Question Answers*

Paweł Łupkowski**
Institute of Psychology / Adam Mickiewicz University, Poznań
Jonathan Ginzburg†
CLILLAC-ARP & LLF (UMR 7110) & LabEx-EFL / Université Paris-Diderot (Paris 7)

In this article we consider the phenomenon of answering a query with a query. Although such answers are common, no large scale, corpus–based characterization exists, with the exception of clarification requests. After briefly reviewing different theoretical approaches on this subject, we present a corpus study of query responses in the British National Corpus and develop a taxonomy for query responses. We point at a variety of response categories that have not been formalized in previous dialogue work, particularly those relevant to adversarial interaction. We show that different response categories have significantly different rates of subsequent answer provision. We sketch a formal analysis of the response categories in the frameworks of KoS and Inferential Erotetic Logic.

1. Introduction

Responding to a query with a query is a common occurrence, representing on a rough estimate more than 20% of all responses to queries found in the British National Corpus (BNC).¹ Research on dialogue has long recognized the existence of such responses. However, with the exception of one of its subclasses—albeit a highly substantial one—the class of query responses has not been characterized empirically in previous work.

The class that has been studied in some detail are Clarification Requests (thereafter referred to as CRs) (see (Purver, Ginzburg, and Healey 2001; Rodriguez and Schlangen 2004; Rieser and Moore 2005)). However, CRs can be triggered by any utterance, interrogative or otherwise. Researchers on the semantics and pragmatics of questions (see e.g. (Carlson 1983; Wiśniewski 2003)) have been aware for many years of the existence of one class of query responses — responses that express questions dependent on the question they respond to, as in (1a,b). This led Carlson to propose (1d) as a sufficient condition for a query response (cf. (1a,c)), which can be formalized using (1e), assuming notions of resolvedness and aboutness (for which see e.g. (Ginzburg and Sag 2000)).

(1)

a. A: Who murdered Smith? B: Who was in town?

b. A: Who is going to win the race? B: Who is going to participate?

* This is a much extended version of the article ‘A corpus-based taxonomy of question responses’ presented at the 10th International Conference on Computational Semantics (IWCS), Potsdam, March 2013. We thank the IWCS 2013 referees and the audience for their many useful comments and suggestions. We would also like to give our thanks to D. Leszczyńska-Jasien, K. Paluszkiewicz, M. Urbasński and A. Wiśniewski for their help and comments on this article.

** Email: Pawel.Lupkowski@amu.edu.pl
† Email: yonatan.ginzburg@univ-paris-diderot.fr

¹ In the spoken part of the BNC, using SCoRE (Purver 2001), we found 9 279 ?/? cross-turn sequences, whereas 41 041 ?/. cross-turn sequences, so the ?/? pairs constitute 22.61%.

© 2005 Association for Computational Linguistics
c. Who killed Smith depends on who was in town at the time.
d. $q_2$ can be used to respond to $q_1$ if $q_1$ depends on $q_2$.
e. $q_1$ depends on $q_2$ iff any proposition $p$ such that $p$ resolves $q_2$, also satisfies $p$ entails $r$ such that $r$ is about $q_1$.

An alternative characterization of the dependency relation between a question and a question-reply is provided within the framework of Inferential Erotetic Logic (IEL) (cf. (Wiśniewski 1995, 2012)). In IEL, the central notion used to express dependency between question – question-reply is *erotetic implication* (e-implication). E-implication is a semantic relation between a question, $Q$, a (possibly empty) set of declarative well formed formulas, $X$, and a question, $Q_1$. For (formal) languages which allow for disjunction it is defined as follows (Wiśniewski 1995):

(2) A question $Q$ implies a question $Q_1$ on the basis of a set of d-wffs $X$ (in symbols: $\text{Im}(Q, X, Q_1)$) iff

(i) 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

(ii) for each direct answer $B$ to the question $Q_1$, there exist a non-empty proper subset $Y$ of the set of direct answer to the question $Q$ such that $X \cup \{B\}$ entails the disjunction of all the elements of $Y$.

If $X = \emptyset$, we say that $Q$ implies $Q_1$ and we write $\text{Im}(Q, Q_1)$.

Intuitively, e-implication ensures the following: (i) if $Q$ has a true direct answer and $X$ consists of truths, then $Q_1$ has a true direct answer as well (‘transmission of soundness’ and truth into soundness’—cf. (Wiśniewski 2003, page 401)), and (ii) each direct answer to $Q_1$, if true, provided that all elements of $X$ are true, narrows down the class at which a true direct answer to $Q$ can be found (‘open-minded cognitive usefulness’—cf. (Wiśniewski 2003, page 402)). Example (19) in Section 5 presents e-implication in action.

A similar (but informal) approach is proposed by (van Kuppevelt 1995). In this approach topicality is the general organizing principle in discourse. The topic (for a discourse unit) is provided by the explicit or implicit question. Van Kuppevelt does not consider simple question – question-reply pairs, but rather speaks about discourse units. However, the relation between such units its determined by the relation between these topic-providing questions. From our perspective the most interesting is the notion of subtopic-constituting subquestion:

(3) An explicit or implicit question $Q_p$ is a subtopic-constituting subquestion if it is asked as the result of an unsatisfactory answer $A_{p-n}$ to a preceding question $Q_{p-n}$ with the purpose of completing $A_{p-n}$ to a satisfactory answer to $Q_{p-n}$.

(van Kuppevelt 1995, page 125)

It is worth noting that in the approaches presented above the source for question generation is a lack of information (that would enable a (propositional) answer to be given.). Nonetheless, other question generation mechanisms have been noticed in the

---

2 A question $Q$ is *sound* iff it has a true direct answer (with respect to the underlying semantics).
literature. (Graesser, Person, and Huber 1992) propose four question generation mechanisms for natural settings (especially in educational contexts). The first group consists of knowledge deficit questions. The other three groups are: common ground questions, social coordination questions and conversation-control questions. Common ground questions, like ‘Are we working on the third problem?’ or ‘Did you mean the independent variable?’, are asked to check whether knowledge is shared between dialogue participants. Social coordination questions relate to different roles of dialogue participants, such as in student – teacher conversations. Social coordination questions are requests for permission to perform a certain action or might be treated as indirect request for the the addressee to perform such an action (e.g., ‘Could you graph these numbers?’; ‘Can we take a break now?’). Conversation-control questions, as it is indicated by their name, aim at manipulating the flow of a dialogue or the attention of its participants (e.g., ‘Can I ask you a question?’).

Larsson (2002) and Asher and Lascarides (2003) argue that the proper characterization of question responses is pragmatically based. Asher and Lascarides (2003) propose to characterize non-CR query responses by means of the rhetorical relation of question elaboration (Q-Elab) with stress on the plan-oriented relation between the initial question and the question expressed by the response. Q-Elab might be informally summarized as follows:

(4) If Q-Elab(α, β) holds between an utterance α uttered by A, where g is a goal associated by convention with utterances of the type α, and the question β uttered by B, then any answer to β must elaborate a plan to achieve g.

The relation of Q-Elab, motivated by interaction in cooperative settings, is vulnerable to examples such as those in (5). There is a reading of (5a) that can be characterized by using dependence (What I like depends on what YOU like), but it can also be used simply as a coherent retort. (5b) could possibly be used in political debate without necessarily involving any attempt to discover an answer to the first question asked.

    b. A: What is Sarkozy going to do about it? B: What is Papandreou?

In order to better understand the nature of question responses, we ran a corpus study on the British National Corpus (BNC). The results we obtained, discussed in Section 3 of the article, show that, apart from CRs, dependent questions are indeed by far the largest class of question responses. However, they reveal also the existence of a number of response categories, characterizable neither as dependent questions nor as plan supporting responses. They include

- a class akin to what Conversation Analysts refer to as counters (Schegloff 2007)—responses that attempt to foist on the conversation a distinct issue from the current discourse topic and
- responses that ignore the current topic but address the situation it concerns.

Attaining completeness in characterizing the response space of a query is of fundamental importance for dialogue management and the design of user interfaces. Beyond that general goal, a better understanding of e.g. counters and situation-relevant responses is important for adversarial interaction (courtroom, interrogation, argumentation, certain
games). Characterizing their coherence is challenging for all approaches that ground dialogue on cooperativity principles (e.g. (Asher and Lascarides 2003; Roberts 2011)).

The rest of the article is structured as follows: in Section 2 we present the taxonomy underlying our corpus study; Sections 3 and 4 describe the results; in Section 5 we sketch a formal analysis of the response categories in the framework of KoS and IEL. We conclude with a summary and future work.

2. A corpus-based taxonomy of question answers

In this section we present a corpus based taxonomy of query responses. It was designed on the basis of 1051 examples of query – query-response pairs obtained from BNC. Initially, examples were obtained by using the search engine SCoRE (Purver 2001). Subsequently, cross talk and tag questions were eliminated manually. The annotation was performed by the first author; we discuss the reliability of this annotation in Section 3. In what follows we describe and exemplify each class of the resulting taxonomy. To make the description clearer we will use $q_1$ for the initial question posed and $q_2$ for a question given as a response to $q_1$. The taxonomy is focused on the function of $q_2$ in the dialogue.

2.1 Clarification requests (CR)

Clarification requests are all question-replies that concern the content or form of $q_1$ that was not completely understood. This class contains intended content queries (see example 6a), repetition requests (example 6b) and relevance clarifications (example 6c). In this article we will not consider this class in detail, mainly because of existing, detailed work on this subject (e.g. (Purver 2006; Ginzburg 2012)).

(6) a. A: What’s Hamlet about?
   B: Hamlet? [KPW, 945–946]  
   b. A: Why are you in?
   B: What?
   A: Why are you in? [KPT, 469–471]
   c. A: Is he knocked out?
   B: What do you mean? [KDN, 3170–3171]

2.2 Dependent questions (DP)

By a dependent question we understand $q_2$ where a dependency statement as in (1e; see page 1) could be assumed to be true. The following examples illustrate this:

(7) a. A: Do you want me to <pause> push it round?
   B: Is it really disturbing you? [FM1, 679–680]
   (cf. Whether I want you to push it depends on whether it really disturbs you.)
   b. A: Any other questions?
   B: Are you accepting questions on the statement of faith at this point? [F85, 70–71]
   (cf. Whether more questions exist depends on whether you are accepting questions on the statement of faith at this point.)

---

3 This notation indicates the BNC file (KPW) together with the sentence numbers (945–946).
2.3 ‘How should I answer this?’ questions (FORM)

This class consists of question-responses addressing the issue of the *way* the answer to $q_1$ should be given. In other words, whether the answer to $q_1$ will be satisfactory to A depends on $q_2$. This relation between $q_1$ and $q_2$ might be noticed in the following examples. Consider (8a). The way B answers A’s question in this case will be dictated by A’s answer to $q_2$ — whether or not A wants to know details point by point.

(8) a. A: Okay then, Hannah, what, what happened in your group?
   B: Right, do you want me to go through every point? [K75, 220–221]
b. A: Where’s that one then?
   B: Erm, you know Albert Square? [KBC, 506–507]
c. A: Another thing I found out today was do we know where our main supplier of our coffee is.
   Any guesses?
   B: Which country? [G3U, 251–253]

2.4 Requests for underlying motivation (MOTIV)

In the case of requests for underlying motivation $q_2$ addresses the issue of the motivation underlying asking $q_1$. Whether an answer to $q_1$ will be provided depends on the answer to $q_2$ (i.e. providing proper reasons for asking $q_1$). In this aspect this class differs from the previous ones, where we may assume that an agent wishes to provide an answer to $q_1$. Most of question-answers of this kind are of the form ‘Why?’ (32 out of 41 gathered examples, see example 9a), but also other formulations were observed (8 out of 41, see examples 9b and 9c). Most direct questions of this kind are: *What’s it got to do with you?; What’s it to you?; Is that any of your business?; What’s that gotta do with anything?*.

(9) a. A: What’s the matter?
   B: Why? [HDM, 470–471]
b. A: Out, how much money have you got in the building society?
   B: What’s it got to do with you? [KBM, 2086–2087]
c. A: Just what the fucking do you think you’re doing?
   B: Is that any of your business? [KDA, 1308–1309]

2.5 ‘I don’t want to answer your question’ (NO ANSW)

The role of query responses of this class is to give a clear signal that an agent does not want to provide an answer to $q_1$. Instead of answering $q_1$ the agent provides $q_2$ and attempts to “turn the table” on the original querier, as exemplified in examples (10 a–b).

(10) a. A: Yeah what was your answer?
   B: What was yours? [KP3, 636–637]
b. A: Sorry why therefore have you virtually abandon[ed] your students standby scheme?
   B: Are you saying you’d like to see that re-introduced? [D91, 222–224]
c. A: Why is it recording me?
   B: Well why not? [KSS, 43–44]

2.6 Indirect answers/responses (QA/IND)

This class consists of query responses, which provide (indirectly) an answer to \( q_1 \). Interestingly, providing answer to \( q_2 \) is not necessary in this case. Consider (11a). By asking the question *Do you know how old this sweater is?*, B clearly suggests that the answer to A’s question is negative. Moreover, B does not expect to obtain an answer to his/her question. This might also be observed in examples (11b) (*of course I am Gemini*) and (11c) (*no, my job is not safe*).

(11) a. A: Is that an early Christmas present, that sweater?
   B: Do you know how old this sweater is? [HM4, 7–8]

   b. A: Are you Gemini?
   B: Well if I’m two days away from your, what do you think? [KPA, 3603–3604]

   c. A: Is your job safe?
   B: Well, whose job’s safe? [G5L, 130–131]

Another means of providing indirect answers can also be observed in the corpus data. These are cases in which by asking \( q_2 \) an agent already presupposes the answer to \( q_1 \). (12a) illustrates this—we note that a positive answer to \( q_1 \) is presupposed in B’s question. A similar situation can be observed in examples (12b) (*no, I have not tasted this*) and (12c) (*I will help you*).

(12) a. A: I’ve got to do the washing up?
   B: Shall I, shall I come and help you? [KPU, 1861–1862]

   b. A: have you tasted this?
   B: are they nice? [KPY, 653–654]

   c. A: Will you help with the <pause> the paint tonight?
   B: What can I do? [KE4, 3263–3264]

2.7 ‘I ignore your question’ (IGNORE)

The final class in the taxonomy is somewhat harder to grasp. These are cases where \( q_2 \) does not address \( q_1 \), but is, nonetheless, related to the situation associated with \( q_1 \). This is evident in example (13c). A and B are playing Monopoly. A asks a question, which is ignored by B. It is not that B does not want to answer A’s question and that’s why he/she asks \( q_2 \). Rather, B ignores \( q_1 \) and asks a question related to the situation (in this case the board game).

(13) a. A: Well do you wanna go down and have a look at that now?
   <pause> While there’s workmen there?
   B: Why haven’t they finished yet? [KCF, 617–619]

   b. A: Just one car is it there?
   B: Why is there no parking there? <unclear> [KP1, 7882–7883]

   c. A: I’ve got Mayfair <pause> Piccadilly, Fleet Street and Regent Street, but I never got a set did I?
   B: Mum, how much, how much do you want for Fleet Street? [KCH, 1503–1504]
Table 1
Dialogue domains in the research sample (BNC)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Frequency</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>free conversation</td>
<td>940</td>
<td>89.44</td>
</tr>
<tr>
<td>educational context (lesson, tutorial, training)</td>
<td>36</td>
<td>3.43</td>
</tr>
<tr>
<td>meeting (public meeting, seminar, conference)</td>
<td>27</td>
<td>2.57</td>
</tr>
<tr>
<td>radio broadcast</td>
<td>25</td>
<td>2.38</td>
</tr>
<tr>
<td>interview</td>
<td>15</td>
<td>1.43</td>
</tr>
<tr>
<td>medical consultation</td>
<td>4</td>
<td>0.38</td>
</tr>
<tr>
<td>TV broadcast</td>
<td>4</td>
<td>0.38</td>
</tr>
<tr>
<td>Total</td>
<td>1051</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2
Tags used to annotate question – question-answer sample

<table>
<thead>
<tr>
<th>Tag</th>
<th>question-answer type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>clarification requests</td>
</tr>
<tr>
<td>DP</td>
<td>dependent questions</td>
</tr>
<tr>
<td>FORM</td>
<td>questions considering the way of answering q1</td>
</tr>
<tr>
<td>MOTIV</td>
<td>questions about the underlying motivations behind asking q1</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>questions aimed at avoiding answering q1</td>
</tr>
<tr>
<td>QA</td>
<td>questions providing an answer to q1</td>
</tr>
<tr>
<td>IGNORE</td>
<td>questions ignoring q1</td>
</tr>
<tr>
<td>IND</td>
<td>questions with a presupposed answer</td>
</tr>
</tbody>
</table>

3. Results

As we noted, this study used a sample of 1051 query – query-response pairs from the BNC. The procedure for obtaining the sample was the following. First the search engine SCoRE was used on the whole spoken part of the BNC using as the search string ? $ | $4. Following this, the search results were checked manually. The collected sample covers a wide range of dialogue domains, like interviews, radio and TV broadcasts, tutorials, meetings, training sessions or medical consultations (blocks D, F, G, H, J, K of the BNC). The summary of dialogue domains for the sample is presented in Table 1.

The sample was classified and annotated by the first author with tags presented in Table 2. To guide the classification process we used the decision tree containing the following questions:

1. (CR) Is $q_2$ a query about something not completely understood in $q_1$?
2. (DP) Is it the case that the answer to $q_1$ depends on the answer to $q_2$?
3. (MOTIV) Does $q_2$ address the motivation underlying asking $q_1$?

4 ‘?’ $|$ expression would match any sentence/turn with a question mark at the end and the pipe character matches the break between sentences/turns. For more details about the SCoRE syntax see http://www.dcs.qmul.ac.uk/imc/ds/score/help.html
Table 3
Frequency of question – question-answer categories in the BNC. The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>832</td>
<td>79.16</td>
</tr>
<tr>
<td>DP</td>
<td>108</td>
<td>10.28 (49)</td>
</tr>
<tr>
<td>MOTIV</td>
<td>41</td>
<td>3.90 (18)</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>26</td>
<td>2.47 (12)</td>
</tr>
<tr>
<td>FORM</td>
<td>16</td>
<td>1.52 (7)</td>
</tr>
<tr>
<td>QA</td>
<td>13</td>
<td>1.24 (6)</td>
</tr>
<tr>
<td>IND</td>
<td>9</td>
<td>0.85 (4)</td>
</tr>
<tr>
<td>IGNORE</td>
<td>6</td>
<td>0.57 (3)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1051</strong></td>
<td><strong>(219) 100</strong></td>
</tr>
</tbody>
</table>

Table 4
Answers provided to query responses (BNC) in % of the total for categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Ans. to q2</th>
<th>Ans. to q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP</td>
<td>76.85</td>
<td>62.96</td>
</tr>
<tr>
<td>MOTIV</td>
<td>78.05</td>
<td>51.22</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>80.77</td>
<td>11.54</td>
</tr>
<tr>
<td>FORM</td>
<td>68.75</td>
<td>81.25</td>
</tr>
<tr>
<td>QA</td>
<td>53.85</td>
<td>100</td>
</tr>
<tr>
<td>IGNORE</td>
<td>50</td>
<td>16.67</td>
</tr>
</tbody>
</table>

4. (NO ANSW) Is it the case that $q_2$ enables the speaker to avoid answering $q_1$ while attempting to force the other speaker to answer $q_2$ first?

5. (FORM) Is it the case that the way the answer to $q_1$ will be given depends on the answer to $q_2$?

6. (QA) Is it the case that $q_2$ is rhetorical and in this sense it does not need to be answered and provides (indirectly) an answer to $q_1$?

7. (IGNORE) Does $q_2$ relate to the situation described by $q_1$?

The results of the performed classification are presented in Table 3. The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

Putting aside CRs, the majoritarian class is indeed DP. What is striking is the relatively large frequency of adversarial responses (the classes MOTIV, NO ANSW, IGNORE). The FORM class, as we discuss below, is the sole class whose coherence clearly requires reasoning about the querier’s intentions. It is relatively infrequent.

We also compared which query categories lead to a subsequent answer, either about $q_2$ or about $q_1$. The results to this are in Table 4. Strikingly, in the adversarial categories there was a relative dearth of responses to $q_1$, whereas, $q_2$ on the whole does get answered (less so in QA, as would be expected from its definition).
Annotation reliability. As we mentioned above, the annotation process was performed by the first author. In order to check the reliability of the classification process, the decision tree was tested by three other annotators. For this purpose a sample of 100 randomly chosen examples of query-query-response was used. Ten examples were eliminated from the initial sample after further consideration suggested they should be classified as tag questions. The distribution of the classes was in line with the distribution observed by the primary annotator: CR: 39 examples; DP: 18 examples; MOTIV: 10 examples; NO ANSW: 10 examples; FORM: 4 examples; QA: 4 examples; IGNORE: 3 examples; OTHER: 2 examples. Annotators were given the sample of 90 question-question pairs and the decision tree. The instruction was to annotate question-reply to the first question in each example. Some of the examples were enriched with additional context (for \( q_2 \)). Two annotators reported that the annotation task would be easier if the context would be present for all examples.

The reliability of the annotation was evaluated using \( \kappa \) (cf. (Carletta 1996)). The agreement on the coding of the control sample by four annotators was moderate (Fleiss \( \kappa = 0.44, SE = 0.0206, 95\% CI = 0.3963 \text{ to } 0.4770 \)). One of the control sample’s annotators is an experienced linguist with extensive past work with dialogue transcripts. In this case agreement on the coding was strong (71\% agreement with Cohen’s \( \kappa = 0.62, SE = 0.0637, 95\% CI = 0.4902 \text{ to } 0.7398 \)). Two other control sample annotators are logicians, but with little experience in corpus annotation. For them agreement on the coding was somewhat lower, i.e. moderate (66\% agreement with Cohen’s \( \kappa = 0.56, SE = 0.0649, 95\% CI = 0.4266 \text{ to } 0.6810 \); and 54\% agreement with Cohen’s \( \kappa = 0.42, SE = 0.0674, 95\% CI = 0.2829 \text{ to } 0.5472 \)).

The most unproblematic cases were CR, MOTIV and IGNORE (the largest groups of examples with at least 3 annotators’ agreement). Also DP, NO ANSW and QA had high agreement between annotators. The main problem was with the FORM class. We suppose that this is caused by the lack of the clarity in the question introducing this class in the decision tree (‘The way the answer to \( q_1 \) will be given depends on the answer to \( q_2 \), while for DP it was ‘Is it the case that the answer to \( q_1 \) depends on the answer to \( q_2 \)?’). Feedback from two of three control sample annotators reported this as a confusing case.

There were two cases in the control sample on which annotators completely disagreed. These were the following:

(14) a. A: You know the one you just took out? B: You want it back? [F77, 86–87]


4. Class distribution over specific genres

We conducted our study in the BNC since it is a general corpus with a variety of domains and genres. However, we wanted also to check how the classes are distributed in more genre specific corpora. To do this we decided to study the following corpora:

- Child Language Data Exchange System (CHILDES), which contains adult-child conversations.
- Basic Electricity and Electronics Corpus (BEE), which contains tutorial dialogues from electronics course.

\( ^5 \) All the data established with http://www.stattools.net. Access 25.11.2012.
Table 5

Frequency of question – question-answer categories (CHILDES). The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>319</td>
<td>88.12</td>
</tr>
<tr>
<td>DP</td>
<td>11</td>
<td>3.04</td>
</tr>
<tr>
<td>MOTIV</td>
<td>2</td>
<td>0.55</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>5</td>
<td>1.38</td>
</tr>
<tr>
<td>FORM</td>
<td>3</td>
<td>0.83</td>
</tr>
<tr>
<td>QA</td>
<td>2</td>
<td>0.55</td>
</tr>
<tr>
<td>IND</td>
<td>3</td>
<td>0.83</td>
</tr>
<tr>
<td>IGNORE</td>
<td>17</td>
<td>4.70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>326 (43)</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 6

Frequency of question – question-answer categories (BEE). The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>10</td>
<td>22.22</td>
</tr>
<tr>
<td>DP</td>
<td>28</td>
<td>62.22 (80)</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>6</td>
<td>13.33 (17.14)</td>
</tr>
<tr>
<td>IGNORE</td>
<td>1</td>
<td>2.22 (2.86)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>45 (35)</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

- SRI/CMU American Express dialogues (AMEX), which contains travel agents conversations.

As in the case of the BNC study, examples were initially obtained by using the search engine SCoRE. Subsequently, cross talk and tag questions were eliminated manually. Subsequently, the annotation was performed by the first author (guided by the decision tree). 362 examples were obtained from the sample of the CHILDES corpus (files bates, belfast, manchester/anne); 45 examples were obtained from the whole BEE corpus and 8 from the whole AMEX corpus (the low numbers for BEE and AMEX are caused by the significantly smaller size of these corpora in comparison to BNC and CHILDES). The results of the performed classification are presented in Tables 5, 6 and 7. The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

As is apparent, the DP class is the second largest class in the CHILDES corpus and is the largest class in the task oriented dialogues obtained from the BEE and AMEX corpora. As for the adversarial classes (MOTIV, NO ANSW, IGNORE), these are very rare in task oriented dialogues. One exception is the NO ANSW class in the case of BEE corpus. Here the percentage of NO ANSW questions is even higher than in the BNC and CHILDES. This type of question-response is used in a teaching context to force a student to provide his/her answer to the teacher’s question. When it comes to the CHILDES corpus, a large percentage of IGNORE question-responses was observed—in all gathered examples it was a child, who used this kind of question-response. One can
Table 7
Frequency of question – question-answer categories (AMEX). The parenthesized percentage is the category’s percentage of the sample that excludes CRs.

<table>
<thead>
<tr>
<th>Category</th>
<th>Frequency</th>
<th>% of the Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>1</td>
<td>12.5</td>
</tr>
<tr>
<td>DP</td>
<td>7</td>
<td>87.5 (100)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8 (7)</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

BNC: 49%
DP
CHILDES: 25.58%
BEE: 80%
AMEX: 100%

BNC: 18%
MOTIV
CHILDES: 4.67%

BNC: 12%
NO ANSW
CHILDES: 11.67%
17.14%

BNC: 7%
FORM
CHILDES: 6.98%

BNC: 6%
QA
CHILDES: 4.65%

BNC: 3%
IGNORE
BEE: 2.86%
CHILDES: 39.53%

Figure 1
Summary of the classes distribution over the corpora (in % of the total, without CRs)

also note that for NO ANSW, FORM and QA the frequency is similar for CHILDES and BNC corpora. The summary of the classes’ distribution in the BNC, CHILDES, AMEX and BEE is presented in Figure 1.

We also compared which query categories lead to a subsequent answer, either about \( q_2 \) or about \( q_1 \). Results are presented in Table 8. In terms of answer analysis, task oriented dialogues are interesting in the context of the DP question-answer class. For all observed examples, an answer was provided to \( q_2 \) and to \( q_1 \) (one example from BEE and one example form AMEX could not be verified, since the corpora file ended).

5. Modeling Query Response Categories in KoS and in Inferential Erotetic Logic

5.1 Dialogue Gameboards, Conversational Rules, and Dialogical Relevance

We offer a formal explication of the coherence that underlies the various different types of query responses within the framework of KoS (Ginzburg and Fernández 2010;
Table 8
Answers provided to query responses (CHILDES, BEE and AMEX) in % of the total for categories

<table>
<thead>
<tr>
<th>Category</th>
<th>CHILDES</th>
<th>BEE</th>
<th>AMEX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ans. to q</td>
<td>Ans. to q</td>
<td>Ans. to q</td>
</tr>
<tr>
<td>DP</td>
<td>72.73</td>
<td>43.43</td>
<td>96.43</td>
</tr>
<tr>
<td>MOTIV</td>
<td>50</td>
<td>0</td>
<td>–</td>
</tr>
<tr>
<td>NO ANSW</td>
<td>80</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>FORM</td>
<td>100</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>QA</td>
<td>0</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>IGNORE</td>
<td>70.59</td>
<td>5.88</td>
<td>0</td>
</tr>
</tbody>
</table>

Ginzburg 2012) and — in the case of DP question-answers — in IEL.\(^6\) KoS is a framework for dialogue whose logical underpinning is Type Theory with Records (TTR) (Cooper 2005, 2012) and which underlies dialogue systems such as GoDIS and CLARIE (Larsson 2002; Purver 2006). On the approach developed in KoS, there is actually no single context — instead of a single context, analysis is formulated at a level of information states, one per conversational participant. The type of such information states is given in (15a). We leave the structure of the private part unanalyzed here, as with one exception all our characterizations do not make reference to this; for one approach to private, see e.g. (Larsson 2002). The dialogue gameboard represents information that arises from publicized interactions. Its structure is given in (15b) — the spkr, addr fields allow one to track turn ownership, Facts represents conversationally shared assumptions, Pending and Moves represent respectively moves that are in the process of/have been grounded, QUD tracks the questions currently under discussion:

\[(15)\]  
\[
\text{a. TotalInformationState (TIS)} = \text{def } \left[ \begin{array}{l} \text{dialoguegameboard : DGB} \\ \text{private : Private} \end{array} \right]
\]

\[
\text{b. DGBType} = \text{def } \\
\left[ \begin{array}{l} \text{spkr: Ind} \\ \text{addr: Ind} \\ \text{utt-time : Time} \\ \text{c-utt : addressing(spkr,addr,utt-time)} \\ \text{Facts : Set(Proposition)} \\ \text{Pending : list(locutionary Proposition)} \\ \text{Moves : list(locutionary Proposition)} \\ \text{QUD : poset(Question)} \end{array} \right]
\]

The basic units of change are mappings between dialogue gameboards that specify how one gameboard configuration can be modified into another on the basis of dialogue moves. We call a mapping between DGB types a conversational rule. The types specifying its domain and its range we dub, respectively, the preconditions and the effects, both of which are supertypes of DGBType. We explain shortly how this allows one to capture the coherence of responses.

\(^6\) We believe that most of the relevant notions of IEL could be reformulated within KoS, but we will not attempt to do so in the current paper.
We start by characterizing the moves that typically involve accepting a question $q_1$ into the DGB. The potential for DP responses is explicated on the basis of the two conversational rules in (16a,b): (16a) says that given a question $q$ and $\text{ASK}(A,B,q)$ being the LatestMove, one can update QUD with $q$ as QUD–maximal. QSPEC is what characterizes the contextual background of reactive queries and assertions. (16b) says that if $q$ is QUD–maximal, then subsequent to this either conversational participant may make a move constrained to be $q$–specific (16c).\footnote{These rules employ a number of abbreviatory conventions. First, instead of specifying the full value of the list Moves, we record merely its first member, which we call ‘LatestMove’. Second the preconditions can be written as a merge of two record types $DGBTy$\textsuperscript{e} $\land_{\text{merge}}$ $\text{PreCondSpec}$, one of which $DGBTy$\textsuperscript{e} is a supertype of DGBTy and therefore represents predictable information common to all conversational rules; $\text{PreCondSpec}$ represents information specific to the preconditions of this particular interaction type. Similarly the effects can be written as a merge of two record types $DGBTy$\textsuperscript{0} $\land_{\text{merge}}$ $\text{ChangePrecondSpec}$, where $DGBTy$\textsuperscript{0} is a supertype of the preconditions and $\text{ChangePrecondSpec}$ represents those aspects of the preconditions that have changed. So we can abbreviate conversational rules as in (i); the unabbreviated version of $\text{Ask QUD–incrementation}$ would be as in (ii):}

(16) a. $\text{Ask QUD–incrementation}$

$$\begin{align*}
\text{pre} : & \quad \text{LatestMove} = \text{Ask}(\text{spkr},\text{addr},q) : \text{IllocProp} \\
\text{effects} : & \quad \text{qud} = \langle q,\text{pre.qud} \rangle : \text{poset(\text{Question})}
\end{align*}$$

(i) $\begin{align*}
\text{pre} \quad : & \quad \text{PreCondSpec} \\
\text{effects} \quad : & \quad \text{ChangePrecondSpec}
\end{align*}$

(ii) $\begin{align*}
\text{pre} : & \quad \text{spkr} : \text{Ind} \\
& \quad \text{addr} : \text{Ind} \\
& \quad \text{utt-time} : \text{Time} \\
& \quad \text{c-utt} : \text{addressing}(\text{spkr},\text{addr},\text{utt-time}) \\
\text{pre} : & \quad \text{Facts} : \text{Set(Proposition)} \\
& \quad \text{Pending} : \text{list(\text{locutionary Proposition}}) \\
& \quad \text{q} : \text{Question} \\
\text{Moves} = & \quad \langle \text{Ask}(\text{spkr},\text{addr},q), m_0 \rangle \text{ list(\text{locutionary Proposition})} \\
\text{QUD} : & \quad \text{poset(\text{Question})} \\
\text{spkr} = & \quad \text{pre.spkr} : \text{Ind} \\
\text{addr} = & \quad \text{pre.addr} : \text{Ind} \\
\text{utt-time} = & \quad \text{pre.utt-time} : \text{Time} \\
\text{c-utt} = & \quad \text{addressing}(\text{spkr},\text{addr},\text{utt-time}) \\
\text{pre} : & \quad \text{Facts} = \text{pre.Facts} : \text{Set(Proposition)} \\
& \quad \text{Pending} = \text{pre.Pending} : \text{list(\text{locutionary Proposition})} \\
\text{Moves} = & \quad \text{pre.Moves} : \text{list(\text{locutionary Proposition})} \\
\text{qud} = & \quad \langle \text{pre.q,pre.qud} \rangle : \text{poset(\text{Question})}
\end{align*}$
b. QSPEC

\[
\begin{aligned}
\text{pre : } & \quad \text{qud} = \langle q, Q \rangle : \text{poset(}\text{Question}\rangle \\
\text{effects : } & \quad \text{TurnUnderspec} \land \text{merge} \\
& \quad \text{r : AbSemObj} \\
& \quad \text{R : IllocRel} \\
& \quad \text{LatestMove} = \text{R} (\text{spkr}, \text{addr}, r) : \text{IllocProp} \\
& \quad \text{c1 : Qspecific(r,q)}
\end{aligned}
\]

\[\]

c. q-specific utterance: an utterance whose content is either a proposition \(p\) About \(q\) or a question \(q_1\) on which \(q\) Depends

We can exemplify how this works. (17a) is a record that satisfies the preconditions of the type (16a), in other words is the appropriate context for Ask QUD–incrementation. The output of that rule is (17b):

\[
\begin{align*}
\text{(17)} \\
a. & \quad \text{spkr} = A \\
& \quad \text{c1} = p1 \\
& \quad \text{addr} = B \\
& \quad \text{c2} = p2 \\
& \quad \text{r} = q0 \\
& \quad \text{LatestMove} = \text{Ask}(A,B,q) \\
& \quad \text{qud} = \langle \rangle \\
& \quad \text{facts} = cg1 \\
\end{align*}
\]

\[
\begin{align*}
b. & \quad \text{spkr} = A \\
& \quad \text{addr} = B \\
& \quad \text{r} = q0 \\
& \quad \text{LatestMove} = \text{Ask}(A,B,q0) \\
& \quad \text{qud} = \langle q0 \rangle \\
& \quad \text{facts} = cg1
\end{align*}
\]

With this in hand, we can now turn to explaining how dialogical relevance gets handled in KoS. Pretheoretically, Relevance relates an utterance \(u\) to an information state \(I\) just in case there is a way to successfully update \(I\) with \(u\). (Ginzburg 2012) defines two notions of relevance, a simpler one at the level of moves, i.e. illocutionary contents of utterances, and a somewhat more complex one at the level of utterances. For expository simplicity, we restrict attention here to the former and refer the reader to (Ginzburg 2010, 2012) for the more complex notion.

The basic concept introduced here is contextual move–coherence defined in (18a) as applying to \(m_1\) and \(dgb_0\) just in case there is a conversational rule \(c_1\) which maps \(dgb_0\) to \(dgb_1\) and such that \(dgb_1\)’s LatestMove value is \(m_1\). Pairwise Move–Coherence, defined in (18b), applies to a pair of moves \(m_1, m_2\) if \(m_1\) is M–Coherent relative to some DGB \(dgb_0\) and there is a sequence of updates leading from LatestMove being \(m_1\) to LatestMove being \(m_2\). Finally, Sequential Move–Coherence, defined in (18c) applies to a sequence of moves \(m_1, \ldots, m_n\) just in case each successive pair of moves are Pairwise M–Coherent:
M(ove)–Coherence: Given a set of conversational rules $\mathcal{C}$ and a dialogue gameboard $dgb_0 : \text{DGBType}$, a move $m_1 : \text{IllocProp}$ is $m(\text{ove})_{dgb_0}$–coherent iff there exists $dgb_1 : \text{DGBType}, c_1 \in \mathcal{C}$ such that $c_1(dgb_0) = dgb_1$ and $dgb_1$.LatestMove = $m_1$.

Pairwise M(ove)–Coherence: Given a set of conversational rules $\mathcal{C}$ two moves $m_1, m_2$ are $m(\text{ove})$-pairwise-coherent iff there exists $dgb_0 : \text{DGBType}$ such that $m_1$ is $m(\text{ove})_{dgb_0}$–coherent and there exist $dgb_i, c_i, (1 \leq i \leq k - 1, dgb_i : \text{DGBType}, c_i \in \mathcal{C})$ such that $c_{i+1}(dgb_i) = dgb_{i+1}$ and $dgb_i$.LatestMove = $m_1$, whereas $dgb_k$.LatestMove = $m_2$.

Sequential M(ove)–Coherence: A sequence of moves $m_1, \ldots, m_n$ is $m(\text{ove})$-coherent iff for any $1 \leq i m_i, m_{i+1}$ are $m(\text{ove})$-pairwise-coherent.

5.2 Question Dependence and its Generation

In order to explicate how dependent questions might be generated we will use the framework of IEL and one of its central notions — e-implication, which we introduced in section 1. Let us consider (following (Urbański and Łupkowski 2010, p. 68)) a simple example of e-implication in action.

The initial question is:

(18) (Q) Who stole the tarts?

Suppose that I manage to establish the following evidence:

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

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

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

$Q^*$ restricts the search area to courtiers of the Queen of Hearts attending the party (i.e. it asks for more specific information than the initial question). What is more, providing the answer to $Q^*$ will certainly be helpful in obtaining the answer to the initial question $Q$.

Let us now take a closer look at some examples obtained from the corpus study. One of the problems that we encounter when analyzing these is the lack of explicit premises among those used by the dialogue participants. To perform the analysis we have to assume premises that are highly probable in the presented dialogue situation. Let us consider the example (20a). In this situation it would be plausible that the premise used by B would be something like $M$ in (20b).

(20) a. A: Do you want me to $\text{<pause>}$ push it round?
    B: Is it really disturbing you? [FM1, 679–680]

b. ?N: Do you want me to push it round?
   M: I want you to push it round iff it is disturbing you.

If we accept that B is using the introduced premise in this situation we may explain how the question-response is appearing using the following e-implication relation: $\text{Im}(?N, M \leftrightarrow N, ?M)$. In other words, B’s question (?)M is e-implied by A’s question (?)N ‘Do you want me to $\text{<pause>}$ push it round?’ on the basis of the declarative premise (M) ‘I want you to push it round iff it is disturbing you’.

15
In the same manner we can analyze examples (21a) and (22a). In both cases, we introduce a plausible premise taken by B and use different e-implication relations to show how B’s question is generated.

(21) a. A: Pound, five ounces, do you want a wee bit more?
    B: Er, erm <pause> can I see it? [KC0, 1812–1813]

b. ?N': do you want a wee bit more than a pound and five ounces?
   \[ N' \leftrightarrow M_1 \land M_2: \text{I want more than a pound and five ounces iff I can see it and I like it.} \]

Since the following hold: \( \text{Im}(?N', N' \leftrightarrow M_1 \land M_2, ?(M_1 \land M_2)) \); \( \text{Im}(?(M_1 \land M_2), ? \pm |M_1, M_2|^B) \); \( \text{Im}(? \pm |M_1, M_2|, ?M_0) \), we may say that in (21b) B’s question (?) \( M_1 \) is e-implied on the basis of the introduced declarative premise ‘I want more iff I can see it and I like it.’ which is represented formally as \( N' \leftrightarrow M_1 \land M_2 \).

(22) a. A: Shut up <pause> can I have a sarnie?
    B: Do you want one? [KBR, 1791–1792]

b. ?M"?: Can I have a sarnie?
   \[ M": \text{If you want a sarnie then you can have it.} \]

In the case of 22b we will use the following: \( \text{Im}(?N", M" \rightarrow N", ?(N", \neg N", M") \}
and \( \text{Im}(?\{N", \neg N", M"\}, ?M") \).

One important question arises in this context: is it always the case, that we have to introduce additional premises to analyze natural language examples. The answer is negative. There are certainly cases where the premises accepted by its participants are revealed in the dialogue. Consider an example taken from the BEE corpus.

(23) a. Tutor Can you tell me how current would flow? Would it flow only through the wire?
    Or only through the meter?
    Or through both?
    Or through neither?
    Student I don’t know.
    Tutor Is there any reason why it wouldn’t flow through the wire?
    Student I don’t know.
    Would the leads prevent or obstruct it in some way?
    Tutor No.
    If you know that the leads do not obstruct the current flow in any way, can you answer my question?
    Student I guess I’d have to say yes.
    The current would flow through both.
    Tutor Good.

We can simplify this conversation to show its structure more clearly:

(24) a. Tutor Can you tell me how current would flow? Would it flow only through the wire? Or only through the meter? Or through both? Or through neither?
    b. Student Would the leads prevent or obstruct it in some way?
    c. Tutor No.

---

8 Let us reiterate that \( \pm |B, C| \) is shorthand for a \textit{binary conjunctive question}, namely \( ?\{B \land C, B \land \neg C, \neg B \land C, \neg B \land \neg C\} \).

9 File: bee/FinalExperiment/Logs/log-stud48.htm
d. **Student** The current would flow through both.

(24a) is the initial problem/question, while (24d) is an answer to this question. What we want to explain is how the auxiliary question (24b) appeared. What is important in order to provide this explanation is what is really asked by the Tutor: *If you know that the leads do not obstruct the current flow in any way, can you answer my question?*. This statement points to the shared knowledge of Tutor and Student, i.e. that the current will flow through the wire and the meter *iff* the leads will not obstruct the current in any way. There are presumably other premises assumed by dialogue participants, but this one is clearly stated in the conversation.

The initial problem expressed by the Tutor, then, is a conjunctive question: $? \pm |N, M|$. The premise revealed in the dialogue is of the form: $N \land M \leftrightarrow \neg L$ (where $L$ = leads obstruct the current flow).

Since the following relation holds: $\text{Im}(? \pm |N, M|, N \land M \leftrightarrow \neg L, ?L)$, we may say that the Student’s question we are interested in was e-implied by the initial question and the premise.

More detailed analysis of question dependency in terms of IEL and more examples can be found in (Łupkowski 2012).

Given a rule for interpreting questions rhetorically, and an extension of the notion of *q*-specificity to allow for indirect answers (see e.g. (Asher and Lascarides 2003)), the potential for the class QA follows directly. For reasons of space we specify this here informally as in (25):

(25) QA: There exists $p_2$ resolving $q_2$ in FACTS and $p_2$ also resolves $q_1$.

The class FORM raises interesting issues since it seems to be the sole class whose coherence intrinsically involves reasoning by the responder about the original querier’s intentions. One possible explication would be in terms similar to the relation Q-ELAB (Asher and Lascarides 2003). Perhaps the simplest way to do this in the current setting would be, following (Larsson 2002), to widen the definition of *q*-specificity so that it is relative to an information state which provides a notion of the agent’s plan, decomposed into a sequence of questions to be resolved:

(26) $u$ is *q*-specific relative to information state $I$: an utterance whose content is either a proposition $p$ *About* $q$ or a question $q_1$ on which $q$ *Depends* or a question $q_1'$ which is a component of $I$.plan

One could try and collapse DP and FORM. One reason not to do this is precisely that the former does not involve reasoning about intentions and so, in principle, its coherence should be significantly easier to compute.

5.3 Adversarial query responses

Adversarial query responses are challenging for most dialogue theories. Common to all three classes is a lack of acceptance of $q_1$ as an issue to be discussed. In MOTIV-type responses the need/desirability to discuss $q_1$ is explicitly posed, in NO ANS-type

---

10 Rhetorical uses arise when an interrogative $q_1$ is used where the DGB contains a fact $f$ that resolves $q_1$. See (Ginzburg 2012), section 4.4.4 for discussion.
responses there is an implicature that \( q_1 \) is of lesser importance/urgency than \( q_2 \), whereas for \textsc{ignore}-type responses there is an implicature that \( q_1 \) as such will not be addressed. Although we will not discuss this here, it is clear that ultimately one needs to tie in any model of dialogue coherence with a model of politeness (following e.g. (Brown and Levinson 1987)) to capture the politeness costs in using any of these categories — in order of decreasing politeness \textsc{ignore} > \textsc{motive} > \textsc{no ans}\.

One commonality between \textsc{motive} and \textsc{no ans} worth noting is that in both cases \( q_1 \) actually needs to be added to \textsc{qud} at the outset. One might think that a consequence of a responder's failure to accept \( q \) for discussion is that \( q \) will only resurface if explicitly reposed. There is evidence, however, that actually \( q \) remains in a conversational participant's \textsc{qud} even when not initially adopted, its very posing makes it temporarily DGB available. In (27) the original question has definitely \textit{not} been reposed and yet B still has the option to address it, which he should be unable to do if it is not added to his gameboard before (27(2)).

(27) A: Who are you meeting next week?
B(2): What's in it for you? / Who are you meeting next week?
A: I'm curious.
B: Aha.
A: Whatever.
B: Oh, OK, Jill.

\textsc{motive} utterances are an instance of metadiscursive interaction—interaction about what should or should not be discussed at a given point in a conversation:

(28) 
\begin{enumerate}
\item a. I don't know.
\item b. Do we need to talk about this now?
\item c. I don't wish to discuss this now.
\end{enumerate}

A natural way to analyze such utterances is along the lines of QSPEC we saw above (16b): \( q \) being Max\textsc{qud} gives (the responder) B the right to follow up with an utterance specific to the issue we could paraphrase informally as \textit{?WishDiscuss}(q). Such a rule is sketched in (29), where the notation \( \text{QUd} = \langle \text{max} = \{ \text{?WishDiscuss}(q_0), q_0 \} \rangle \) indicates that both \textit{?WishDiscuss}(q0) and q0 are maximal in \textsc{qud}, unordered with respect to each other. The motivation for this latter is the need to integrate \( q_1 \) in context, as per (27) above.
MetaDiscussing q1

In case information is accepted indicating negative resolution of \(\text{WishDiscuss}(q)\), then \(q_1\) may be downdated from QUD. This involves a minor modification of the Fact Update/QUD Downdate rule, for which see (Ginzburg 2012).

\(\text{NO ANSW}\)–queries can be analyzed in a fairly similar fashion. The main challenge such queries pose is to consider the coherence relation between \(q_1\) and \(q_2\). In contrast to \(\text{IGNORE}\), where it seems like there is little that need connect the two questions, save for some reference to the situation associated with \(q_1\), for \(\text{NO ANSW}\) the questions seem to need a fairly tight link. A tentative characterization of this link is the following: \(q_1\) and \(q_2\) are not dependent on each other, but instead there exists a third question, \(q_3\), such that \(q_3\) depends on \(q_1\) and \(q_3\) depends on \(q_2\). The rationale behind this characterization is that by responding with \(q_2\) B provides (a) an issue that is not unconnected with \(q_1\), but

---

\[\text{NonResolve} = \text{def} \]

\[
\begin{align*}
\text{pre} : & \quad \text{QUD} = \langle q_1, Q \rangle : \text{poset(Question)} \\
\text{spkr} = & \quad \text{pre.addr} : \text{Ind} \\
\text{addr} = & \quad \text{pre.spkr} : \text{Ind} \\
r = & \quad \text{AbSemObj} \\
\text{R} = & \quad \text{IllocRel} \\
\text{Moves} = & \quad \langle R(\text{spkr}, \text{addr}, r) \rangle \oplus \\
\text{pre.Moves} = & \quad \text{list(IllocProp)} \\
c_1 = & \quad \text{Qspecific}(R(\text{spkr}, \text{addr}, r), \\
\text{WishDiscuss}(\text{pre.maxqud})) \\
\text{qud} = & \quad \langle \text{max} = \{ \text{WishDiscuss}(q_1), q_1 \} \rangle _Q \\
\text{poset(Question)}
\end{align*}
\]

---

[11] All that this involves is a modification of the function NonResolve which fixes the value of QUD after the fact update: in its new definition it maps a poset of questions \(\text{poset}(q)\) and a set of propositions \(P\) to a poset of questions \(\text{poset}(q)\) which is identical to \(\text{poset}(q)\) modulo those questions in \(\text{poset}(q)\) resolved by members of \(P\), as well as those questions \(q\) for whom \(\text{WishDiscuss}(q)\) is negatively resolved.

\[
\begin{align*}
\text{pre} : & \quad p : \text{Prop} \\
\text{LatestMove} = & \quad \text{Accept}((\text{spkr}, \text{addr}, p)) \\
\text{qud} = & \quad \langle p, \text{pre.qud} \rangle : \text{poset(Question)} \\
\text{effects} : & \quad \text{facts} = \text{pre.facts} \cup \{ p \} : \text{Set(Prop)} \\
& \quad \text{qud} = \text{NonResolve}((\text{pre.qud}, \text{facts}), Q') \\
& \quad \text{Q'} : \text{Poset(Question)}
\end{align*}
\]

\[\text{NonResolve} = \text{def} \]

\[
\begin{align*}
\text{pre} : & \quad \text{B} : \text{Ind} \\
& \quad \text{r} : \{ \text{F} : \text{set(Prop)} \\
& \quad \text{Q} : \text{poset(Question)} \}
\end{align*}
\]

\[
\begin{align*}
\text{Q'} : & \quad \text{poset(InfoStruc)} \\
\text{pre} : & \quad c_1 : \text{Q'} \subseteq rQ \\
c_2 : & \quad \forall q_0 \in Q' \neg \exists f \in F \\
& \quad \text{Resolve}(f, q_0, q) \\
& \quad \text{Resolve}(f, \text{WishDiscuss}(r.B, q_0, q))
\end{align*}
\]
(b) it is informationally not subservient to \(q_1\). Hence, it has an arguable case to being at least as discussion worthy as \(q_1\):

\[(30)\]

a. \(q_1 = \text{what do you (B) like?} \quad q_2 = \text{what do you (A) like?} \quad q_3 = \text{Who likes what?}\)

b. \(q_1 = \text{Why should we buy that scanner?} \quad q_2 = \text{Why should we not buy that scanner?} \quad q_3 = \text{Should we buy that scanner?}\)

The potential for making such queries can be captured by the conversational rule in (31). Given that \(q_1\) is MaxQU, the responder may respond with \(q_2\), related to \(q_1\) via \(q_3\), as discussed above. The immediate effect of this is to update QUD with the issue ?WishDiscuss\((q_1)\).

\[(31)\]

**Challenging \(q_1\)**

\[
\begin{align*}
\text{pre} & : \quad \text{qud} = \langle q_1, Q \rangle; \text{poset( } \text{Question} ) \\
& \quad \text{spkr} = \text{pre.addr} : \text{Ind} \\
& \quad \text{addr} = \text{pre.spkr} : \text{Ind} \\
& \quad q_2 : \text{Question} \\
& \quad q_3 : \text{Question} \\
& \quad \text{Moves} = \langle \text{Ask}(\text{spkr}, \text{addr}, q_2) \rangle \\
& \quad \varepsilon \text{ pre.Moves : list( } \text{IllocProp} ) \\
\text{effects} & : \quad c_1 : \text{Depend}(q_3,q_1) \wedge \\
& \quad \text{Depend}(q_3,q_2) \\
& \quad c_1 : \neg \text{Depend}(q_2,q_1) \wedge \\
& \quad \neg \text{Depend}(q_2,q_1) \\
& \quad \text{qud} = \langle \text{max} = \{ \text{?WishDiscuss}(q_1), \text{q1} \}, Q \rangle; \\
& \quad \text{poset( } \text{Question} ) 
\end{align*}
\]

Finally, we consider \textsc{Ignore}-type responses. Such responses implicate that \(q_1\) will not be addressed, somewhat analogously to the classic Gricean floutings of relevance (A: Bob is an embarrassment  B: It’s very hot in here). Nonetheless, the effect such responses have is different from Gricean floutings since these responses are situationally relevant, which appears to minimize significantly the potential impoliteness associated with ignoring \(q_1\). We think the difference between these two cases should be experimentally testable (e.g. response times for Gricean floutings should be significantly larger than for \textsc{Ignore}s.)

The conversational rule we propose both allows the potential for \(q_2\) and captures the implicature concerning \(q_1\)’s being ignored. The formulation of such a rule presupposes a notion of \textit{irrelevance} between the content of an utterance \((q_2)\) and the current context. We use here the notion we mentioned earlier in section 5.1, where \(u\) being IrRelevant to an information state \(I\) amounts to: there is no way to successfully update \(I\) with \(u\). At the same time we assume that \(q_2\) being \textit{situationally} relevant means that the open proposition component of \(q_2\) is of the form \(p_2(\ldots a \ldots )\) with \(a\) being in the situation which concerns \(q_1\).

This involves positing a conversational rule along the lines of (32)—given that (the content of) MaxPending—the most recent utterance, as yet ungrounded, hence maximal
in Pending—is irrelevant to the DGB but situationally relevant to q2, one can make MaxPending into LatestMove while updating Facts with the fact that the speaker of MaxPending does not wish to discuss MaxQUD:

(32) Ignoring questions

\[
\begin{align*}
&a : \text{IND} \\
&s_1 : \text{SIT} \\
&q_1 = (G) \begin{bmatrix}
\text{sit} = s_1 \\
\text{sit-type} = T
\end{bmatrix} : \text{Question} \\
&\text{pre : } q_2 = (G_1) \begin{bmatrix}
\text{sit} = s \\
\text{sit-type} = \begin{bmatrix}
\text{c : p}\begin{pmatrix} 2(a) \end{pmatrix}
\end{bmatrix}
\end{bmatrix} : \text{Question} \\
\text{In}(s_1,a) \\
\text{dgb} = \begin{bmatrix}
\text{MaxQUD} = q_1 : \text{Question} \\
\text{maxpending}_{\text{content}} = q_2 : \text{Question}
\end{bmatrix} : \text{DGBType} \\
\text{c : IrRelevant(maxpending}_{\text{content}}\text{,dgb}) \\
\text{effects : } \begin{bmatrix}
\text{LatestMove} = \text{pre.maxpending} : \text{LocProp} \\
\text{Facts} = \text{pre.Facts} \cup \\
\{ \neg \text{WishDiscuss}(\text{pre.spkr,pre.maxqud}) \}
\end{bmatrix}
\end{align*}
\]

Note that this does not make the unwillingness to discuss be the content of the offending utterance; it is merely an inference. Still this inference will allow MaxQUD to be down dated, via fact update/question down date, as was discussed with respect to MOTIV moves and the rule MetaDiscussing q1.

6. Summary and Future Work

The article provides the first comprehensive, empirically-based study of query responses to queries. The most interesting finding here is the existence of a number of classes of adversarial responses, that involve the rejection/ignoring of the original query. Indeed, in such cases the original query is rarely responded to in subsequent interaction. We designed our taxonomy based on data from the BNC since it is a general corpus with a variety of domains and genres, but have also shown that our classification works well in a number of more specific genres and domains.

We have shown how the coherence of such responses can be modeled within KoS. The coherence follows in some cases on the basis of quite general conversational rules (e.g. QSPEC and MetaDiscussing q1) and in other cases on the basis of rather specific—though domain independent—rules (e.g. Ignoring questions). An obvious issue is whether one can attain similar coverage on the basis of more “general” rules allied with some other very general pragmatic principles. Conversely, will investigation of specific genres lead to the need for genre–specific conversational rules?

A significant challenge for future work is automatic classification of query responses into a taxonomy like the one provided here. We intend to address this in future work.
Acknowledgments
This work was supported by the Iuventus Plus grant (IP2011-031-771) and by funds of the National Science Council, Poland (DEC 2012/04/A/HS1/00715).

References

