps to the right. The left fielder caught the ball and the batter was out." The action that involves the goal state is in the final sentence, but the
first sentences contain information that is part of the play. This type of action is termed auxiliary.

The propositions shown in Table 2a were classified in terms of goal states and game actions. The former are denoted by G, followed by a number indicating the level of goal state involved in that proposition. Game actions are denoted by A, followed by a number indicating the level. An A following the number denotes that the action is auxiliary, for example, A1A.

A note is inserted here to answer some potential questions. The goal state propositions are those which make explicit a change in the state of a particular component of the goal structure. If a runner reaches second base safely, that is a change in the state. How the runner reached second (i.e., by hitting a double, by "stealing" second base, by an error, etc.) is an action.

The final knowledge structure information shown in Table 3 is termed non-game actions. These are actions that are not part of the game per se, but actions that may occur during a particular game. An example is a batter wiping his/her hands with a resin bag.

Non-game actions are classified in three ways. First, relevant actions are in some way related to the game even though they are not related to the play of the game. The second category, irrelevant actions, consists of actions less related to the game. The third category, irrelevant (non-baseball) actions, consists of actions not at all related to baseball. Examples of these three types of actions are found in Table 4. In the propositional classification of Table 2a, the three types of non-game actions are denoted, respectively, as NAR, NAI, and NANB.
The Scoring of Protocols

The protocol scoring method was quite straightforward. Each protocol was read sentence by sentence and the information contained in each sentence was scored in terms of the propositional analysis of Table 2a. Credit was thus given for the particular propositions whose contents were contained in the protocol. The reliability of this method, obtained by two raters with blind scoring of 16 (of 46) protocols, was 81% and 78% for HK and LK, respectively.

Tables 5 and 6 present a protocol of a HK and LK subject, respectively. Tables 7 and 8 present the propositions listed in Table 2a as they were recalled in the protocols of Tables 5 and 6, respectively.

Table 5
A High-Knowledge Protocol

The Robins and the Cougars are playing in a 5-3 game, favor of the Robins. It is in the last of the fifth and it is raining. The left-handed pitcher (E.R.A. 6.0) is having a usual day, 4 hits, 6 strikeouts (he usually gets a lot of strikeouts). The first batter flies out, bringing up Johnson, a .310 power hitter who leads the league with 23 homers. The first pitch is an inside curve ball for a strike. Johnson then raps a long foul which is followed by a brushback pitch. Johnson starts toward the mound, but then just goes to put resin on his slippery bat. The next pitch is an inside slider to even the count 2-2. Again Johnson puts resin on the bat. The next pitch is lined to left field for a double. The next batter, a .260 hitter, beats out an infield single to short, Johnson holding second. A .255 hitter follows, and the first pitch to him sails by the catcher and the runners each move up a base. He then shoots a single up the middle. Johnson scores, but the runner on second is out trying to score. The runner advances to second on the throw. Beck, a relief pitcher, starts to warm up, but the last batter strikes out to end the inning. The umpires then confer, and the game is called.
The score was 5-3. At the start of the inning, the sky started getting dark and as the inning went on it began raining and the game had to be called. The first batter of the inning had an average of .310, and the pitcher had allowed only 4 hits. The batter did not make it on base, and the pitcher was relieved because the next batter was very good. At one point, his count was 2 and 2. One of the batters had to use resin on his hands twice because the bat was slippery due to the rain. Someone’s E.R.A. was 6.00. One of the batter’s names was Churniak.

Table 7

Propositions Correctly Recalled for HK Protocol
(By Numbers from Table 2a)

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Table 8
Propositions Correctly Recalled for LK Protocol
(By Numbers from Table 2a)

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</table>

32

34
The Scoring of the Questionnaire

In the procedure used by Spilich et al. (in press), the subjects were given a series of 40 questions on the contents of the text after they had recalled the contents of the text. The purpose of the questionnaire was (a) to determine whether HK and LK differences would occur on this type of test, and (b) to determine whether HK and/or LK individuals were able to recall information (via question probe) that was not stated in the recall protocol. While HK individuals yielded better recall than LK individuals on the questionnaire performances, both groups recalled information in response to questions which they had not stated in their recall protocols. The questions employed in the questionnaire are presented in Table 9. (The order of questions generally follows the order of the text.)

Table 9

Questionnaire

1. What was the score of the game at the beginning of the account?
2. Which team was ahead?
3. Who were the teams that were playing?
4. Which team was at bat during the account?
5. Was the team at bat the home or visiting team?
6. What were the weather conditions?
7. Who was the pitcher for the team in the field?
8. Who was the first batter in the account?
9. What was his batting average?
10. Was he right- or left-handed?
11. What was the pitcher's earned run average?
12. Was he a good pitcher? Why or why not?
13. What parts of his own body or uniform did the pitcher touch before delivering the ball?
14. What happened when the first batter hit the ball?
15. What was the ball-strike count on him when he hit the ball?
16. Who was the second batter?
17. What was his batting average?
18. How many home runs did he hit?
19. Why did this batter take a step toward the pitcher?
20. What did this batter do? How?
21. What was the ball-strike count on this batter when he hit the ball?
22. Why did this batter use a resin bag?
23. Who was warming up in the bullpen? Why?
24. Who was the next batter?
25. What happened when he hit the ball?
26. What was the ball-strike count on the batter when he hit the ball?
27. Why did the runner on base not advance when this man hit the ball?
28. After this man batted, on which base(s) (was) (were) the (runner) (runners)?
29. Who was the next batter?
30. What was his batting average?
31. What happened that affected the (man) (men) on base?
32. What happened when this batter hit the ball?
33. What kind of pitch did he hit?
34. What happened to the runner(s) when this batter hit the ball?
35. Who was the next batter?
36. What was his batting average?
37. What happened to this batter?
38. Name as many players on the team in the field and state their positions.
39. Was the game official? How do you know?
40. What was the score at the end of the account?
<table>
<thead>
<tr>
<th>Question</th>
<th>Number of Correct Responses (of 23) for HK</th>
<th>Question</th>
<th>Number of Correct Responses (of 23) for HK</th>
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* Question #34 thrown out due to redundancy

** Eight correct responses per subject were possible
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* Question #34 thrown out due to redundancy

** Eight correct responses per subject were possible
While the more important results of this phase of the experiment were discussed by Spilich et al. (in press), the results for each question were not presented. Table 9 therefore also indicates the number of correct answers given by the 23 high-knowledge and 23 low-knowledge subjects in the experiment.

Final Comments

This paper presented in detail the procedures used for the text analysis and protocol analysis of the Spilich et al. paper. Also included is a summary of the results of the questionnaire given. While the methodology cannot be noted for its precision, it did involve procedures that were reliable and were apparently valid.
References


Turner, A., & Greene, E. The construction of a propositional text base. JSAS Catalog of Selected Documents in Psychology, in press.