Formal specifications for dialogue games in multi-party healthcare coaching

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We present our analysis in terms of Inference Anchoring theory of a dataset of patient interviews, in the context of multi-party health coaching. For each dialogue game specification we first provide a general description of the game, followed by descriptions of the participants, and rules for: locutions, commitment, structure, termination, and outcome. We then implement these theoretical dialogue game specifications by taking their subsequent representation in a Dialogue Game Description Language.

KEYWORDS: formal dialogue game, health coaching, Dialogue Game Description Language

1. INTRODUCTION

To design dialogue games that allow for realistic interactions between patients and healthcare professionals in a virtual setting, it is first necessary to understand how such interactions might take place between patients and real healthcare professionals. By far the best way to understand these interactions is to examine them happening in real life;

this, however, is almost impossible to do. First, putting real patient consultations under observation risks changing the dynamic of those consultations, thus providing inaccurate data. Second, it is unusual for consultations to take place with more than one medical practitioner, and so finding such sessions in the first instance would prove a significant challenge. We therefore adopted a role-playing approach, in which real medical practitioners carried out a series of consultations with patients played by actors. Across the consultations, different actors played to carefully designed different personas, in consultation with different practitioners. In this paper we describe our analysis of the role plays, in terms of Inference Anchoring Theory (IAT) -- a philosophically grounded theory which has been developed to capture relationships between argument structures and dialogue structures (Budzynksa et. al., 2016).

We firstly use this analysis as the foundation for formal specifications for dialogue games in this context. We then implement these theoretical dialogue game specifications by taking their subsequent representation in a Dialogue Game Description Language (DGDL).

A total of 35 excerpts have been analysed in OVA+ (Janier et. al. 2014) using the IAT annotation scheme. These gave a total of 662 turns, out of 2179 total moves; around 31% of the total dialogues. In particular, a complete session has been annotated which gives a better insight into the shape and content of the Council of Coaches dialogues. The other analysed excerpts, taken from 5 different sessions, aim at being a representative sample of the wide variety of communication situations in couch dialogues. Since the topics tackled, the patients' character and the professionals' domain of expertise are different in every dialogue, the annotated data present a wide range of dialogical and argumentative dynamics which can help to refine and generalise the dialogue games. Our 35 annotated maps can be seen at http://corpora.aifdb.org/couch, with full argument analytics at http://analytics.arg-tech.org/overview.php?c=couch.

2. BACKGROUND

2.1 Patient Consultation Corpus

To design dialogue games that allow for realistic interactions between patients and their virtual coaches, it is first necessary to understand how such interactions might take place between patients and real medical practitioners. By far the best way to understand these interactions is to examine them happening in real life; this, however, is almost impossible to do. First, putting real patient consultations under observation risks changing the dynamic of those consultations, thus providing inaccurate data. Second, it is unusual for consultations to take place with more than one medical practitioner, and so finding such sessions in the first instance would prove a significant challenge.

We therefore adopted a role-playing approach, in which real medical practitioners carried out a series of consultations with patients played by actors. Across the consultations, different actors played to different personas (that we specified), in consultation with different practitioners.

The audio from each session was transcribed by a professional transcription service, then anonymised to remove the names of the medical practitioner ("patient" names did not need removed because they were fake to begin with).

Several different personas were devised for the actors to play to, which are summarised in **Error! Reference source not found.**. All personas describe patients that have recently been diagnosed with Type 2 diabetes. Note that while a gender is specified for the persona, this was not fixed: through only tweaking minor details, each persona was adaptable to be played by an actor of any gender. The sessions recorded are summarised in **Error! Reference source not found.**.

No	Gender	Age	Personality
1	Male	57	Know-it-all
2	Female	63	Anxious
3	Female	50	Unengaged
4	Male	67	Benchmark

Table 1: Patient personas

Session ID	Actor	Type of patient	Practitioners involved
S1	Male	Know-it-all	General practitioner, diabetes practitioner
S2	Male	Benchmark	General practitioner, diabetes practitioner
S3	Female 1	Unengaged	Podiatrist, general practitioner
S4	Female 1	Anxious	Podiatrist, general practitioner
S5	Female 1	Benchmark	Podiatrist, general practitioner
S6	Female 1	Know-it-all	Podiatrist, general practitioner
S7	Female 2	Unengaged	General practitioner, motivational interviewer, dietician
S8	Female 2	Know-it-all	Motivational interviewer, dietician
S9	Female 2	Benchmark	Motivational interviewer, dietician

Table 2: Sessions recorded

2.2 Inference Anchoring Theory

Inference Anchoring Theory (IAT) is a philosophically grounded theory which has been developed to capture relationships between argument structures and dialogue (Budzynska et. al., 2016). By taking into account the illocutionary force of utterances, IAT allows us to represent illocutionary structures which link locution nodes (L-nodes) to information nodes (I-nodes). Moreover, given that some speakers' communicative intentions cannot be determined without knowing the broader context of the dialogue that is, what an utterance is responding to – IAT assumes that it is only by taking into account the relation between L-nodes that some illocutionary forces can be inferred. As a consequence, these illocutionary structures are anchored in transition nodes (TA-nodes) and can target I-nodes or scheme nodes (S-nodes) (to elicit inference or conflict relations between propositions) (Budzynska et. al., 2016) IAT is therefore a framework developed for the analysis of dialogues in order to elicit argumentative structures.

By making the illocutionary forces of locutions apparent, the model allows us to identify argumentative dynamics which have been generated by dialogical moves. The IAT graphical representations of dialogical structures and the attached illocutionary and argumentative structures represent a valuable framework for fine-grained analyses of discourse.

This theory is very well suited to our goal of building a dialogue game from our corpus of patient interviews, since our corpus consists of natural language dialogue and IAT provides a way of linking dialogue argumentative dynamics via the analysis of speech acts.

Figure 1 shows an example of an IAT analysis taken from the Patient Consultation Corpus.

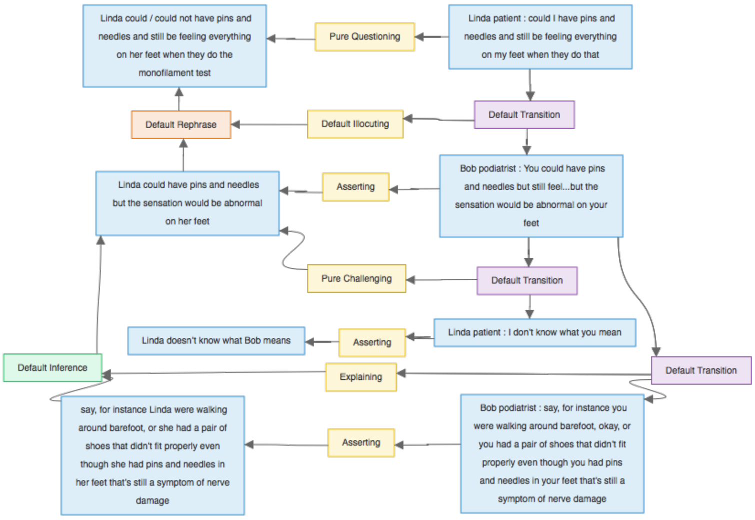

Figure 1: IAT analysis

3. DIALOGUE GAME SPECIFICATIONS

3.1 Game 1: Pre-interviews

The Pre-interview takes place before the patient is in the room. Its purpose is for the coaches to discuss how each of them may contribute and possibly what strategies might be effective in a particular case. This follows informal practice used in medical settings. The specification follows patterns found in the data collected from the patient interview sessions described in Section 3. Locution, commitment, structural, termination and outcome rules are shown in Tables 3 through 7 in the appendix, while a visualisation of the general structure of the game is in Figure 2.

The participants in a pre-interview dialogue consist of a set of at least two coaches (X), where a single coach (C) is designated the "Lead Coach" (LC). The Lead Coach is the coach who has the most familiarity with the patient and who can advise on which other experts should be present at the session and on strategies that might be useful, given the patient's personality and situation.

It is important to note that we do not specify a locution rule to permit players to argue or explain. As stated in (van Eemeren and Grootendorst, 1982) and (Budzynska et al., 2014a), 'arguing' is a complex illocutionary force which takes shape only by virtue of the interrelation between locutions: one can build an argument by asserting p and q and showing that there is an inference between p and q, e.g. "p because q". Hence, arguing is automatically created when support for a proposition is given and, in the pre-interviews game, PCh allows for triggering inference. Moreover, it has been shown that in some discursive contexts, AQ is more frequent than challenges to trigger argumentation (e.g. in debates, see (Yaskorska and Janier, 2015)) or in financial dialogues (Budzynska et al., 2014b)). Pure Challenging indeed has a low frequency in the COUCH corpus, this is explained by the fact that speakers do not necessarily wait to be challenged to support their opinion. However, formal dialectical systems' standards are followed here by including challenges which are, in the game, the only way for players to construct inference between propositions because parties cannot advance two propositions in a single turn.

Hamblin's view of speakers' commitments (Hamblin, 1971) is followed in our game: a speaker is committed to a statement if he personally utters the statement (CR1) or when he agrees with a statement uttered by an interlocutor (CR3). As in most formal dialogue systems (e.g. DC (Mackenzie, 1979), CB (Walton, 1984), PPD (Walton and Krabbe, 1995)), the pre-interviews game allows players to retract propositions: if a proposition is withdrawn, it is assumed that the players are no more in conflict about this proposition and consensus is reached on this particular proposition (CR2). Commitment rules in the pre-interviews game however differ from those in other dialogue games since propositions are added to a commitment store only if they have been asserted or agreed with. In many dialogue games, indeed, a stated proposition is added to all players' stores; if a player is not committed to this proposition, he has to explicitly withdraw it. In the pre-interviews game, on the other hand, a proposition is solely added in the store of the player who asserted (or agreed on) it. This is defined in CR1 and CR3. CR4 specifies that if a proposition p is disagreed with, then the opposite proposition (-p) is added to a store (see also (Wells and Reed, 2012)). This rule allows M to deploy a strategy: when :p is added to a player's commitment store after he disagreed with p, M is able to ask him whether his disagreement with p means that he is committed to :p. This is to ensure the relevance and consistency of dialogues: a player cannot simply disagree on p; he has to agree with :p, provide reasons for :p or withdraw :p.

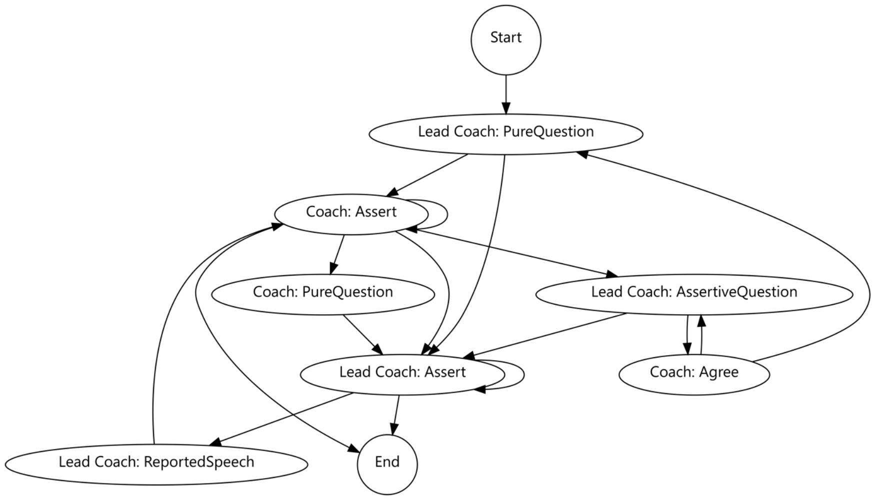

Figure 2: Visualisation of the pre-interview dialogue game

3.2 Game 2: Patient interview

The patient interview is the main consultation between the patient and multiple coaches, providing a broad framework for one or more coaches to engage in a consultation with a patient. Locution, commitment, structural, termination and outcome rules are provided in Tables 8-12 in the appendix.

The participants in a patient interview are a (possibly unit) set of coaches, and a patient. Note that there is no "Lead Coach" in this dialogue game – where there is more than one coach, all are given equal standing.

Due to the expressivity of the patient interview dialogue game, in all participants share the same set of locutions and (mostly) structural rules, any visualisation is highly complex and difficult to read. We therefore do not provide such a visualisation for this game.

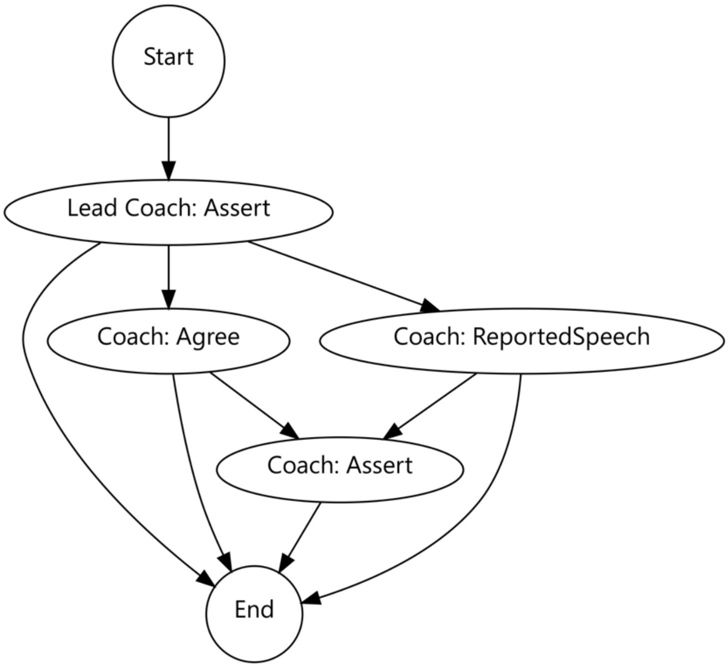

Figure 3: Visualisation of the post-interview dialogue game

3.3 Game 3: Post-interview

The Post-interview takes place after the patient interview. Its purpose is for the coaches to debrief and discuss how the session went. This follows informal practice used in medical settings. Locution, commitment, structural, termination and outcome rules are provided in Tables 13-16 in the appendix, while a visualisation of the general structure of the game is in Figure 2.

The participants in a Post-interview dialogue consist of a set of at least two coaches (X), where a single coach (C) is designated the "Lead Coach" (LC). The Lead Coach is the coach who has the most familiarity with the patient.

4. CONCLUSION

We have in this paper provided a set of specifications for dialogue games in multi-party health coaching. These are based on Inference Anchoring Theory analyses of a corpora of simulated consultations between various healthcare professionals and a patient.

Three dialogue games were provided: a pre-interview game, where the healthcare professionals discuss the patient's history; the interview game, which is the main consultation between the healthcare professionals and the patient; and the post-interview game, in which the healthcare professionals discuss what happened during the consultation (interview), and potential future steps.

Each dialogue game specification describes: the participants in the dialogue, and rules for locutions, commitment, structure (turn-taking), termination and outcome.

In future work, we will implement these game specifications computationally in Dialogue Game Description Language (DGDL for execution on the Dialogue Game Execution Platform (DGEP) (Wells and Reed, 2012).

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APPENDIX

LR1	C can: 1. PQ(p) when he asks whether p is the case, i.e. if LC believes p 2. A(p) when he gives his opinion on p 4. PCh(p) when he seeks LC's ground for stating p 5. Agr(p) when he agrees on p
LR2	LC, in addition to those locutions available to all coaches, can: 1. AQ(p) when he seeks C's agreement on p 2. R(p) when he restates p (usually to summarise Patient's situation) 3. *ReportedSpeech*(s, *IllocutionaryForce*(p)) when he reports that speaker s said proposition p with a specific Illocutionary Force. *4. PatientSummaryConcluded* when the LC has concluded a patient summary

Table 3: Locution rules for pre-interviews dialogue game

CR1	Following a A(p), performed by C≠LC, p is added to CS_{c_i}
CR2	Following a Agr(p), performed by C≠LC, p is added to CS_{c_i}
CR3	Following a Disagr(p), performed by C≠LC, -p is added to CS_{c_i}
CR4	Following a AQ(p), performed by C≠LC, p is added to CS_{c_i}
CR5	Following a R(p), performed by C≠LC, p is added to CS_{c_i}

Table 4: Commitment rules for pre-interviews dialogue game

SR1	LC moves first with *PQ(p),* where p = “have a moment”
SR2	After LC OR C≠LC performs *PQ(p)*, C≠LC OR C must perform: 1. *A(p)*; or 2. *A(-p)*
SR3	After LC OR C≠LC performs *AQ(p)*, C≠LC OR C must perform: 1. *Agr(p)*; or 2. Dis*agr(p)*
SR4	After C≠LC performs *A(p_1),either*: 1. C can perform PQ(p), or 2. *LC can* perform a sequence of locutions asserting some finite number of propositions about S, many of which are rephrases (because he summarises S): *Assert(p_i)...,* where 1 ≤ <= $i \leq n$ for some n ∈ Natural Numbers (S=Situation) and then 3. *LC* end the summary of the situation by saying: *PatientSummaryConcluded*
SR5	After LC asserts *PatientSummaryConcluded,* LC can perform*:* *ReportedSpeech*(P, *IllocutionaryForce*(p)) to report propositions p that the patient P has said in previous sessions
SR6	After *LC* performs *ReportedSpeech*(P, *IllocutionaryForce*(p)), C≠LC can perform: 1) a sequence of locutions asserting some finite number of propositions, with inferential structure between them: *A(p_i)...,* where 1 ≤ $i \leq n$ for some n ∈ Natural Numbers
SR7	After C≠LC performs *A(p_i)...* with inferential structure between them: C can perform PQ, where: 1. C≠LC performs PQ(s), where s=situation, or 2. LC performs PQ(p), where p=proposition
SR8	After C≠LC performs *A(p_i)*, LC performs: 1. AQ(p) where p = “see Patient P”

SR9	After LC performs AQ(p) where p = “see Patient P”, all C≠LC must perform: 1. Agr(p)
SR10	After all C≠LC perform Agr(p) where p = “see Patient P”, C≠LC can perform 1. PQ(p), or 2. AQ(p) where p is a strategy for dealing with the patient

Table 5: Structural rules for pre-interview dialogue game

T1	A dialogue terminates if any C≠LC performs: 1. *A(-p),* where p = “have a moment” Or All C≠LC performs: 2. Agr(p), where p = “see Patient P” And, if C≠LC performs 3. if C≠LC performs PQ(p), then the LC performs Assert(p), or if 4. if C≠LC performs AQ(p), then the LC performs Agr(p) where p is a strategy for dealing with the patient.

Table 6: Termination rules for pre-interview dialogue game

Outcome	Conditions
Don’t agree to see Patient P	any C≠LC performs *A(-p),* where p = “have a moment”
Agree to see Patient P (no strategy for dealing with the patient)	All C in C/LC Agr(p) where p = “see Patient P”

Agree to see Patient P (and strategy for dealing with the patient)	All C in C/LC Agr(p) where p = "see Patient P"

Table 7: Outcome rules for pre-interview dialogue game

LR1	All participants can: 1. PQ(p) when they ask whether p is the case, i.e. if the hearer believes p 2. A(p) when they give their opinion on p 4. PCh(p) when they seek hearers' ground for stating p 5. Agr(p) when they agree on p 6. R(p) when they restate p (to exemplify, generalise, paraphrase, repeat, etc) 7. AQ(p) when they seeks the hearer's agreement on p 8. *ReportedSpeech*(s, *IllocutionaryForce*(p)) when they report that speaker s said proposition p 9.RQ(p) when they grammatically state a question, but in fact are just conveying that they do (or do) believe p and do not wait for the other participants to answer the question 10.Backchannel when they want the previous speaker to continue 11. Disagr(p) when they disagree on p

Table 8: Locution rules for patient interview dialogue game

CR1	Following a A(p), performed by X, p is added to CSx_i
CR2	Following a Agr(p), performed by X, p is added to CSx_i
CR3	Following a Disagr(p), performed by X, -p is added to CSx_i
CR4	Following a AQ(p), performed by X, p is added to CSx_i
CR5	Following a R(p), performed by X, p is added to CSx_i
CR6	Following a RQ(p), performed by X, p is added to CSx_i

CR7	Following a Disagr(p), performed by X, -p is added to CSx_i

Table 9: Commitment rules for patient interview dialogue game

SR1	[After greetings] The dialogue starts with C performing PQ(p) addressed to P
SR2	After X performs *PQ(p)*, the answerer must perform: 1. *Assert(p)*; or 2. *Assert(-p)*
SR3	After P performs Assert(p): 1. Any participant can Assert(q) where p and q form either a rephrasing structure or an inferential structure, or 2. Any participant can ReportSpeech(s,(IF(q)), or 3. Any participant can ReportSpeech(X,(A(p)), or 4. Any participant can AQ(p), or 5. Any participant can AQ(q), or 6. Any participant can RQ(p), or 7. Any participant can PQ(q), or 8. Any participant can PCh(p), 9. Any participant can Agr(p) 10. C can Disagr(p)
SR4	After C performs Assert(p): 1. Any participant can A(q) where p and q form either a rephrasing structure or an inferential structure, or 2. Any participant can ReportSpeech(s,(IF(q)), or 3. Any participant can ReportSpeech(X,(A(p)), or 4. Any participant can AQ(p), or 5. Any participant can AQ(q), or 6. Any participant can RQ(p), or 7. Any participant can PQ(q), or

	8. Any participant can PCh(p), 9. Any participant can Agr(p) 10. P can Disagr(p)
SR5	After P performs Assert(-p), 1. Any participant can A(q) where -p and q form either a rephrasing structure or an inferential structure, or 2. Any participant can ReportSpeech(s,(IF(q)), or 3. Any participant can ReportSpeech(X,(A(-p)), or 4. Any participant can AQ(-p), or 5. Any participant can AQ(q), or 6. Any participant can RQ(-p), or 7. Any participant can PQ(q), or 8. Any participant can PCh(-p), 9. Any participant can Agr(-p) 10. C can Disagr(p)
SR6	After C performs Assert(-p), 11. Any participant can A(q) where -p and q form either a rephrasing structure or an inferential structure, or 12. Any participant can ReportSpeech(s,(IF(q)), or 13. Any participant can ReportSpeech(X,(A(-p)), or 14. Any participant can AQ(-p), or 15. Any participant can AQ(q), or 16. Any participant can RQ(-p), or 17. Any participant can PQ(q), or 18. Any participant can PCh(-p), 19. Any participant can Agr(-p) 20. P can Disagr(-p)

SR7	After P performs ReportSpeech(s,(IF(p)), 1. Any participant can Assert(q) where p and q form either a rephrasing structure or an inferential structure, or 2. Any participant can ReportSpeech(s,(IF(q)), where p and q form an inferential structure, or 3. Any participant can AQ(p), or 4. Any participant can AQ(q), or 5. Any participant can RQ(p), or 6. Any participant can PQ(q), or 7. Any participant can PCh(p), 8. Any participant can Agr(p) 9. C can Disagr(p)
SR8	After C performs ReportSpeech(s,(IF(p)), 10. Any participant can A(q) where p and q form either a rephrasing structure or an inferential structure, or 11. Any participant can ReportSpeech(s,(IF(q)), where p and q form an inferential structure, or 12. Any participant can AQ(p), or 13. Any participant can AQ(q), or 14. Any participant can RQ(p), or 15. Any participant can PQ(q), or 16. Any participant can PCh(p), 17. Any participant can Agr(p) 18. P can Disagr(p)

SR9	After P performs AQ(p) addressed to C_i , C_i can: 1. C_i can Agr(p), or 2. C_i can Disagr(p), or 3. C_i can R(q) where q is a rephrase of p For $i \neq j$, $1 \leq i,j \leq n$ where n is the number of coaches
SR10	After C performs AQ(p) addressed to P, P can: 1. Agr(p), or 2. Disagr(p)
SR11	After C performs AQ(p) addressed to C_i, C_I can: 1. Agr(p), or 2. R(q) where p is a rephrase of p
SR12	After X performs RQ(p), X can: 1. A(q) 2. PQ(q) 3. AQ(p) 4. AQ(q) 5. PCh(p) 6. R(q) where p and q form either a rephrasing structure or an inferential structure
SR13	After X performs PCh(p) addressed to C_i, 1. C_i can A(q) where p and q form an inferential structure, or 2. C_i can R(q) where p and q form a rephrasing structure addressed to X_i

SR14	After X performs Agr(p), any participant can: 1. A(q) where p and q form either a rephrasing structure or an inferential structure, or 2. ReportSpeech(s,(IF(q)), where p and q form a rephrasing structure or an inferential structure, or 3. AQ(q), or 4. PQ(q), or 5. Agr(p)
SR15	After P performs Disagr(p), 1. P can A(q) where -p and q form a rephrasing structure or an inferential structure 2. P can ReportSpeech(s,(IF(q)), where -p and q form a rephrasing structure or an inferential structure 3. P can PCh(p) 4. C can PCh(-p)
SR16	After C performs Disagr(p), 1. Any participant can PCh(-p) 2. C can A(q) where -p and q form a rephrasing structure or an inferential structure 3. C can R(q) where -p and q form a rephrasing structure or an inferential structure 4. C can AQ(-p) addressed to C_i 5. C can PQ(q) addressed to any other participant 6. C_i can Agr(-p)

Table 10: Structural rules for patient interview dialogue game

T1	A dialogue terminates if: 1. All participants agree on p, where p= “all issues have been raised and resolved”

Table 11: Termination rules for patient interview dialogue game

Outcome	Conditions
Plan of action and/or further session have not been agreed	P Agr(p) where p= “plan of action/further session
Plan of action and/or further session have been agreed	P Agr(p) where p= “plan of action/further session”

Table 12: Outcome rules for patient interview dialogue game

LR1	C can: 1. A(p) when he gives his opinion on p 2. Agr(p) when he agrees on p *3. ReportedSpeech*(s, *IllocutionaryForce*(p)) when he reports that speaker s said proposition p *4. ArgumentConcluded* when the C has concluded an argument

Table 13: Locution rules for post-interview dialogue game

CR1	Following a A(p), performed by C $\in$ X, p is added to CSc_i
CR2	Following a Agr(p), performed by C $\in$ X, p is added to CSc_i

Table 14: Commitment rules for post-interview dialogue game

SR1	LC moves first with: 1. a sequence of locutions asserting some finite number of propositions: *Assert*(p_i)..., where $1 \leq i \leq n$ for some n $\in$ Natural Numbers with inferential structure between them, and then *2. ArgumentConcluded*
SR2	After any coach performs *ArgumentConcluded*, any other coach can perform: *1. Agr(p), or*

	2. *ReportedSpeech*(P, *IllocutionaryForce*(q)) to report propositions q that the patient P has said in previous sessions
SR3	After *Agr(p)*, any coach can perform: 1. a sequence of locutions asserting some finite number of propositions: *Assert(q_i)*..., where 1 <= i <= n for some n ∈ Natural Numbers with inferential structure between them, and then 2. *ArgumentConcluded*
SR4	After *ReportedSpeech*(P, *IllocutionaryForce*(p)), any coach can perform: 3. a sequence of locutions asserting some finite number of propositions: *Assert(q_i)*..., where 1 <= i <= n for some n ∈ Natural Numbers with inferential structure between them, and then 4. *ArgumentConcluded*

Table 15: Structural rules for post-interview dialogue game

T1	A dialogue terminates if no-one performs a move.

Table 16: Termination rules for post-interview dialogue game

Outcome	Conditions
End of session	Post-interview is concluded

Table 17: Outcome rules for post-interview dialogue game