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Chapter 3

Erotetic Problem Solving: From Real Data to Formal Models. An Analysis of Solutions to Erotetic Reasoning Test Task

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Abstract. In this paper we model solutions to one of the Erotetic Reasoning Test tasks. Logical framework for our research is set up by one of the most influential current paradigms in the logic of questions – Inferential Erotetic Logic. We propose a weakened version of the relation of erotetic implication, which allows for adequate account on suboptimal solutions to the task in question.

1. Introduction

The aim of this paper is to offer formal models of solutions to one of the Erotetic Reasoning Test (ER) tasks (Urbański et al., 2013). ER was designed in order to operationalize fluency in solving difficult deductive tasks involving conditionals, thus extending the framework for research on deduction set up by the Wason selection task (see Stenning and van Lambalgen, 2008).

Erotetic inferences are inferences which involve questions as conclusions or as premises and conclusions. They form good representations of some techniques of problem solving, either by reduction of an initial problem to a simpler one(s), or by identifying missing information which is needed in order to solve the initial problem (Urbański & Łupkowski, 2010). By analogy to the tripartite division of reasoning rules (Stanovich, 1999) we shall show that such inferences can be modeled not only from the point of view of a normative yardstick of assumed logical background. Our formal framework allows for modeling such inferences from a prescriptive perspective, as well as for an adequate descriptive account on slips and errors made by reasoning subjects.

We start with outlining logical basis of our research, which is one of the most influential current paradigms in the logic of questions – Inferential Erotetic Logic (section 2). Then we present the ER task we are interested in and its normatively correct solution (section 3). Subsequently, drawing on the subjects’ justifications to suboptimal solutions (section 4), we introduce the concept of weak erotetic implication (section 5), in terms of which solutions described earlier can be modeled.
2. Logical Framework: Inferential Erotetic Logic

In order to define validity of erotetic inferences a logic of questions is needed, which allows to define semantic properties of and relations between questions (or interrogatives). However, there are many possible models of validity of erotetic inferences.

Logical framework for this research was set up by Inferential Erotetic Logic (IEL; Wiśniewski, 1995, 2013). This choice is justified by a couple of reasons. Firstly, IEL is flexible: it is not tied up to any specific logic of declaratives. IEL-style logic of questions can be based on any such logic which satisfies some simple syntactic and semantic conditions; examples include many-valued logics (Urbański, 2002), modal logics (Leszczyńska-Jasion, 2007, 2008), paraconsistent logics (Wiśniewski, Vanackere, & Leszczyńska, 2005; Chlebowski & Leszczyńska-Jasion, 2015), intuitionistic logic (Skura, 2005). Consequently, IEL allows for formalization of erotetic reasoning at different levels of complexity of specification of considered verbal representations and with different underlying semantic requirements.

Secondly, formal representation of questions in IEL is friendly to the user, as in representing questions IEL follows so-called set-of-answers methodology (Harrah, 2002; see Peliš, 2016, for a comprehensive introduction). The idea stems from Hamblin’s (1958, p. 162) postulate that “Knowing what counts as an answer is equivalent to knowing the question”. Thus in IEL a representation for the question ‘Is John the good, the bad, or the ugly?’ is \(?\{p, q, r\}\) (where \(p\) stands for ‘John is the good’, \(q\) for ‘John is the bad’ and \(r\) for ‘John is the ugly’). In general, for any question \(Q\) of the form \(?\{A_1, ..., A_n\}\) the formulas \(A_1, ..., A_n\) are considered as direct answers to \(Q\) (the assumption is that \(A_1, ..., A_n\) are pairwise syntactically distinct formulas). As a result, while advocating for a non-reductionist account on questions as having the meaning on their own (see Belnap, 1983; Wiśniewski, 1995, pp. 37-42), IEL offers some straightforward tools for modeling erotetic inferences. It should be noted, however, that we are not entering into the details of the lively discussion concerning relations between questions and interrogatives (see for example Wiśniewski, 2015).

Thirdly, in general IEL is not limited to an analysis of any specific class of questions (although in this paper we are going to consider only questions with finite number of answers). In particular, IEL defies another Hamblin’s (1958, p. 163) postulate which states that “The possible answers to a question are an exhaustive set of mutually exclusive possibilities”. Such questions (which elsewhere we call maximally informative questions; see Paluszkiewicz and Urbański, 2016) are ubiquitous in natural language; nevertheless, as humans do reason with questions lacking this property, we need a framework which is able to cope with such inferences.

We were interested in inferences in which conclusion and one premise are questions and other premises – if there are other premises at all – are declarative sentences. In IEL validity of such inferences is defined in terms of semantic relation of erotetic implication (e-implication for short), which meets the following conditions:

1. transmission of truth/soundness into soundness: if the question-premise is sound (i.e., there exists a true direct answer to this question) and all the declarative premises (if there are any) are true, then the question-conclusion is sound as well;
2. cognitive usefulness: each answer to the question-conclusion is useful in answering the question-premise (each answer to the question-conclusion narrows down the class of possible answers to the question-premise), provided that all the declarative premises (if there are any) are true.
Consider a simple example (Urbański & Łupkowski, 2010, p. 68). Suppose that our problem is expressed by the initial question:

(Q) **Who stole the tarts?**

Suppose also that we managed to establish the following evidence:

(E₁) *It is one of the courtiers of the Queen of Hearts attending the afternoon tea-party who stole the tarts.*

Thus the initial question together with the evidence erotetically implies the question:

(Q*) **Which of the Queen of Hearts’ courtiers attended the afternoon tea-party?**

It is intuitively justified to ask for the list of courtiers – participants of the afternoon tea-party (Q*) in order to solve the problem (Q), in view of the established evidence (E₁). This justification can be expressed in exact terms by fulfilment of both conditions of e-implication. First, if somebody really stole the tarts and if it is true, that the culprit is one of the courtiers of the Queen of Hearts attending the afternoon tea-party (that is, if Q is sound and if E₁ is true), then some of the courtiers must have attended the party (that is, Q is sound as well). Second, each non-empty list of courtiers – participants of the party narrows down the class of suspects, provided that it is really one of the courtiers of the Queen of Hearts attending the afternoon tea-party who stole the tarts (that is, each direct answer to Q narrows down the class of possible answers to Q, in view of E₁).

If moreover we know that:

(E₂) *Queen of Hearts invites for a tea-party only these courtiers who made her laugh the previous day.*

then Q* and E₂ erotetically imply the question:

(Q**) **Which courtiers made the Queen of Hearts laugh the previous day?**

It is easy to check that in this case both conditions of e-implication are fulfilled as well.

Formal definition of e-implication offers precise explication for conditions of transmission of truth/soundness into soundness and of cognitive usefulness (Definition 1; see Wiśniewski, 2013). For the sake of simplicity we consider only the case of questions with finite sets of direct answers.

**Definition 1.** A question Q e-implies a question Q₁ on the basis of a set X of declaratives (Im(Q; X; Q₁)) iff:

1. transmission of truth/soundness into soundness: for each direct answer A to the question Q: X ∪ {A} entails the disjunction of all the direct answers to the question Q₁, and
2. cognitive usefulness: for each direct answer B to the question Q₁ there exists a non-empty proper subset Y of the set of direct answers to the question Q such that X ∪ {B} entails the disjunction of all the elements of Y.
Such erotetic inferences clearly involve deductive reasoning (especially in view of the first condition imposed on e-implication). However, the presence of verbal representations different than the usual declaratives, and the presence of an additional condition of cognitive usefulness suggest that carrying out erotetic reasoning may be a task both more difficult than carrying out simple syllogistic reasoning, widely used in deductive reasoning tests (Stenning & van Lambalgen, 2008) and more comprehensive with respect to deduction than solving conditionals of Wason selection task. These claims were confirmed in the research in which tests based on syllogistic reasoning as well as on erotetic reasoning were used (Urbański et al., 2013).

3. Erotetic Reasoning Test: An Exemplary Task and Its Normatively Correct Solution

Erotetic Reasoning Test (ER), designed by the authors and carried out in Polish, contains 3 items (time limit 30 min). Each item consists of a detective-like story in which the initial problem and the evidence gained are indicated. The task is to pick a question (one out of four), each answer to which will lead to some solution to the initial problem. The subjects are asked to justify their choices.

All three stories describe some investigation and they invoke search for a solution to an initial problem by means of posing further (auxiliary) questions. The stories are set up in such a way that the impact of previous content-related experience of the subjects on the choice of solution is minimized. All the relevant information is explicitly listed and the subjects are asked to solve each task (i.e., to pick a correct question) solely on the basis of what is given.

There is only one correct answer in each item. However, the criterion of correctness is somewhat complicated. What matters is not only correct choice of the question-solution but also a proper justification of the choice, based on two conditions of validity of erotetic implication: transmission of truth/soundness into soundness and cognitive usefulness. Thus assessment of overall correctness of an answer in each ER task is based on the presence of all these three elements.

Our research were carried out between February and May, 2012 and between January and March, 2015. 137 subjects were recruited (M=21.69, SD=1.44, 111 women), students at Adam Mickiewicz University in Poznań, who volunteered to participate in these research. Reliability of the ER test turned out to be acceptable (Cronbach’s α = .74). Interested reader can find detailed results of this study (including more psychometric data) and discussion of their implications in (Urbański et al., 2016).

We shall elaborate our formal model on the example of one of the ER tasks, ‘The Bomb’ (the phenomena we are going to address were also observed in case of the remaining two tasks). It runs as follows:

In the capital of a certain country someone planted a bomb in the palace of the king. The best royal engineer, who arrived immediately, established the following evidence:

1. There are three wires in the bomb: green, red and orange.
2. To disarm the bomb either the green or the red wire must be cut. Cutting the wrong wire will cause an explosion.
3. If the bomb has been planted by Steve, cutting the green wire will disarm it.
4. If the bomb has been planted by John, cutting the red wire will disarm it.
Moreover, no one but John would have used the red wire.
5. If the bomb has not been planted on an even day of the month, the culprit is Steve.
6. The bomb has been planted either by Steve, or by John, or by someone else.

Each of the following questions below can be answered either ‘yes’ or ‘no’. Mark the question to which the answer (regardless of it being ‘yes’ or ‘no’) will allow you to establish in the shortest possible time which wire should be cut in order to disarm the bomb:

☐ Was the bomb planted on an even day of the month?
☐ Was the bomb planted by Steve?
☐ Was the bomb planted by John?
☐ Was the bomb planted by someone else than Steve or John?

Justify your choice.

The normative yardstick for correctness of solving ER tasks was determined by the aforementioned concept of erotetic implication (which we shall call further on canonical e-implication).

Reasoning underlying solutions to ER tasks can be represented concisely in terms of Erotetic Search Scenarios (ESSs; Wiśniewski, 2013, p. 103–126). ESSs provide a formal account on the Erotetic Decomposition Principle:

Transform a principal question into auxiliary questions in such a way that: (a) consecutive auxiliary questions are dependent upon previous questions and, possibly, answers to previous auxiliary questions, and (b) once auxiliary questions are resolved, the principal question is resolved as well.

A scenario is a tree-like structure consisting of branches. Each branch satisfies the following conditions (Wiśniewski, 2013, p. 106–107):

1. It begins with the principal question and ends with a direct answer to it;
2. Each declarative sentence involved:
   (a) is an initial premise, or
   (b) is a direct answer to an auxiliary question that immediately precedes it on the branch, or
   (c) is entailed by some declarative sentence(s) which occur(s) earlier on the branch.
3. Each auxiliary question involved is e-implied, in the sense of IEL, by some question and declarative sentence(s) that occur earlier on the branch.

Some auxiliary questions in a scenario are queries: these are questions which are immediately followed by all their direct answers (and thus queries are the only branching points of a scenario). Notice, that not all auxiliary questions need to be answered in a scenario; we shall come back to this issue in the section 5.

From a pragmatic point of view, a scenario offers conditional instructions on what questions should be asked and when they should be asked in order to solve an initial problem. Moreover, a scenario shows where to go if such-and-such a direct answer to a query appears to be acceptable and does so with respect to any direct answer to each query (Wiśniewski, 2003, p. 422).
A scenario underlying the normatively correct solution to the task is presented in Figure 1, expressed in the language which is an erotetic extension of Classical Propositional Calculus (see Wiśniewski, 2013, p. 18–20); ¬ stands for negation, ∧ for conjunction, ∨ for disjunction, ⊥ for exclusive disjunction, → for implication and ↔ for equivalence. Propositional variables represent the following sentences:

- \( p \) – Cutting the green wire disarms the bomb.
- \( q \) – Cutting the red wire disarms the bomb.
- \( v \) – Cutting the orange wire disarms the bomb.
- \( s \) – The bomb has been planted by Steve.
- \( r \) – The bomb has been planted by John.
- \( t \) – The bomb has been planted on an even day of the month.
- \( u \) – The bomb has been planted by someone else than Steve or John.

In the scenario presented in Figure 1, the question \( ?\{r, \neg r\} \) (“Was the bomb planted by John?”), which is the correct solution to the considered task, is canonically e-implied by the initial question, \( ?\{p, q, v\} \), on the basis of the following declarative premises: \( p \lor q \), \( r \leftrightarrow q \).

**Figure 1. A scenario for normatively correct solution**

In the scenario presented in Figure 1, the question \( ?\{r, \neg r\} \) (“Was the bomb planted by John?”), which is the correct solution to the considered task, is canonically e-implied by the initial question, \( ?\{p, q, v\} \), on the basis of the following declarative premises: \( p \lor q \), \( r \leftrightarrow q \).

**4. Subjects’ Justifications to ER Task Solutions**

In ER tasks the subjects were asked to provide justifications to their solutions. This way some insight into reasoning leading to these solutions was obtained. Some subjects offered justifications which exactly fit normatively correct solution given in the previous section. These justifications complied with the two conditions of canonical e-implication (Definition 1), as in the example 1.

**Example 1.** [Subject A100, solution: Was the bomb planted by John?] I considered all the possibilities. If it is John, then one should cut the red one. If not, then the green one, because only these two disarm the bomb. And only John would have used the red one, so anybody else would have used the green one. This is the only question answer to which gives clear solution. Using any other there is a risk that one will need to answer some further questions.
This is exactly our normatively correct solution, represented by the scenario in the previous section. We shall focus, however, on suboptimal solutions, which nevertheless are somewhat justified in view of the informational goal being pursued.

A significant number of participants did not comply with the requirements imposed by the canonical e-implication. In particular, they violated the cognitive usefulness condition, expressed in the instruction as “to choose that question to which the answer (regardless of it being ‘yes’ or ‘no’) will allow to establish solution” to the initial problem. Nevertheless, most choices were motivated by the possibility of gaining relevant information; the subjects often found it justified to choose a question only some answer to which will lead to the solution to the initial problem. Let us clarify this issue by means of further examples.

*Example 2.* [Subject A81, solution: Was the bomb planted on an even day of the month?] This answer, because if the bomb wasn’t planted on an even day of the month, then Steve did this. And it will be known who did this, you only need to pay attention to whether it was an odd or an even day of the month.

In this case the subject has chosen a solution which is useful, but only partially. The negative answer to it leads to the solution to the initial problem. However, the affirmative answer is of no use. The solution can be modeled by means of the scenario presented in Figure 2.

*Example 3.* [Subject A78, solution: Was the bomb planted on an even day of the month?] Because if it was an even day of the month, then the culprit is known.

This solution can be modeled by means of the same scenario as the previous one, albeit with focus on different branch of it. It points out at the branch containing affirmative answer, which in fact does not lead to any solution to the initial problem. Most probably this was caused by misreading the content of the task (“the bomb has been planted on an even day of the month”, instead of “has not been planted”). Still, the justification refers to partial usefulness of the chosen question.

![Figure 2](image)

*Figure 2.* A scenario for examples 2 and 3.

*Example 4.* [Subject A101, solution: Was the bomb planted on an even day of the month?] No matter which question we’ll ask it will exclude one suspect and it will be necessary to ask another question which will decide who planted the bomb.
This is an interesting solution. The subject’s claim is to some extent justified: although it is not the case that all the questions offered as solutions are of only partial use, asking two partially useful questions will lead to the solution. In this case, after asking the question concerning a day of planting the bomb one might ask the question “Was the bomb planted by Steve?” and then “Was the bomb planted by someone else than Steve or John?” (in whichever order, in fact). This way one would obtain a scenario for solving the initial problem. The scenario in question is represented in Figure 3. Notice, that in order to generate such a scenario an additional premise is needed (u→¬p, i.e. “If the bomb has been planted by someone else than Steve or John, then cutting the green wire disarms it”). This premise is justified in view of the information provided, so it can be interpreted as an enthymematic one. It is important, however, at which stage this premise is added. If it precedes the query ?\{u, ¬u\}, this query becomes canonically e-implied by the initial question and declarative premises; if not, introduction of the query does not meet the usefulness condition.

Another possibility, consistent with the subject’s justification, would be to combine one of the above questions with the question ?\{r, ¬r\} (although this would mean that the subject did not consider both answers to this question as useful).

Example 5. [Subject A82, solution: Was the bomb planted on an even day of the month?] We don’t know if the bomb exploded at all and we do not know who planted the bomb.

The subject is not able to infer any solution, so the choice of a question can be viewed as just a random one.
Example 6. [Subject A91, solution: Was the bomb planted by Steve?] Because if the bomb was planted by Steve, then cutting the green wire will disarm it.

This solution is similar to the one of example 2, as witnessed by the scenario presented in Figure 4. The subject has chosen a question which is partially useful and did not consider the branch containing negative answer to the query.

\[
\begin{align*}
?\{p, q, v\} \\
p \lor q \\
s \rightarrow p \\
r \leftrightarrow q \\
\neg t \rightarrow s \\
r \perp s \perp u \\
?\{s, \neg s\} \\
s & \quad \neg s \\
p & \quad \ldots
\end{align*}
\]

*Figure 4. A scenario for example 6*

Example 7. [Subject A103, solution: Was the bomb planted by Steve?] If we’ll get an affirmative answer to this question, then we’ll know that the green wire needs to be cut. If a negative one, then there will be only one possibility left – the red wire, and additionally we’ll know that the culprit is John.

Here the subject interprets the conditional \(s \rightarrow p\) as a biconditional, which is quite common in everyday reasoning (cf. Stenning and van Lambalgen, 2008 on Wason selection task). As a result, inferences marked by an asterix (Figure 5) are not valid.

\[
\begin{align*}
?\{p, q, v\} \\
p \lor q \\
s \rightarrow p \\
r \leftrightarrow q \\
\neg t \rightarrow s \\
r \perp s \perp u \\
?\{s, \neg s\} \\
s & \quad \neg s \\
p & \quad r* \\
q* & \quad \ldots
\end{align*}
\]

*Figure 5. A scenario for example 7*
5. Weak Erotetic Implication

Reasoning by which choices of suboptimal solutions to the ER task were justified do not comply with the normative requirements imposed by canonical e-implication. Nevertheless, as we have shown in the previous section, some of them are not just incorrect: from a prescriptive point of view there is some decent rationality involved in choosing partially useful solutions. Such reasoning can be modeled in terms of a relation weaker than canonical e-implication; we shall call it weak erotic implication.

**Definition 2.** A question $Q$ weakly e-implies a question $Q_1$ on the basis of a set $X$ of declaratives ($\text{Im}_w(Q; X; Q_1)$) iff:

1. Transmission of truth/soundness into soundness: for each direct answer $A$ to the question $Q$: $X \cup \{A\}$ entails the disjunction of all the direct answers to the question $Q_1$, and
2. Partial cognitive usefulness: for some direct answer $B$ to the question $Q_1$ there exists a non-empty proper subset $Y$ of the set of direct answers to the question $Q$ such that $X \cup \{B\}$ entails the disjunction of all the elements of $Y$.

As we have seen in the justification of their choices, there are two main reasons for which subjects find it reasonable to indicate these partially useful solutions. The first one can be concisely summarized by a quotation from one of the subjects: because by asking and answering such a question “we know at least something”. This resembles somewhat the ‘seizing’ phase of information gathering in terms of the need for cognitive closure (Kruglanski, 2004). The second reason is that some subjects found it difficult to point at a single question, each answer to which would allow to solve an initial problem, but what they claimed was that the task can be solved by means of asking a sequence of questions. From this point of view choices of partially useful weakly implied questions form a working example of what Hintikka calls strategic rules; such rules make sense not in move-by-move terms, only in terms of complete strategies for solving problems (Hintikka, 1999, p. 97–98).

As the relation of weak e-implication is weaker than the canonical one, there is an obvious relationship between the two: if a question $Q$ canonically e-implies a question $Q_1$ on the basis of a set $X$ of declaratives, then $Q$ also weakly e-implies $Q_1$ on the basis of $X$, and not the other way around. Erotetic implications on which our models of exemplary solutions to the ER task are based are summarized in Table 1 (in each case $Q = \{p, q, v\}$).

<table>
<thead>
<tr>
<th>Examples</th>
<th>$Q; X; Q_1$</th>
<th>E-implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$Q; p \lor q, r \leftrightarrow q; {r, \neg r}$</td>
<td>$\text{Im}, \text{Im}_w$</td>
</tr>
<tr>
<td>2, 3, 4</td>
<td>$Q; \neg t \rightarrow s, s \rightarrow p; {t, \neg t}$</td>
<td>$\text{Im}_w$</td>
</tr>
<tr>
<td>4, 6, 7</td>
<td>$Q; s \rightarrow p; {s, \neg s}$</td>
<td>$\text{Im}$</td>
</tr>
<tr>
<td>4</td>
<td>$Q; p \lor q, r \perp s \perp u, r \leftrightarrow q; {u, \neg u}$</td>
<td>$\text{Im}_w$</td>
</tr>
<tr>
<td>4</td>
<td>$Q; p \lor q, r \perp s \perp u, r \leftrightarrow q, \neg s; {u, \neg u}$</td>
<td>$\text{Im}, \text{Im}_w$</td>
</tr>
</tbody>
</table>

Table 1. Weak and canonical e-implications

Now we are in a position to present a more general overview of the solutions to the considered ER task. In Table 2 a statistics of the solutions chosen by the subjects is given.
As we mentioned above, criterion of correctness of each of ER tasks consists not only of correct choice of the question-solution but also of a proper justification to the choice, based on two conditions of validity of erotetic implication. Some of the subjects who have chosen the normatively correct solution (i.e., the question “Was the bomb planted by John?”) did not meet requirements for its proper justification: 9.8% of them have given justifications modeled by weak e-implication while 3.3% have given solutions for which we were unable to find a formal model within our framework. Of all the subjects, 57.5% have given the normatively correct justification modeled by canonical e-implication, 33.1% have given justifications modeled by weak e-implication. The remaining 9.4% have given solutions for which we were unable to find a formal model (see example 5).

Models based on weak erotetic implication account well for reasoning of subjects who solve ER tasks choosing partially useful questions. However, these solutions can be represented in terms of canonical e-implication as well, in a way emulating its weaker version.

We shall elaborate this issue on an example of asking a sequence of questions in order to solve the task. Some of the subjects pointed out that a viable solution would be to ask if the bomb has been planted by Steve and then, in case the answers is negative, if the bomb has been planted by someone else than Steve or John (this solution is somewhat similar to that of example 4). Clearly, the question about Steve (\(?\{s, \neg s\}\)) is only partially useful in solving the initial problem and thus it is only weakly e-implied in this context. The second question is also only partially useful and also only weakly e-implied by the initial question and declarative premises. The relevant scenario is presented in Figure 6.
This scenario can be interpreted as representing a strategy for solving the initial problem in the sense proposed by Hintikka. Not all inferential steps are ‘safe’ here (from the normative point of view of canonical e-implication), but combined they lead to a valid solution. Notice also, that if ¬s is added to the declarative premises, the question ?{u, ¬u} becomes canonically e-implied by the initial problem and extended set of declarative premises (the same holds in the case of the scenario given in example 4).

The fact that both queries of the above scenario are not canonically e-implied by the initial question and declarative premises stems from a particular property of canonical e-implication. Namely, this relation is not transitive: the facts that Q₁ e-implies Q₂ on the basis of X and that Q₂ e-implies Q₃ on the basis of X does not warrant that Q₁ e-implies Q₃ on the basis of X.

Consider the next scenario (Figure 7) which differs from the previous one with respect to one additional auxiliary question: ?{s∧u, s∧¬u, ¬s∧u, ¬s∧¬u}.
Let us label it by $Q_c$, as it is a conjunctive question (see Urbański, 2001, p. 76). $Q_c$ is canonically e-implied by the initial question on the basis of the declarative premises. Also, $Q_c$ canonically e-implies both $\{s, \neg s\}$ and $\{u, \neg u\}$ (no declaratives needed). However, as we mentioned above, neither of these two questions is canonically e-implied by the initial one and declarative premises.

$Q_c$ is not a query of this scenario, as it is not answered in it. Its only role is to provide a bridge over an e-implicational gap between the initial question and the queries of the scenario. From the formal point of view, $Q_c$ is just processed in order to arrive at the queries. The same holds in case of the question $\{s, \neg s \land u, \neg s \land \neg u\}$ in the next scenario (Figure 8).

Such ‘bridging’ questions are very useful in modeling erotetic reasoning by means of canonical e-implication. However, they are not present in subjects’ justifications. Thus modeling the solutions by means of weak e-implication introduces an important descriptive factor into the formal framework of IEL.

6. Conclusion

There is only a little exaggeration in saying that fluency in erotetic inferences is a landmark of intelligence. Extended framework of IEL allows for modeling of such inferences from all the three interesting perspectives: normative, prescriptive and descriptive. In particular, weak erotetic implication is a useful tool for formally addressing the issue of strategic component of reasoning with questions. We need to acknowledge that, even with weakened condition of cognitive usefulness, our analysis is constrained by the condition of transmission of truth/soundness into soundness. As we aimed here at modeling certain class of inferences, forming erotetic counterparts to deductive problem solving, this is not a major limitation in the context of reasoning underlying solutions to Erotetic Reasoning Test task. Nevertheless, further research on even weaker versions of e-implication are needed in order to account for erotetic inferences which do not involve deductive reasoning.

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