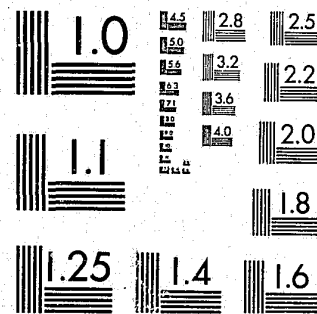


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11/16/82

Representation and Inference in Juror Reasoning: Two Illustrative Analyses

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Paper presented at the second annual meeting of the Cognitive Science Society, New Haven, Connecticut, June, 1980. This research was supported in part by a grant from the National Institute for Law Enforcement and Criminal Justice (78-NI-AX-0146).

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Abstract

Theoretical and empirical work is presented on the characterization of "story" representation and inference processes involved in the comprehension and decision making of jurors reasoning about a legal trial. Extensive post-trial protocol analyses are used to obtain data on juror information processing. The representation of the story or stories induced from the case materials (filmed murder trial) are identified and summarized using a Schank and Abelson style causal event chain and goal/plan hierarchy analysis. The structure and content of inferences underlying the causal representation are identified and characterized using Allan Collins' (1979) theory of human plausible reasoning. The adequacy of these schemes in characterizing talk-aloud protocol text is examined for two juror protocols.

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Tonight I am going to describe an application of cognitive science theories. Aside from practical benefits, applications are important because they force us to work hard to extend our theories, to establish limits on the generality of our theories, and to find where our theories fail. The application that we have been exploring is judicial decision making. More specifically, we have been studying the mental representation and inference products that are generated by individual jurors as they attempt to render a legally proper verdict from the evidence presented in a murder trial.

We have characterized the juror's task in the following idealized terms (see Pennington & Hastie, in press, for an extensive task analysis):

1. As the trial events occur, the juror comprehends the information presented by witness' testimony, attorneys' questions and arguments, and the trial judge's instructions and stores it in memory.

2. At the end of the trial the judge instructs the jury on the law, on what information is to be used to render a verdict, and on certain procedural rules concerning the burden of proof, the standard of proof, and the presumption of innocence. The juror comprehends this information and

produces a representation of possible verdict categories defined by abstract attributes such as, "presence of malice," "premeditation," "exhaust all means to avoid further combat," and so forth.

3. During and after the presentation of trial information, the juror constructs a story that provides a causally and temporally coherent ordering of events described in testimony. Note that this construction process requires considerable reordering of information from the sequence in which it occurs at presentation in the trial. This construction process, like any story comprehension process, requires the juror to make many inferences to connect story events, to resolve apparent contradictions between segments of testimony, and to identify verdict-relevant attributes of the story.

4. To reach a verdict, the juror performs a category-classification task in which the story is identified as belonging in the verdict category for which the best story-attribute/category-attribute match occurs.

Note that this task description is idealized in that it reflects our intuitions about the operations that a sufficient juror process model would have to include, and it assumes that the juror is motivated to follow the procedural rules

presented in the trial judge's instructions.

Two developments in cognitive science have been the major sources of theoretical constructs for our present analysis: Schank & Abelson's notation to represent causal event chains and goal/plan hierarchies (Schank & Abelson, 1977; Schank, 1975) and Allan Collins' typology to classify human plausible inference forms (Collins, 1979).

Our overall goal is to develop a theory that convincingly simulates the event representations and processes that occur in the juror's mind as trial events are perceived and the juror reasons to a pre-deliberation verdict. In this paper, I will describe our work to solve only one preliminary problem that is part of our effort to develop a general theory of juror performance. We are applying the Schank & Abelson and Collins notations to summarize the structures of jurors' talk-aloud protocols. For the present our goal is to reliably and sensitively translate talk-aloud texts into these abstract notations. The task of demonstrating that these structures reflect mental events and processes in the juror's mind involves additional experimental work (Pennington & Hastie, work in progress) not reported here.

To collect data for our first step, sixty jurors were sampled from a superior court jury pool in Boston and were shown a three-hour filmed reenactment of an actual murder trial. A summary of the stimulus trial information is presented in Appendix A. After watching the filmed trial, each juror was asked to reach an individual verdict decision for the case and to talk aloud about the case and his or her decision. The talk-aloud protocols were analyzed to yield the schematic summaries that are presented here as illustrations of our analyses.

Our first analysis characterizes the juror's representation of the sequence of events on the day of the crime (not the day of the trial) as a causally connected event-chain and goal/plan hierarchy. Figures 1 and 2 represent "maps" of the event-chain and goal/plan structure of

Insert Figure 1 about here.

two different jurors' verbal protocol "stories." Looking for a moment at Figure 1, some basic features of the representational scheme may be noted: There are two streams

of the representation -- the event chain, composed of events and causal links tells us what happened. In this map, events are grouped into episodes and the degree of elaboration of an episode is indicated by the number of crossed lines in the episode circle. For example, in Figure 1, the top left episode is labeled "At bar, victim threatens defendant." This circle actually represents a set of events (grouped as an episode) and the crossed lines indicate that this particular juror actually referred to eight different states and/or acts that are events within the episode. For this juror, this episode is highly elaborated (compare with the same episode node for another juror in Figure 2). In Figure 1, a "main chain" of episodes is indicated by shaded circles. The main chain is determined by redundancy of mention, degree of elaboration, and configuration of causal connections to other events in the juror's protocol. In Figure 1, the "essence" of what happened in this juror's eyes is summarized in the main chain as: Defendant was threatened, was humiliated, goes home, gets his knife, and goes back to the bar. (Note that the map presents only the first half of the complete story presented in Appendix A.)

The second portion of the proposed representational

structure is the goal/plan hierarchy. This portion represents the interpretation of the event chain or "why" events occurred as they did. The complete story requires the interaction of these two portions. In Figure 1, the explanation for the event chain is quite simple. When threatened, the defendant wished to retaliate but lacked a weapon. Humiliated, the defendant developed a plan for revenge that included taking his knife and going back to the bar to find his attacker. This juror was firm in a verdict choice of first degree murder.

A second event chain goal/plan representation is presented

Insert Figure 2 about here.

in Figure 2 for contrast. First, the episode structure of the two stories is virtually identical although the story told is quite different. (By saying that the episode structure is identical, we mean that the same episodes -- "threat", "at home", "take knife", "return to bar" -- are present although the elaborations and causal links are different.) The differences in the stories are illustrated first, by the "main

chain" in Figure 2. This juror sees two chains of events as relatively separate. The first chain contains the "defendant threatened," "defendant afraid" portion of the story. A second independent chain is initiated by the defendant's friend who suggests that they go for a drink, followed by the decision to go to the bar. (Note that the juror in Figure 1 did not include the plans and goals of other characters in his/her narrative.) The pattern of causal links, and the goal/plan hierarchy are also different in this story -- indicating the different interpretation placed on the "same sequence" of events. The juror in Figure 2 proposes that the defendant's plan (after the threat) was to stay away from trouble (the victim) and to stay home. This goal is brought into conflict when the defendant's friend suggests going back to the bar. As part of a plan to resolve this conflict (scare, bluff victim) the knife is taken. This juror was firm in a verdict choice of self defense.

What is the purpose of describing the jurors' "story" representations? First, over the protocols of our 60 jurors, we can identify features of jurors' stories that are not so easily representable with the Schank & Abelson tools. For example, quite early we found the need to represent goal

conflict as a reason for other behavior. (Recent work by Wilensky, 1978 addresses this issue.) Also, with the simple formulation I have illustrated on these maps, it is difficult to represent behavior or goal/plans that result from elaborate knowledge or expectations of other participants. (Recent work by Bruce & Newman, 1978, addresses this issue.) These are, however, frequent features of jurors' stories and explanations. There are other kinds of events such as negative events (e.g., He wasn't in the bar all day) and hypothetical events (e.g., If Johnson were smart, he would have gone back with Clemens) that are currently difficult to incorporate into the representational scheme. Thus, one use of the story map analysis is to identify problems for an application of the Schank-Abelson-type notation. A second use is to generate tests of the psychological validity of the representation. For example, we can identify the central causal chain that is characteristic of each verdict choice. To the extent that the causal chains and central events discriminate between verdict groups, further experimentation will enable us to test predictions about jurors' recognition and recall memory for trial material. We also have evidence that jurors bring varying degrees of reasoning skill to this task. The story map analysis makes it possible to compare

groups of individuals by the integratedness, complexity, thoroughness and consistency of their story representations.

Where did these stories come from? A second analysis that we apply to jurors' protocols is an examination of the inference structure connecting trial information, world knowledge, verdict category information and major story conclusions. We summarize the juror's inference structure using Allan Collins (1979) theory of human plausible inference. In this theory, Collins proposes a set of content-independent inference procedures, in which the traditional rules of logic are generalized from two values of certainty to a continuum of certainty. Thus, by specifying "certainty conditions" for each inference procedure, "plausible inference types" that have traditionally been treated as formal errors in reasoning may be regarded as acceptable inference strategies.

Figure 3 illustrates the inference structure (for our first degree murder juror) that underlies the "take knife" and

Insert Figure 3 about here.

"go back to bar" episodes on the story maps. In the diagram in Figure 3, each circle represents an inference. Although only the conclusion is shown in the diagram, each inference is composed of at least two premises and a conclusion that appear as content in the juror's verbal protocol. (See Appendix B for complete statements of each inference premises and conclusion.) For example, looking at the inference labeled "B" in Figure 3, the complete inference was: If the defendant weren't looking for revenge, he would never go back to the same place. The defendant went back to the same place. (Therefore) he was looking for revenge. Each inference is typed by looking at the structure (i.e., the relationship of the information contained in the premises and conclusion) and then classified according to Collins' scheme (for example, as instances of deduction, induction, analogy). As with the application of the Schank & Abelson notation, some types of inferences appearing in the protocols do not neatly fit the Collins typology. For example, in Figure 3, the reasoner uses a form of analogy that we have specified as a hypothetical self-analogy. This inference form occurs when the juror uses a hypothetical example of what he would do under circumstances similar to those in the trial. For example, inference "A" in Figure 3 in its complete form is: If I had been threatened

with a razor, I would never go back to the bar unless I were looking for revenge, which Mr. Johnson did.

In the inference analysis, we also note the source of the premise content which may be trial information, personal knowledge of the juror, or another inference conclusion. In the case where the conclusion of one inference is included as a premise in a subsequent inference, the inferences are considered to be linked and we have indicated linking relationships in Figure 3 by the connecting lines.

As a last comment on notation, some of the connections between inferences are drawn as thick lines. These are used where the inferential chain leading to a major conclusion argues for the major conclusion indirectly by disconfirming a competing conclusion. In figure 3, the inferences labeled "O" and "N" argue for the conclusion that "The defendant went back to the bar because he wanted revenge" by arguing against his "going back to the bar out of pride." "Feelings of pride" provides a competing explanation for Johnson's (the defendant) return to the bar. Most of the inferences and inference chains in Figure 3 offer supporting or confirming (rather than disconfirming) arguments for the conclusions reached by this juror. While I have not gone into the actual inference forms proposed by Collins' theory and utilized in our analysis (see

Collins, 1979), we feel that it is possible, using this vocabulary to examine the form, complexity, and sources of information for the arguments establishing the major story conclusions. This can be seen by contrasting the inference structure for the same two story episodes produced by our

Insert Figure 4 about here.

"self-defense" juror in Figure 4. Two things may be noticed about this juror's inference structure. First, the two story conclusions are not linked inferentially -- in keeping with this juror's separated story representation. Second, this juror uses arguments to disconfirm alternatives that are considerably more elaborate than the confirming inferences offered. In keeping with a disconfirming strategy, this juror relies on the more frequent use of an inference form called contradiction in Collins' scheme. It is anticipated that contrasts such as these across juror protocols both within and across verdict choice may be used both to describe the range of inference strategies characteristic of individuals and those associated with the implicit information differences arising from the consideration of information relevant to

particular verdicts.

In conclusion, I would like to argue that an empirical application such as the one we have introduced should interest cognitive scientists for several reasons:

1. The task is typically performed by non-experts sampled from a tremendously broad range of backgrounds. This diversity provides a solid foundation for the generalization of any successful theory as well as stiff challenges to the power of the theory to capture individual differences in capacity and strategy.

2. The juror's decision task is well-specified in comparison to many other naturally-occurring decision tasks such as medical diagnosis, investment selection, or public policy formation. Legal procedures sharply limit and structure the decision-relevant information base and provide standard, relatively clear task instructions to the juror.

3. As the juror performs the task, a rich variety of inference and memory phenomena occur. We have noted that the task includes learning, story construction, inference, and classification components. Forms of reasoning exhibited in jurors' talk-aloud protocols also include great variety with some particularly intricate examples of analogical reasoning

and hypothetical reasoning.

4. There is a long history of applications of decision theoretic, descriptive-algebraic, and legal models to the juror's task. Thus, there are numerous possibilities for comparison between traditional models and cognitive science applications (see Pennington & Hastie, in press).

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Figure 1. Causal event chain and goal/plan hierarchy for juror #128 (verdict=first degree murder)

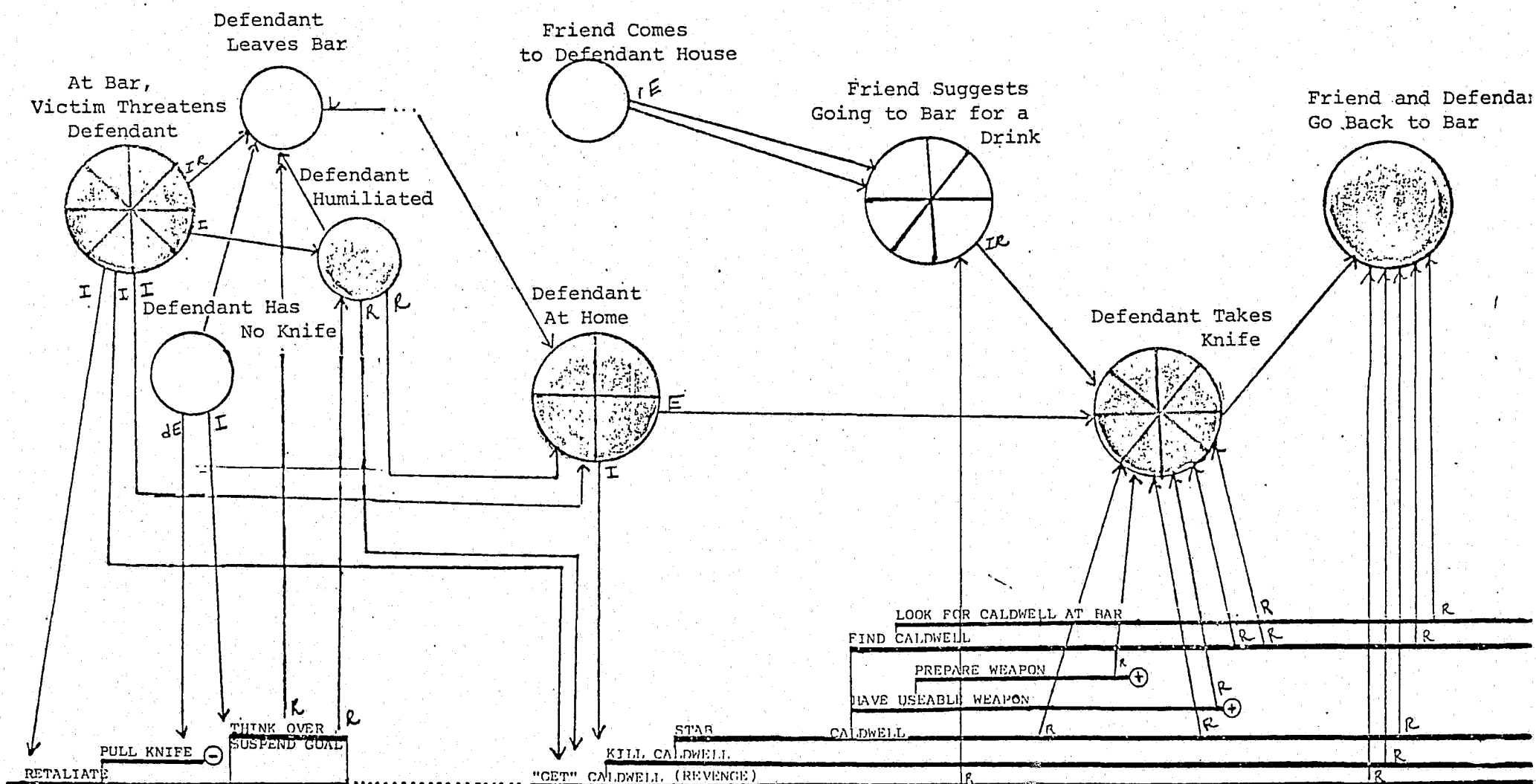
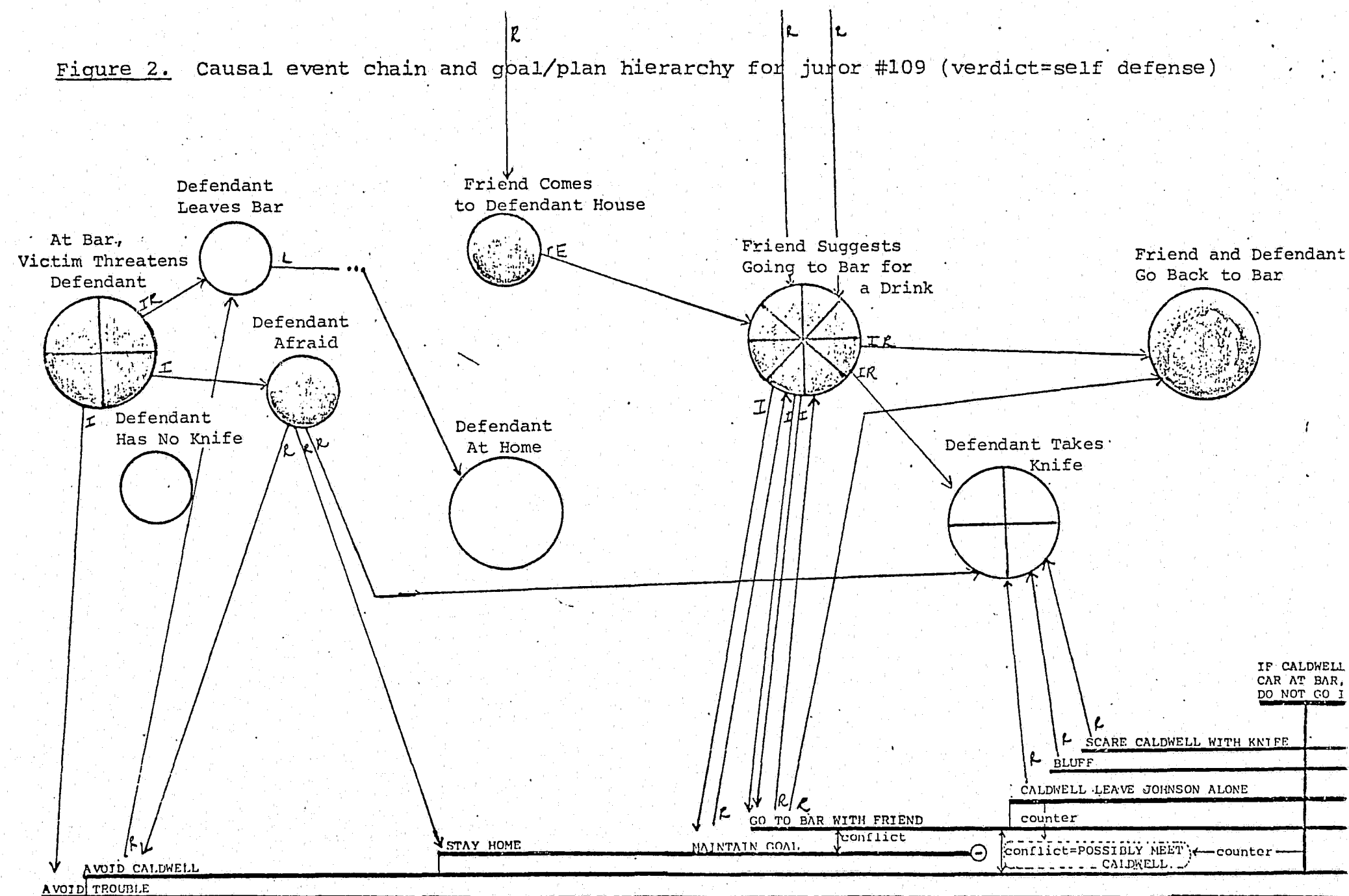


Figure 2. Causal event chain and goal/plan hierarchy for juror #109 (verdict=self defense)



KEY

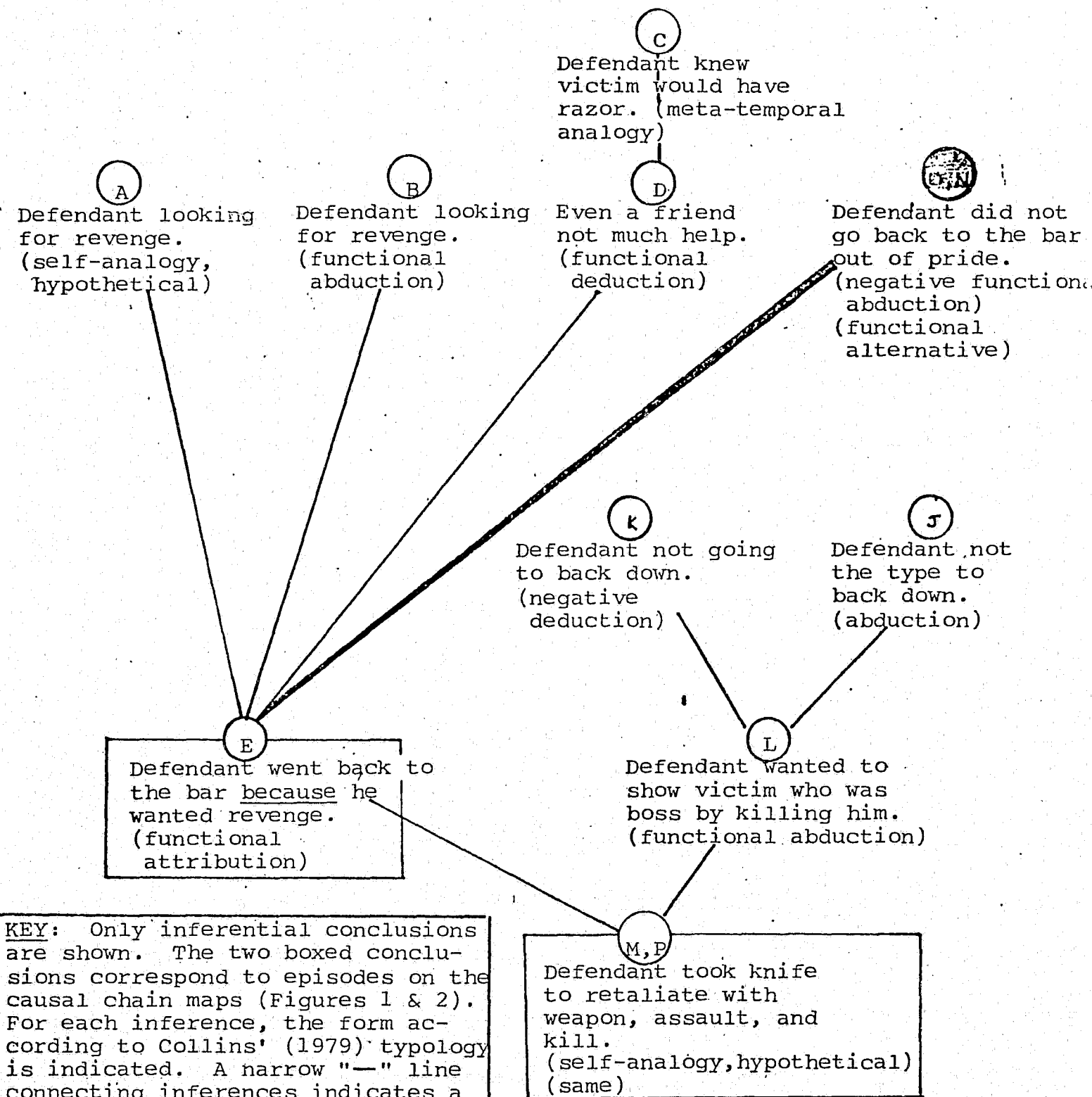


= Episode; ⊕ = Degree of elaboration of episode;

= Central event; — = goal/plan line;

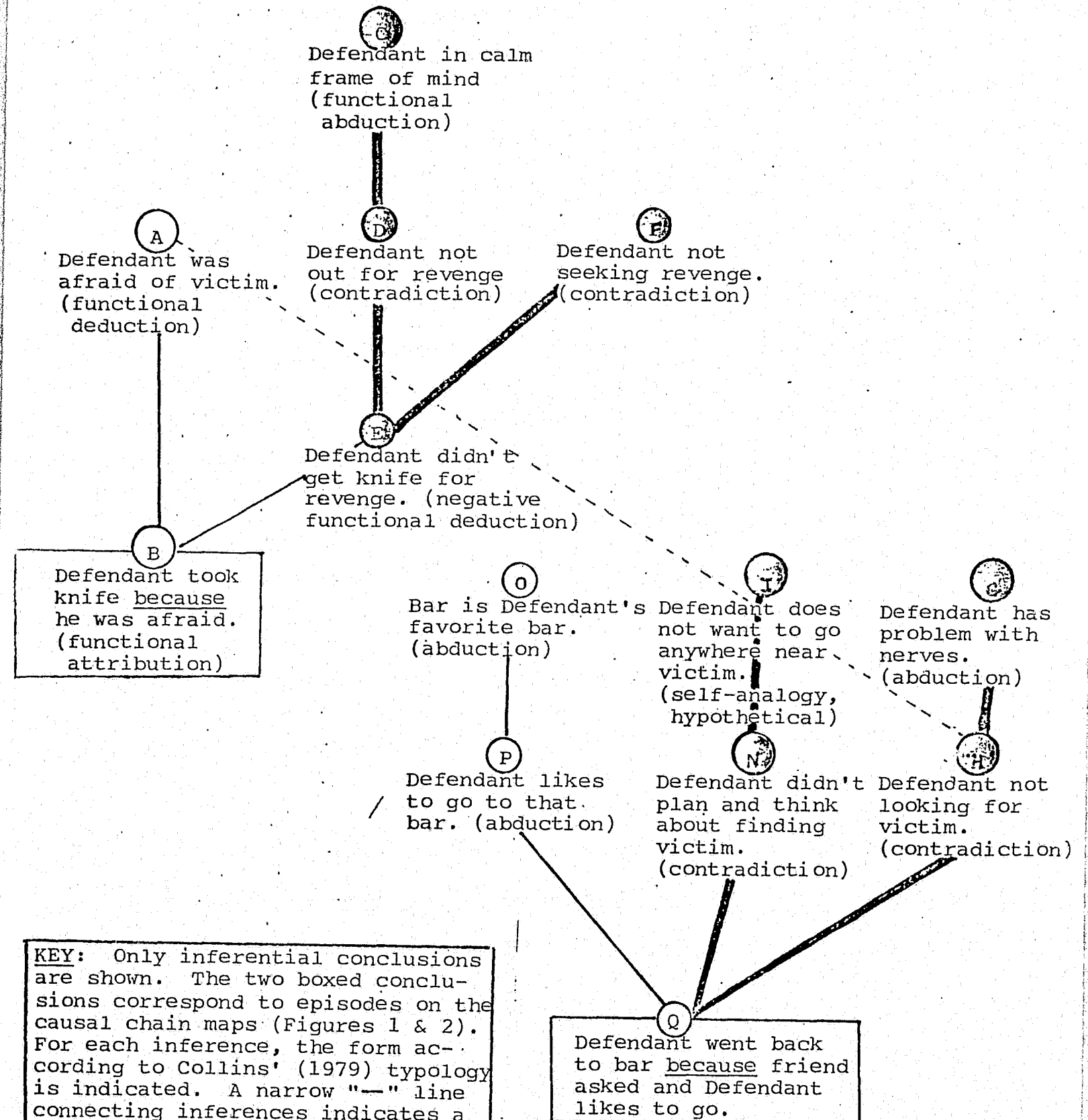
I = Initiation causation; R = Reason causation;

Figure 3. Partial inference structure for juror #128 (first degree verdict)



KEY: Only inferential conclusions are shown. The two boxed conclusions correspond to episodes on the causal chain maps (Figures 1 & 2). For each inference, the form according to Collins' (1979) typology is indicated. A narrow "—" line connecting inferences indicates a directly confirming argument. The wider "—" line and the darkened circle indicate an argument for a position by disconfirming opposing arguments. Collins' inference types are not fully illustrated here since the premises for each inference are not shown.

Figure 4. Partial inference structure for juror #109 (self defense verdict)



KEY: Only inferential conclusions are shown. The two boxed conclusions correspond to episodes on the causal chain maps (Figures 1 & 2). For each inference, the form according to Collins' (1979) typology is indicated. A narrow "—" line connecting inferences indicates a directly confirming argument. The wider "—" line and the darkened circle indicate an argument for a position by disconfirming opposing arguments. Collins' inference types are not fully illustrated here since the premises for each inference are not shown.

Appendix A: Summary of murder trial, COMMONWEALTH v. JOHNSON

The defendant, Frank Johnson was accused of murder in the first degree. Johnson pleaded not guilty, claiming that he acted in self defense.

On the afternoon of the day of the killing, Frank Johnson (the defendant) and Alan Caldwell (the victim) were both in Gleason's Bar and Grille having a drink. Caldwell became angry at Johnson when a woman asked Johnson to give her an automobile ride and Johnson agreed. Caldwell stood up, pulled a straight razor out of his pocket and threatened to kill Johnson. Johnson left the bar at that time, later claiming that he was upset and frightened. It is unclear whether Johnson had a weapon with him at that time, but Johnson thinks that he probably didn't.

Johnson went home and spent the rest of the afternoon and early evening with his wife and six children. At some point in the afternoon or evening, Johnson put his fishing knife in his front pocket. He said he frequently carried it with him and that he did so to keep it out of the hands of his children. On the afternoon in question he had taken it from one of the children and put it in his pocket.

In the late evening, Johnson's friend, Dennis Clemens came over and suggested that they go to Gleason's Bar for a drink. Johnson told him about the argument in the afternoon and said that he was reluctant to return to the bar. They decided to go anyway. They checked the area around the bar for Caldwell's car before going in. Johnson says that, if Caldwell's car had been there, they would not have gone in because he was trying to avoid seeing Caldwell again.

About an hour after Johnson and Clemens returned to the bar, Caldwell arrived. They encountered each other in the bar (contradictory evidence was presented about this meeting) and Johnson testifies that Caldwell suggested that they go outside. Johnson also said he thought that they were going to talk things over and patch things up. Caldwell was observed removing his watch as the two men walked outside.

Outside on the sidewalk, there may have been some conversation and possibly some laughter. In any case, Caldwell threw a punch at Johnson and knocked him against the wall. What happened next was not clear. Johnson says that Caldwell pulled his razor and threatened to kill him. Some witnesses say they did not see a razor. Johnson

pulled his knife (the fishing knife in his pocket) and either Johnson stabbed Caldwell or Caldwell lunged at Johnson, lunging onto the knife. Caldwell died from the knife wound. The razor was later found, by the autopsy pathologist in Caldwell's left rear pocket.

The Decision

The prosecution claims that Johnson went home in order to get his knife and came back looking for Caldwell in order to kill him (first degree murder). Johnson claimed that Caldwell threatened him with a razor and lunged at him, running onto the knife; he usually carries the knife and happened to have it that evening (self defense). The judge instructs the jury that they may choose among four verdicts: first degree murder, second degree murder, manslaughter, or self defense (not guilty). These alternatives are described at length by the trial judge.

(NOTE: This summary is arranged in story form for ease of reading. The evidence in the trial is arranged differently with respect to temporal order.)

Appendix B: Complete Inference Listing for Figures 3 and 4

Inferences for Figure 3

- A. If somebody threatened me with a razor, I would not go back to the same place unless I were looking for revenge.
Mr. Caldwell threatened Mr. Johnson with a razor.
Mr. Johnson returned to the same place.
Mr. Johnson was looking for revenge.
- B. If Mr. Johnson wasn't looking for revenge, he would never go back to the same place.
He went back to the same place.
Mr. Johnson was looking for revenge.
- C. Johnson knew Caldwell had a razor on him in the afternoon.
The evening is near in time to the afternoon.
Johnson knew that Caldwell would have a razor in the evening.
- D. A friend is not much help when confronted by a razor.
Johnson knew Caldwell would have a razor.
Johnson's friend would not be much help.
- E. One reason for returning to a place known to be dangerous without much help is to get revenge.
Johnson knew Caldwell would have a razor.
Clemens would not be much help.
Johnson returned to the bar because he wanted revenge.
- J. A renitent person says things like ...
Johnson (in testimony) said things like...
Mr. Johnson is a renitent person (doesn't like to back

down).

- K. Having to back down makes you an underdog.
Johnson didn't want to be an underdog.
Johnson wasn't going to back down.
- L. Not backing down depends on going back and showing Caldwell who is boss by killing him.
Johnson is not going to back down.
Johnson went back to show Caldwell who is boss by killing him.
- M. If anybody pulled a razor on me in a bar, I would never go back unless I was going to retaliate with another weapon.
Caldwell pulled a razor on Johnson.
Johnson went back with a knife.
Johnson went back with a knife to retaliate with a weapon.
- N. If Johnson went back out of pride, he would not need a knife.
Johnson took a knife.
Johnson did not go back out of pride.
- O. Johnson went back either out of pride or to fix Caldwell.
Johnson went back to fix him.
Johnson did not go back out of pride.
- P. I am quick tempered.
If someone embarrassed me, I would go back with malice and do a job on him.
Johnson is quick-tempered.
Caldwell embarrassed Johnson.

Johnson went back with malice to do a job on Caldwell.

Inferences for Figure 4

- A. Reasons to be afraid of someone include if that person is a troublemaker, is big.
Johnson knew Caldwell was a troublemaker.
Caldwell was big.

Johnson was afraid of Caldwell.

- B. One reason for carrying a weapon is being afraid.
Johnson carried a knife.
Johnson was afraid of Caldwell.

Johnson took his knife because he was afraid of Caldwell.

- C. Johnson went to the park with his family, came home, had supper...
Going to the park with your family, being home, eating supper... depend on a calm frame of mind.

Johnson was in a calm frame of mind.

- D. Johnson was in a calm frame of mind.
Being in a calm frame of mind is incompatible with being out for revenge.

Johnson was not out for revenge.

- E. If Johnson were going home to get his knife for revenge, he would have gone right back.
Johnson didn't go right back.

Johnson was not out for revenge.

- F. Johnson was trying to avoid Caldwell.
Avoiding Caldwell is incompatible with seeking revenge.

Johnson was not seeking revenge.

- G. Johnson has asthma.
Asthma is associated with nervous problems.

Johnson has nervous problems.

- H. Johnson had nervous problems and was afraid of Caldwell.
Being nervous and afraid is incompatible with looking for Caldwell.

Johnson was not looking for Caldwell.

- I. If someone were going to fight with me, I wouldn't want to go anywhere near them.
Caldwell wanted to fight with Johnson.

Johnson did not want to go anywhere near Caldwell.

- N. Johnson was trying to stay away from Caldwell.
Staying away from someone is incompatible with planning to find them.

Johnson didn't plan and think about finding Caldwell.

- O. A favorite place is where you go all the time.
They drink at Gleason's all the time.

Gleason's is their favorite place.

- P. People like to go to their favorite place for relaxation.
Gleason's is Johnson's favorite place.

Johnson likes to go to Gleason's.

- Q. Going somewhere depends on liking the place, having company, being invited, ...
Clemens asked Johnson to go to Gleason's.
They know everybody there.
Gleason's is Johnson's favorite place.
Johnson likes to go to Gleason's.

Johnson went to Gleason's because Clemens asked and Johnson likes to go to Gleason's.

END