Confrontation and Collaboration Analysis: Experimental and Mathematical Results

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Abstract: Experiments with military students as subjects have confirmed basic predictions of Drama Theory concerning responses to 'dilemmas'. Most subjects communicated different feelings (positive, negative and apprehensive) and changed their preferences as Drama Theory predicts they should. However, the experimental procedure, which was explorative in nature, failed to test the drama-theoretic predictions in a number of cases. Our mathematical research for this year concerned the manner in which players might be expected to change their preferences. This suggest the reason for the experimental failures may be that the procedure used did not allow subjects to give reasons (i.e., 'rationalisations') for their preference change.

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Introduction: the purpose of the research

Confrontation and Collaboration Analysis (CCA) is the latest version of Confrontation Analysis [1]. It is based on the idea that missions arrange themselves along a spectrum with absolute war at one end and Peace Operations (PO) at the other, as argued in [2,3]. Movement along this spectrum, towards PO, is characterised by increased emphasis on the psychological aspects of Confronting Non-Compliant Parties (NCPs), as against merely fighting them. Collaboration with civilian agencies in order to confront NCPs effectively also becomes more important. Increasingly, Confrontation and Collaboration (CC) becomes the Commander's Main Effort, rather than War-Fighting. Research reported in [3] brought out significant behavioural and psychological differences between interactions that are confrontational (because parties take overtly different positions) and those that are collaborative (because there is formally a common position, albeit one that is subject to mistrust and differences of

interpretation). For this reason, we now use the term Confrontation and Collaboration Analysis (CCA), rather than simply Confrontation Analysis.

Actually, CC is an aspect of a Commander's task at any point along the spectrum, from War Fighting to Peace Operations. Even in War-fighting, he must enhance collaboration between different components and coalition partners, and must psychologically confront the enemy as well as attack them. The difference is one of emphasis and the placing of the Main Effort. In War-fighting, the Main Effort lies in destruction. In the later stages of a Peace Operation, a commander's Main Effort may lie in persuading civilian agencies to collaborate in a strategy of obtaining NCP compliance through a variety of carrots and sticks, many of them non-military.

If the Commander is unsuccessful in this confrontational mission, exit from the theatre may be delayed or the mission as a whole may fail. To illustrate this, [2] analyses Operation Desert Storm and shows how failure at the point when confrontation took over from War-fighting meant that the operation failed to achieve its political end-state, despite overwhelming success in War-fighting.

A paper [4] by Smith, Howard and Tait in this year's symposium extends these ideas to the War Against Terrorism (WAT). Firstly, it argues that Peace Operations are an essential part of WAT. Having rooted out terrorist networks from a state (such as Afghanistan) that has supported them, a Peace Operation is necessary to ensure a regime (democratic if possible) that will no longer support terrorism. Secondly, WAT requires forming and maintaining anti-terrorist coalitions at every level, from the international level where nations must be persuaded to join a coalition right down to the level of a unit commander who must work in coalition with local players pursuing their own agendas and interests. Forming and maintaining these coalitions is a task of confronting those that will not join whilst offering to collaborate with those that will.

What is the nature of the confrontational task? During War-Fighting, it is to dominate the enemy psychologically. At the other extreme, in a Peace Operation, commanders at every level work with civilian agencies to bring various NCPs into compliance. This requires confronting NCPs as long as they are openly non-compliant while offering collaboration in the pursuit of compliant aims. The threat of fighting—use of

military force—is always present, or there would be no need for a military presence. But as a Peace Operation proceeds, this threat tends to recede into the background as the emphasis shifts to inducements such as reconstruction aid and threats such as replacing officials.

In CC, the commander personally is the 'shooter'. In the later stages of a Peace Operation, he may have a mere background role in the civil-military coalition that interacts with NCPs. At earlier stages, where the threat to initiate or continue the use of force is the main inducement, he may be the key or only player representing the International Community. At all stages, however, he personally participates because he personally is able to decide on the use of force. He therefore confronts others and offers collaboration on behalf of his command. This personal role is in contrast to War-fighting, where the task of a commander and his staff is generally to direct and co-ordinate the activities of shooters that are 'on the ground'.

It is believed by senior serving officers that commanders need more help in the task of CC than they are given by present doctrine, training, systems and organisation. To this end, the purpose of QinetiQ's CCA research is to develop the foundations for a C2CC system—a command and control system for confronting and collaborating. CCA is expected to play a central role in this system.

Contents of this paper

CCA itself is an applied technique based upon Drama Theory, an extension of mathematical Game Theory [5]. Its roots are therefore in Operational Analysis.

Despite these mathematical roots, Drama Theory proposes a number of psychological hypotheses that need to be explored experimentally. The difficulty is to develop procedures that are rigorous and founded upon empirically valid assumptions. In this paper, we discuss the progress made by QinetiQ this year in researching the psychological and mathematical foundations of CCA and Drama Theory. On the psychological side, exploratory experiments conducted last year [3] have been repeated and extended. The subjects used this year were students undergoing military training, rather than students at a 6th-form college (a college preparing students for entry to UK universities) as was the case last year, and the scenarios specifically

described Peace Operations, rather than an abstract structure of monetary rewards. Also, the experiments were conducted over a computer network rather than by hand. The upshot has been that where we obtained firm results last year, these were confirmed under different experimental conditions this year. These results were in predicting the *preference changes* induced by drama-theoretic 'dilemmas' and the *feelings* that accompany these changes. However, a large number of our experiments failed to meet the conditions required to enable us to make a prediction (see *Experimental predictions and results*). This was the case last year too, and we are continuing to explore experimental procedures that would be more effective in this respect.

On the mathematical side, a system of transformations has been defined that gives us a psychologically plausible way of representing the manner in which players 'redefine the game' when confronted with drama-theoretic dilemmas.

The experiments – general considerations

The mathematical basis of Drama Theory and CCA is based on the concept that real-life players in communication with each other react to various 'dilemmas' in a predictable, though not unique, manner. We tried to find ways to test these predictions as to how real-life players would respond.

In order to get testable predictions, given the fact that the theory's predictions are not unique, we tried to design procedures that made certain responses impossible. In this way subjects might be 'forced' to exhibit only some of the theoretically valid responses. This was expected to make predictions sharper and deviations more statistically significant.

What are the theoretically valid responses to dilemmas? They are:

1. Demonstrations of emotion.
2. Statements of preference change.
3. Displays of irrationality.
4. Rational argumentation.
5. Changing the set of cards (options) and the set of players.
6. Changing the perceived consequences of playing various selections of cards.
7. Deceit in relation to any of the above.

Of these seven responses, our experiments allowed only 1, 2 and 7 to be manifested. Subjects' means of communications were limited so that all they could do was to express their feelings to each other in a severely constrained manner (response 1) and communicate changes in their preferences (response 2). Deceit (response 7) was, however, possible in relation to these. Thus, we tested predictions not as to whether subjects actually experienced predicted emotions and changes in their preferences, but whether they *communicated* them. However, the experimental procedures did allow us to determine whether some of the reported preference change was actual – in that some kinds of preference change were revealed in the choices subjects made.

The predictions of the theory

Before describing the procedure in detail, we first review the predictions of Drama Theory that we aimed to test.

Dilemmas, and hence drama-theoretic predictions, theoretically arise at a so-called '*moment of truth*' in an interaction. This is a point when each party has adopted a 'position' (its suggested joint solution) and a fallback strategy (the unilateral strategy it says it will pursue if *its* position is rejected). At a moment of truth, both positions and fallback strategies are intended by the parties to be 'final'—i.e., they have decided not to change them further, though the theory states that psychological

pressures could cause them to do so. At this point, the following outcomes have been defined: a particular outcome for each player (its position) and an additional outcome, called the 'fallback', that would result from all players' fallback strategies being implemented. To illustrate, Figures 1 and 2 set out the two interactions we used in our experiments this year (the 'stories' that accompanied them are described below).

- In the interaction of Figure 1, the Commander's (COM) position is B and his fallback strategy is *don't release aid*. The Mayor's position is also B, and his fallback strategy is *don't restore utilities*. The fallback is therefore A.
- In the interaction of Figure 2, the Commander's position is C and his fallback strategy is *send returnees*. The Mayor's position is A, and his fallback strategy is *block returnees*. The fallback is therefore B.

We will refer to these interactions as Scenario 1 and Scenario 2. Last year, the same two decision trees were used without 'stories' of any kind, but with different monetary rewards (£1-£5) attached to the end-points.

In order to make predictions, the following theoretical question had to be answered before doing the experiments. Suppose we ask subjects to make choices of Left or Right (thereby taking the roles of Commander and Mayor) in these interactions. Suppose that before making these choices, they adopt the 'final' positions and fallback strategies shown. What dilemmas would they face and how would we predict their responses to those dilemmas? The answer is that the subjects would face four of the six dilemmas identified by Drama Theory, and the theory would make the following predictions as to the feelings they would express and the preference changes they would communicate:

- In Figure 1, the subjects' common position is B. Starting from B, the Mayor could move to an outcome he prefers by changing his decision from *restore utilities* to *don't restore utilities* (since in doing so, he would go from Failure to Success). Consequently:
    - The Commander faces a 'trust dilemma'. He has a problem trusting the Mayor to implement his (the Commander's) position even though the Mayor agrees to it. *Consequently Drama Theory predicts that the Commander will communicate Neutral, Positive or Apprehensive feelings, and no change in his preferences.*
    - The Mayor faces a 'co-operation dilemma': he has a problem making it credible that he will co-operate in the implementation of his own position. *Consequently Drama Theory predicts that the Commander will communicate Neutral or Positive feelings, and either no change in his*

preferences or a change that promotes B (i.e., makes it more preferred) and/or demotes C.

- In Figure 2, the fallback is B. Starting from B, either player can move to a preferred outcome by changing its strategy-choice. The Mayor can move to C, thereby moving from Disaster to Failure. The Commander can move to A, also moving from Disaster to Failure. Hence, each faces a 'threat dilemma', as the threat he is making is one he would prefer not to carry out. Each also faces an 'inducement dilemma', since he prefers the other's position (C or A) to the fallback, and hence is under pressure to give in to the other. *Consequently Drama Theory predicts that each player will communicate Neutral or Negative feelings, and*
    - *the Commander will communicate either no change in his preferences or a change that promotes B and/or demotes A*
    - *the Mayor will communicate either no change in his preferences or a change that promotes B and/or demotes C.*

Note that in each case, 'no change' (i.e., neutral feelings or no change in preferences) is not ruled out by the theory. The reason for this is '*friction'* – i.e., a certain strength of feeling is needed to overcome the 'inertia' of given preferences and initially indifferent feelings. The theory predicts a tendency for feelings and preferences to move in the directions indicated, but does not predict how strong this tendency will be, hence cannot predict that the inertia will necessarily be overcome.

The experimental procedure

There were 36 subjects in our experiments were students at the Royal Military College of Science in Shrivenham, England. Interacting over a computer network, they were assigned roles as NATO Commander (COM) and Mayor in Scenario 1 and Scenario 2—the situations in Figures 1 and 2. Each subject played both roles, and both scenarios, twice according to the sequence: Commander, Scenario 1; Mayor, Scenario 1; Commander, Scenario 2; Mayor, Scenario 2; (repeat) – or verse versa for the 'opponent' player.

The subjects were shown these decision trees (but without indications of positions and fallback strategies) and were briefed as follows.

> Briefing of NATO commander in Figure 1: You are a NATO commander in communication with the Mayor of the Bosnian Serb village of Granica. You have to decide whether sufficient progress has been made in returning Muslim refugees to Granica. If sufficient progress has been made, economic reconstruction aid should be released to the village. The Mayor is pressing for this money, which the village badly needs. You are trying to assure yourself

that the progress that has been made – which is frankly not very much, though more is promised – will be followed up in future. A batch of returnees is due next month. Will the Mayor use part of the reconstruction aid, if you release it, to restore utilities to the returnees' houses?

In terms of the decision tree, you have to make the first decision, whether or not to release aid (choose Left or Right). If you release aid (go Left), the Mayor will decide whether to go Left (restore utilities to the returnees' housing) or Right (use the money on his own people). In terms of achieving mission objectives, your best outcome would be Success (outcome B); your worst, Disaster (outcome C). In between would come Failure (A).

You estimate that for the Mayor, (A) would be the worst outcome. Better for him would be your Success (B). Best of all would be your Disaster (outcome C).

Briefing of Bosnian Serb Mayor in Figure 1: You are Mayor of the Bosnian Serb village of Granica. You are in communication with the local NATO commander. He is deciding whether to release reconstruction aid to you. The aid agency has asked him to decide whether your village has done enough to help Muslim refugees return to Granica. These refugees were responsible for massacring Serbs and driving them from their homes. Afterwards they themselves were driven out by Bosnian Serb forces. Now the families of murdered people are being asked to welcome their murderers!

You and your people are willing to agree in order to get reconstruction aid. The first batch of returnees is due next month. Now the Commander has said that if he releases reconstruction aid, most of the money must be spent on repairing homes for returning refugees. Your people will be furious if this is done while they are in need. Fortunately, once the money has been released, it won't be possible for the Commander to take it back. You can spend it how you like. You have to decide what to say to him.

In terms of the decision tree, he has to make the first decision, whether or not to *release aid* (he chooses Left or Right). If he releases aid (goes Left), you will be free to decide whether to go Right (*use the money first on returnees' housing*) or Left (*use the money on Serb people*). Your best outcome would be Success: Serbs Helped (outcome C); your worst, Disaster: No Aid (outcome A). In between would come Failure: Muslims helped first (B).

As for what the Commander wants, you're sure that Serbs Helped (C) would be the worst outcome for him. Better for him would be No Aid (A). Best of all would be Muslims helped first (outcome B).

Briefing of NATO Commander in Figure 2: You are a NATO commander in communication with the Mayor of the Bosnian Serb village of Granica. You have to decide whether it is safe to allow a batch of Muslim refugees to return to Granica. If you allow them to go, their return will coincide with a visit by aid agencies to decide whether to give reconstruction aid to the village. So if the Mayor encourages his people to block the return of the refugees, the refugees will be turned back, but the village will not get aid. If the Mayor

persuades his people to allow the returns to proceed peacefully, returns will be off to a good start, and the village will get aid.

You have two objectives: getting refugees returned and getting aid to this village, which badly needs it. Your best outcome will be C: Success. The refugees return peacefully and the village gets aid. Your worst outcome is B: Disaster. The refugees are turned back and the village doesn't get aid. Better than this would be A: Partial Success. There are no returns, but the village does get aid.

From the Mayor's point of view, you believe his first priority is getting aid. Second is stopping refugee returns. His best outcome would be A: Aid, No Returns. But if aid is tied to returns, his preference would be for C: Aid *and* Returns, rather than for B: No Aid, No Returns

In terms of the decision tree, you have to make the first decision, whether or not to *send returnees* (choose Left or Right). If you send returnees (go Left), the Mayor will decide whether to go Left (*block returnees*) or Right (*allow them, and get aid*).

Briefing of Serb Mayor in Figure 2: You are Mayor of the Bosnian Serb village of Granica. You are in communication with the local NATO commander. He is deciding whether to send a batch of Muslim refugees to return to your village next week. If he sends them, this would coincide with a visit by the aid agencies to decide whether your village gets reconstruction aid – a decision that depends on whether they think you are doing enough to help Muslim refugees return.

These same refugees were responsible for massacring Serb villagers and driving them from their homes. Afterwards they themselves were driven out by Bosnian Serb forces. Now the families of murdered people are being blackmailed and bribed to make them welcome their murderers!

In spite of all this, your first priority is to get reconstruction aid for your village. If the Commander decides to send the returnees, you must decide whether to persuade your people to let them come. If you don't exercise leadership, they're going to stone the buses, block the streets and stop the returns. The result will be no returnees – and no aid.

In terms of the decision tree, the Commander has to make the first decision, whether or not to *send returnees* (he chooses Left or Right). If he sends them (goes Left), you will have to decide whether to go Left (allow your people to *block the returnees*) or Right (persuade them to *let them come*). Your best outcome would be A: Success: Aid, No Returns. Your next best would be C: Failure: Aid *and* Returns. Your worst would be B: Disaster: No Aid, No Returns.

As for what the Commander wants, you're sure that your Disaster: No Aid, No Returns (B) would also be worst for him. His best outcome would be your Failure: Aid *and* Returns (C). In between would be your Success: Aid, No Returns (A).

After reading these briefings, the role-players were presented with a decision screen like that in Figure 3. This shows the screen seen by the NATO Commander. The screen seen by the Mayor was similar, but with sides reversed; i.e., with the Mayor's choices on the left and the Commander's on the right. Each player filled in his own screen on the left, and saw the other's choices displayed on the right. While making choices, each could consult the decision tree (Figure 1 or Figure 2).

The procedure for making decisions was as follows.

Step 1. Each made a suggestion (A, B or C). After making his own suggestion, he saw the other's suggestion.

Step 2.

- If their suggestions differed, each stated an intention (Left or Right, the intention being contingent in the Mayor's case). After stating their own intention, they saw each other's stated intention.
- If their suggestions agreed, each proceeded straight to step 3.

Step 3. Each stated a feeling (by selecting an adjective from a drop-down list) and preferences (by stating how they would be inclined to choose between each pair of outcomes). After stating their feelings and preferences, they saw each other's stated feelings and preferences.

Step 4. Each chose either to go back to Step 1 or to make a final decision (Right or Left). If either player chose to go back, then both returned to Step 1. If both declared themselves ready to choose Right or Left, they went to Step 5.

Step 5. Each made a final decision to go Right or Left (this being a contingent decision in the Mayor's case).

After final decisions had been made, the subjects 'final' positions were defined, operationally, as the final suggestions they had made and their 'final' fallback strategies were defined (for the case when their positions differed) as the final intentions they had stated.

Experimental predictions and results

It should now be fairly clear how Drama Theory yielded predictions as to the way subjects would fill out the form in Figure 3. Our predictions were:

<u>In the interaction of Figure 1 (Scenario 1):</u>

If subjects do not both finally suggest B, then no prediction could be made (i.e., they have not met the experimental conditions). If both finally suggest B, then:

- The Commander's choice of adjectives to represent his feelings will be taken from the groups pre-classified as Neutral, Positive or Apprehensive.
- The Commander's stated preference ordering (obtained by asking him how he 'would choose' between each pair of outcomes) will be B:A:C (the same as the ordering Success:Failure:Disaster in his briefing) or B:C:A (an ordering obtained by demoting A).
- The Mayor's choice of adjectives to communicate his feelings will be Neutral or Positive.

- The Mayor's stated preference ordering will be C:B:A (the same as the ordering in his briefing), B:C:A or B:A:C (orderings obtained by demoting C or promoting B).

In the interaction of Figure 2 (Scenario 2):

If the Commander and the Mayor do not finally suggest, respectively, the outcomes C and A and then state the intention of going Left, no prediction could be made. If they finally suggest these outcomes and state this intention, then:

- The Commander's choice of adjectives to communicate his feelings will be Neutral or Negative.
- The Commander's stated preference ordering will be C:A:B (the same as the ordering in his briefing) or C:B:A (obtained by demoting A).
- The Mayor's choice of adjectives to communicate his feelings will be Neutral or Negative.
- The Mayor's stated preference ordering will be A:C:B (the same as the ordering in his briefing) or A:B:C (obtained by demoting C).

The experimental results are given in Tables 1 to 4. Table 1 gives the results for Blue (the NATO commander) of all the Scenario 1 experiments in which both parties gave outcome B as their final suggestion.

- The first three columns show Blue's expressed preferences—i.e., subjects' answers to the question how they would be inclined to choose between A and B (answer in column A/B), A and C (column A/C) and B and C (B/C).
- The fourth column indicates whether Blue's *expressed* preferences had changed from the Success/Failure/Disaster ordering given by the Commander's briefing. Only 5 out of 29 cases showed a change—not surprising in view of the non-essential nature of this particular change, it merely eliminates Blue's trust dilemma by Blue changing its preferences to say 'I don't mind if you *do* renege on our deal.'
- The fifth column indicates whether Blue revealed (by a final decision to go Left) that either Blue's *actual* preferences had changed, or Blue *believed* that the Mayor's (Red's) actual preferences had changed. 26/29 cases revealed such a change in preferences or beliefs; presumably, it was mostly a change in Blue's beliefs about Red's preferences, given the non-essential nature of a change in Blue's preferences (see above).
- The last two columns show the adjective the subject chose from a given list and the category (Positive, Negative, Neutral, Up, Down, Apprehensive or Confused) to which that adjective had been pre-assigned. Choosing an adjective allowed a subject to communicate its feelings toward the other party.

A statistical analysis of the results is given below the table. Both subjects (of the negotiating pair) gave B as their final suggestion in 29 experiments (out of a total of 56). This gave 29 tests of the prediction as to Blue's expressed preference change and 29 tests of the prediction as to Blue's expressed feelings. There were no counter-examples (c-e) to the preference change prediction and one counter-example to the

feelings prediction (one subject chose to say she felt 'clever'). The cell containing this counter-example is boxed.

The next lines analyse the significance of this. The predictions were quite weak: one half of the possible orderings of outcomes and one-half of the possible choices of adjectives did not constitute counter-examples; hence, a random experimental error (e-e) had only 0.5 probability of leading to a counter-example. Therefore, assuming some random experimental error (due to data being wrongly input, the experiment being misunderstood, and so on) we need to halve the assumed level of experimental error (5%, 10%, 15%, 20%, 30% or 40%) in order to get the probability of a counter-example in a single experiment. Given the number of tests of each prediction, we were then able to use the cumulative binomial distribution (which is good for small or large samples) to calculate the probability of getting x or more counter-examples, assuming various levels of experimental error.

The results confirm the drama-theoretic predictions. There was one counter-example to the feelings prediction—but one or more counter-examples had a 52% probability of occurring in 29 trials, assuming experimental error at 5%. (One or more counter-examples to the preferences prediction—which did not occur—also had a 52% chance of occurring, given this level of experimental error.)

Table 2 similarly shows the results for Red (the Bosnian Serb Mayor) of all Scenario 1 experiments in which both subjects gave B as their final suggestion. In this case there were only 27 preference predictions and 28 feelings predictions to test. This is because we discarded one of the preference statements on the grounds that the preferences stated were "cyclic" (as when an outcome B is preferred to C, which is preferred to A, which is preferred to B), and discarded both the preference and the feelings statements in the case of a subject who admitted to being Confused (these cases are boxed). In this we were following rules designed to cut out as much experimental error as possible.

Again, there were no counter-examples to the preference change prediction. 19/27 subjects stated a preference change. If we ask whether their preferences underwent an *actual* change, we find that 17/27 revealed (by choosing to go Left if Blue went Left)

that their preferences had *actually* changed. Of these 17 actual preference-changers, 7 were not among the 19 who had stated a change. This was quite interesting. It showed that many subjects (9/19) who communicated a change did so deceitfully. Secondly, it showed that many others (7/17) actually underwent a change without communicating it (other than by suggesting B and expressing positive feelings).

There were two counter-examples to the feelings prediction. As two or more had a 24% chance of occurring in 28 trials with 5% experimental error, our predictions were still confirmed. (Note that as we predicted only Positive or Neutral feelings, random experimental error had a 67% probability of causing a counter-example). The counter-examples are boxed; one subject chose to say they were confident, the other that they were apprehensive.

Table 3 shows the results for Blue of all Scenario 2 experiments in which Blue finally suggested C, Red suggested A, and both subjects said they intended to go Left. Only 7 out of 56 experiments met this criterion; clearly, this means we have not yet found a good way to test predictions in the case when subjects confront each other with different positions. The total of 7 was reduced to 4 by the fact that 3 subjects' feelings were in the Confused category. Among these 4, there were no counter-examples to the prediction that Blue's preferences would either remain unchanged or would change by the promotion of outcome B and/or demotion of A; in fact, Blue's preferences always remained unchanged. There was one counter-example to the prediction that Blue would communicate Neutral or Negative feelings: one subject chose to say they felt 'mistrustful.' One or more counter-examples had, however, a 10% probability of occurrence assuming experimental error at 5%. We cannot reject our theory on this evidence.

Table 4 shows the results for Red of the same seven Scenario 2 experiments (where Blue finally suggested C, Red suggested A, and both intended to go Left). As there were no Confused subjects or cyclic preferences, all 7 experiments tested our predictions (that Red might promote B and/or demote C and would feel Neutral or Negative). Four subjects communicated a change of preferences. Of these, one provided a counter-example—but one or more counter-examples had a 16% probability of occurrence assuming 5% experimental error, so that the experiments

did not disconfirm the prediction. Two showed (by choosing to go Left if Blue went Left) that their preferences had actually changed. There was also one counter-example to the feelings prediction; this had a 21% probability of occurrence assuming 5% experimental error. Actually, the same subject was responsible for both counter-examples, making it likely that the subject was confused.

Summing up, these experiments confirmed our predictions, but failed to provide a sufficient number of tests. Tests were particularly few in the case of scenario 2, the interaction where subjects were expected to confront each other. We need to find better experimental methods for testing our predictions, particularly for this case.

Before discussing this further, we explain the results of our mathematical research this year. This has succeeded in building a formal model of the change processes predicted by Drama Theory, and this model suggests reasons for the lack of success in our experimental methods.

Modelling transformations of the frame

We will describe and illustrate the formal model we developed without using mathematical notation or giving proofs of theorems. Interested readers should contact us for these.

The drama-theoretic equivalent of a game in strategic form is a 'frame'. The standard model of a frame is the 'card table'. Figure 3 illustrates; it is a card-table model of Scenario 1, the interaction in Figure 1. Players are listed to the left, with their options (yes/no alternatives) represented by 'cards'. Outcomes are represented by columns with cards placed in the rows where the corresponding option is taken. Preferences are shown by numbers against players' names, the most preferred outcome being given the number 1. A slash is placed in any cell where the 'value' of a card (i.e., its playing or not playing) is 'fixed' by the other values in that particular column; for example, if aid is not given, it cannot be shared, hence there is a slash in the cell at bottom right.

Consider the moment of truth when both players have chosen Shared Aid as their position. The problem is: how can we model the process by which the Mayor comes

to prefer Shared Aid to Unshared Aid (i.e., the preference change by which subjects playing the Mayor came to prefer outcome B in Figure 1 to outcome C)?

The problem is to define a group of transformations between frames. Note that dilemmas at a moment of truth can be eliminated *either* by changes in the frame (including changes in players, cards and preferences between outcomes) *or* by changes in players' positions or fallback strategies. However, the latter changes are not problematic, since positions and fallback strategies are chosen by players, who, having chosen them, are surely free to change their choice. Changes in the frame, by contrast, require changes in players' *beliefs* (about cards, players and outcomes) and *preferences*. These are not 'chosen' in the same way, if at all. Hence the need for a psychologically plausible model of how the frame can change.

Mathematically, we need to define a group of transformations between frames that is *complete* (i.e., any frame is transformable into any other frame) and *psychologically plausible* (i.e., it models the way in which individuals and organisations actually change their minds). The following six elementary transformations seem to meet these requirements.

1. Adding a 'cardless' player.
2. Adding a 'tied' card (one whose value is always fixed by other cell values, meaning that its cell has a diagonal slash in every column).
3. 'Liberating' an infeasible outcome (one that cannot occur because of slashes in certain cells—e.g., in our model it is infeasible to have a card in the bottom row but no card in the top row).
4. 'Diverting' a feasible outcome (i.e., making it infeasible by using slashes to change some of the values it contains).
5. Deleting a cardless player.
6. Deleting a tied card.

Note that these transformations require thinking 'outside the box'—i.e., they require scanning the context of the model to see what players, cards and 'slashes' may reasonably be added or removed. Thinking of ways in which dilemmas can be eliminated generally requires such 'outside the box' thinking, as the presence of dilemmas in a model indicates that the model is under pressure from the players' efforts to change it. We illustrate by a treatment of the example in Figure 4 that is based on an actual operation in Bosnia.

Adding a player. Thinking 'outside the box', the NATO commander orders his patrols to talk to villagers, telling them how much aid they will be giving up if the Mayor does not share aid. *Transformation: Arrow 1 in figure 5. Adds the player VILLAGERS with the preferences shown.*
Adding a tied card. Having perceived the player VILLAGERS, the players next perceive that this player has a card 'attack Mayor'. This card has been ignored because perceived to be tied (in that it is never played). *Transformation: adds the tied card 'attack Mayor' (Arrow 2 in Figure 5)).*
Liberating an infeasible outcome. Having perceived that the player VILLAGERS has the card 'attack Mayor', players perceive that this card might be played if aid is not released. *Transformation: liberates the infeasible outcome shown by arrow 3 in Figure 6 and assigns preferences for it as shown.*

These three transformations give us the model in Figure 6. Note that while the first two transformations seem innocuous (nothing, it seems, can possibly be achieved by adding cardless players and tied cards) this is not true of the third transformation. After outcomes are liberated, new feasible outcomes are created. Players may take advantage of this by adopting new positions and/or fallback strategies. In the Bosnia example, after the last column has been liberated VILLAGERS may adopt 'attack Mayor' as their fallback strategy in case the Mayor refuses to share aid.

The next transformation consists in assuming that they will do just this.

Diverting a feasible outcome. Players assume that VILLAGERS will 'attack Mayor' if aid is not shared; hence they perceive the second column to be infeasible. *Transformation: 2nd column is diverted to last column; that is, column 2 is deleted as infeasible and its feasible consequence is taken to be the last column (starburst 4 in Table 7).*

The next two transformations simplify the model by making 'innocuous' changes.

Deleting a tied card. *Transformation: delete 'attack Mayor' (starburst 5 in Figure 7).*
Deleting a cardless player. *Transformation: delete VILLAGERS (starburst 6 in Figure 7).*

Though these last two transformations are formally innocuous, we may decide to omit them, instead keeping the model of Figure 6 because it makes our assumptions explicit. This illustrates how CCA models are used to store information as well as conduct analyses. If made, the last two transformations bring us back to a simple 2-person model (Figure 8). It is the same as Figure 4 except that the preference change predicted by Drama Theory and found in our experiments has been achieved.

Conclusions and directions for future research

Our general mathematical result is that our six elementary transformations (all but two of which are innocuous) can be combined to transform an arbitrary frame into any other frame. Also, the transformations are, we suggest, psychologically plausible as representing the thought processes by which a player trying to eliminate dilemmas will examine the real-world context of the model, perceive that various elements actually present have been assumed away (by the assumption that certain potential players have only tied cards) and re-visit the assumptions in question in a such a way as to achieve the aimed-for effect. 'Re-visiting' may consist of taking actions (as the NATO commander did in ordering his patrols to talk to villagers), re-perceiving possibilities, or both. In any case, the dilemma is eliminated by 'rationalising' (i.e., giving reasons for) a desired change in the frame.

This way of conceptualising dilemma-elimination—a dilemma leads to emotion which leads to rationalisation of a change in the frame (when there is not a change of positions or fallback strategies)—suggests that the missing element in our experiments is rationalisation. We gave subjects the opportunity to express emotion and communicate preference change, but no way for their emotion to lead to rationalisation. Subjects may have rationalised the change in their preferences in their private thought processes; presumably they did so in the (frequent) cases when change was genuine, not deceitful. But they were not able to communicate their rationalisations. This may account for the fact that only about one-half of the subjects (in Scenario 1) and about one-eighth in (Scenario 2) took the positions and fallback strategies that we expected them to take. Subjects may have felt that they had insufficient means of overcoming the dilemmas inherent in these positions.

Our experimental work next year will explore the possibility of allowing subjects to communicate arguments (i.e., rationalisations), as well as feelings. Also, we intend to make the experiments more complex and realistic by forming a tree-like structure with trees resembling those in Figure 1 and Figure 2 as nodes; that is, interactions similar to Scenario 1 and Scenario 2 will have, as their outcomes, other such interactions—rather than simple end-points. In this way, we hope to create realistic exercises. We are encouraged by the fact that, in their answers to a questionnaire following the exercises, most subjects found them both enjoyable and informative as to the nature of Peace Operations.

Our mathematical work will complement this effort by developing the 'extensive form' of Drama Theory—i.e., the application of dilemma analysis to a game tree, rather than, as at present, to a game in strategic form.

References

1) Howard, N. *Confrontation Analysis, How to Win Operations Other Than War*. CCRP Publication Series, 1999.
2) Smith, R., Howard, N. and Tait, A. 'Confrontations in War and Peace.' CCRTS Symposium, 2001.
3) Murray-Jones P., Howard N. 'Foundations of a Decision Support System for Peace Operations: Designing Experiments to Test the Psychological Hypotheses of Confrontation Analysis', CCRTS Symposium, 2001
4) Smith, R., Howard, N. and Tait, A. 'Commanding Anti-Terrorist Coalitions: A Mid-East Illustration.' CCRTS Symposium, 2002.
5) For an introduction to modern Game Theory, see Osborne, M.J. and Rubinstein, A. *A Course in Game Theory*. MIT Press, 1994.

Figures and Tables

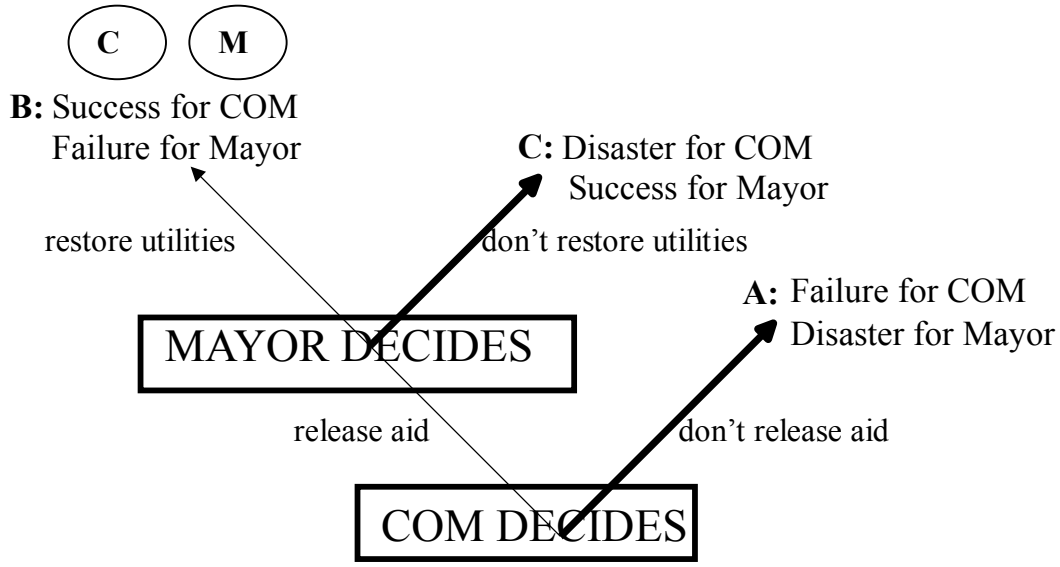

Figure 1: Moment of truth giving rise to trust and co-operation dilemmas. Circled letters indicate positions, thick lines indicate fallback strategies

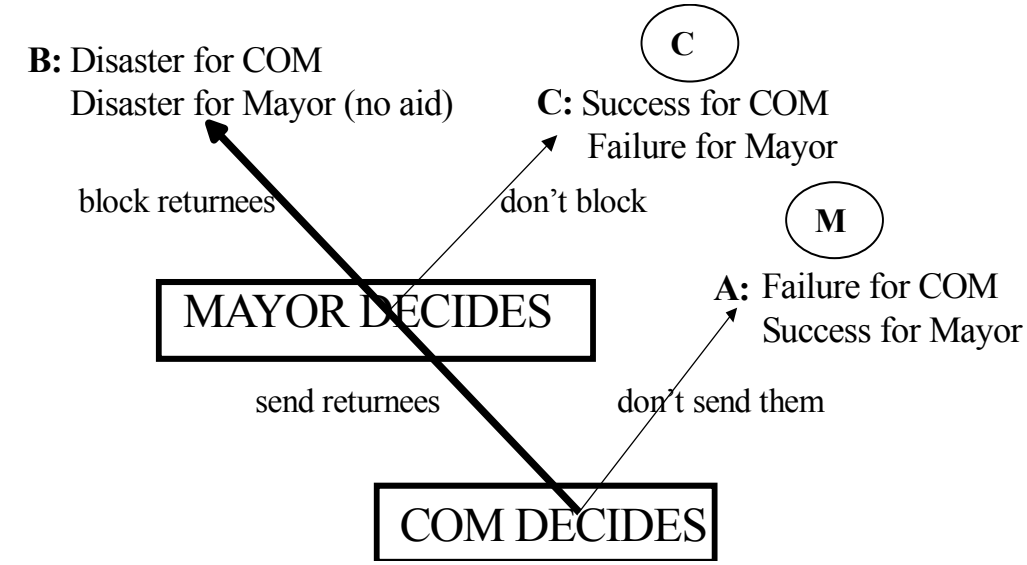

Figure 2: Moment of truth giving rise to threat and inducement dilemmas

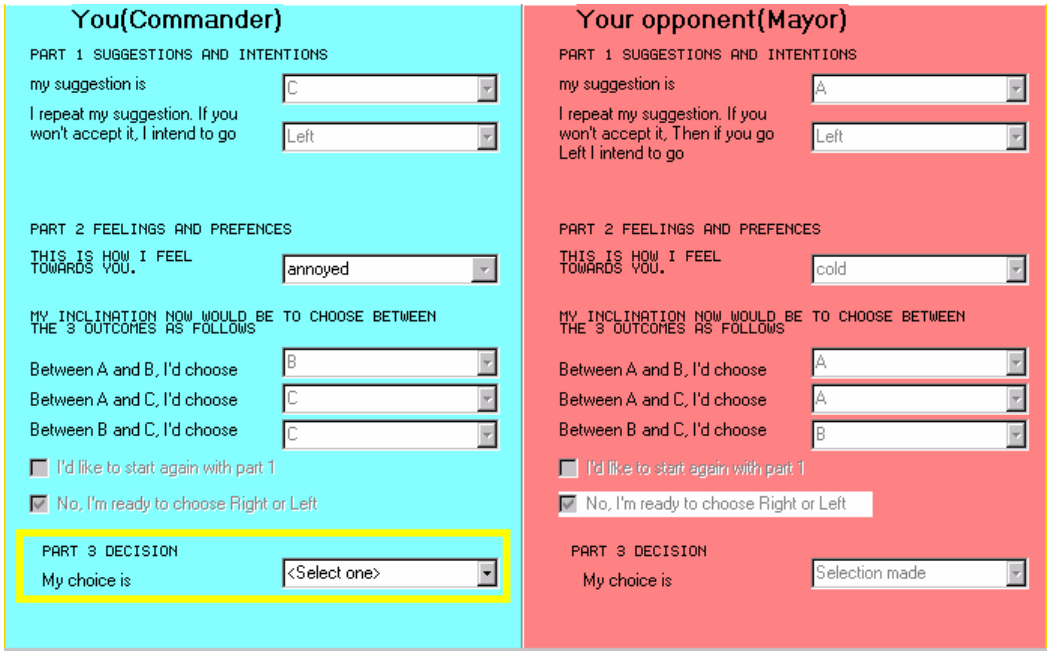

Figure 3: NATO Commander's decision screen as used in experiments

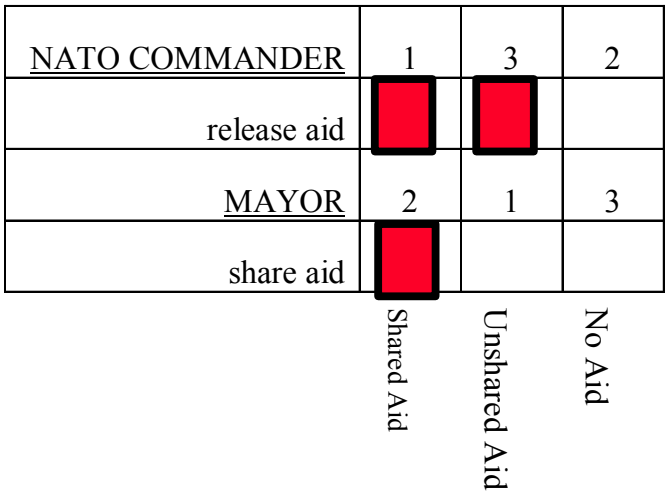

Figure 4: Card table model of interaction in Figure 1.

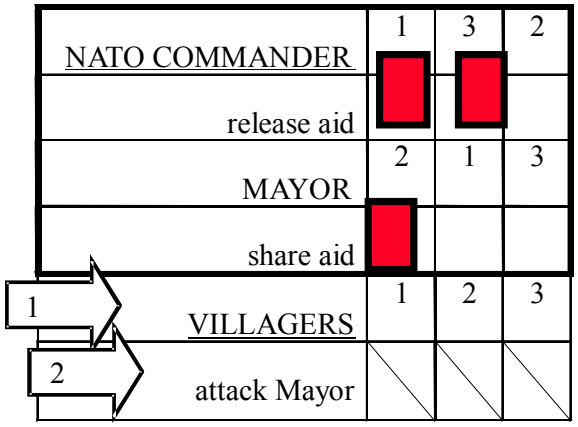

Figure 5: Adding a cardless player, then a tied card.

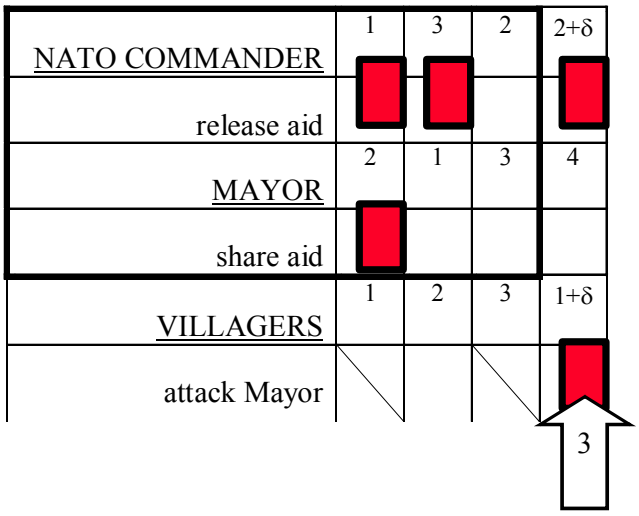

Figure 6: Liberating an outcome

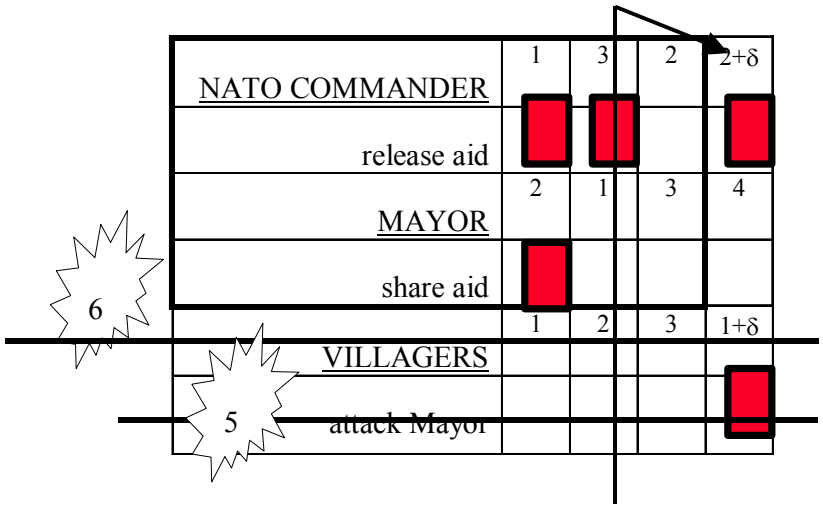

Figure 7: Diverting an outcome, then deleting a tied card and a cardless player

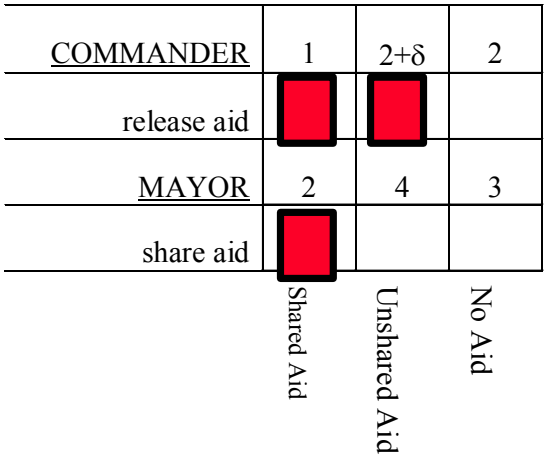

Figure 8: Transformed frame

Blue prefs A/B	A/C	B/C	Stated pref change	Revealed pref or belief change	Blue Adjective	Adjective Group
B	A	B		yes	friendly	Positive
B	A	B		yes	friendly	Positive
B	A	B		yes	friendly	Positive
B	A	B		yes	co-operative	Positive
B	A	B		yes	co-operative	Positive
B	A	B			mistrustful	Apprehensive
B	A	B			co-operative	Positive
B	A	B		yes	apprehensive	Apprehensive
B	A	B		yes	friendly	Positive
B	A	B		yes	co-operative	Positive
B	A	B		yes	neutral	Neutral
B	A	B		yes	clever	Up
B	A	B		yes	friendly	Positive
B	C	B	yes	yes	co-operative	Positive
B	A	B		yes	neutral	Neutral
B	C	B	yes	yes	co-operative	Positive
B	C	B	yes	yes	co-operative	Positive
B	A	B		yes	co-operative	Positive
B	A	B		yes	friendly	Positive
B	A	B		yes	friendly	Positive
B	A	B		yes	friendly	Positive
B	A	B		yes	neutral	Neutral
B	A	B		yes	friendly	Positive
B	A	B		yes	neutral	Neutral
B	A	B		yes	friendly	Positive
B	A	B		yes	friendly	Positive
B	C	B	yes		friendly	Positive
B	C	B	yes	yes	friendly	Positive
B	A	B		yes	friendly	Positive
No of changes	=		5	26		

	Type of prediction	
No of expts = 56	Pref change	Feelings
No of tests	29	29
No of c-e's	0	1
Pr(c-e|e-e)	0.5	0.5
Pr(this many c-e's)		
assuming e-e is: 5%	1.00	0.52
15%	1.00	0.90
20%	1.00	0.95
30%	1.00	0.99
40%	1.00	1.00

Table 1: Lists the results for Blue (NATO Commander) of all Scenario 1 experiments in which both parties' final suggestion was B.

	Red prefs			Stated pref	Revealed pref	Red	Adjective
	A/B	A/C	B/C	change	change	Adjective	group
	B	C	C		yes	co-operative	Positive
	B	C	B	yes	yes	co-operative	Positive
	B	C	C		yes	co-operative	Positive
	B	C	C		yes	friendly	Positive
	B	C	B	yes	yes	friendly	Positive
	B	C	B	yes	yes	friendly	Positive
	B	C	C			co-operative	Positive
	B	C	B	yes	yes	neutral	Neutral
	B	C	B	yes	yes	confused	Confused
	B	C	B	yes		neutral	Neutral
	B	A	C			friendly	Positive
	B	A	B	yes		friendly	Positive
	B	C	C		yes	friendly	Positive
	B	C	C		yes	confident	Up
	B	C	C		yes	friendly	Positive
	B	A	B	yes	yes	friendly	Positive
	B	C	B	yes		friendly	Positive
	B	C	B	yes		co-operative	Positive
	B	C	C		yes	friendly	Positive
	B	A	B	yes		friendly	Positive
	B	A	B	yes		friendly	Positive
	B	C	B	yes	yes	friendly	Positive
	B	C	C			indifferent	Neutral
	B	C	B	yes		friendly	Positive
	B	C	B	yes		apprehensiv	Apprehensiv
	B	C	B	yes	yes	friendly	Positive
	B	C	B	yes	yes	compliant	Positive
	B	C	B	yes	yes	friendly	Positive
	B	C	B	yes		unconcernec	Neutral
No of changes				19	17		

		Type of prediction	
No of expts = 56		Pref change	Feelings
No of tests		27	28
No of c-e's		0	2
Pr(c-e|e-e)		0.5	0.67
Pr(this many c-e's)			
assuming e-e is:	5%	1.00	0.24
	10%	1.00	0.57
	15%	1.00	0.79
	20%	1.00	0.91
	30%	1.00	0.98
	40%	1.00	1.00

Table 2: The results for Red (the Bosnian Serb Mayor) of all Scenario 1 experiments in which both parties' final suggestion was B.

	Blue prefs			Stated pref	Revealed pref	Blue	Adjective
	A/B	A/C	B/C	change	or belief change	Adjective	Group
	A	C	C			confused	Confused
	A	C	C			mistrustful	Apprehensive
	A	C	C			bewildered	Confused
	A	C	C			annoyed	Negative
	A	C	C			confused	Confused
	A	C	C			unconcerned	Neutral
	A	C	C			angry	Negative
No of changes		=		0	0		
					Type of prediction		
No of exercises = 56			Pref change				Feelings
No of tests		=	4				4
No of c-e's		=	0				1
Pr(c-e | e-e)		=	0.5				0.5
Pr(this many c-e's)							
assuming e-e is:	5%	=	1.00				0.10
	15%	=	1.00				0.27
	20%	=	1.00				0.34
	30%	=	1.00				0.48
	40%	=	1.00				0.59

Table 3: The results for Blue (NATO Commander) of all Scenario 2 experiments in which Blue's final suggestion was C, Red's was A, and both parties' final intention was Left.

	Red prefs			Stated pref	Revealed pref	Red	Adjective
	A/B	A/C	B/C	change	change	Adjective	group
	A	A	C			annoyed	Negative
	A	A	C		yes	angry	Negative
	A	A	C			annoyed	Negative
	A	A	B	yes	yes	neutral	Neutral
	A	C	C	yes		friendly	Positive
	A	A	B	yes		angry	Negative
	A	A	B	yes		angry	Negative
No of changes		=		4	2		
					Type of prediction		
No of exercises = 56			Pref change				Feelings
No of tests		=	7				7
No of c-e's		=	1				1
Pr(c-e | e-e)		=	0.5				0.67
Pr(this many c-e's)							
assuming e-e is:	5%	=	0.16				0.21
	15%	=	0.42				0.52
	20%	=	0.52				0.63
	30%	=	0.68				0.79
	40%	=	0.79				0.89

Table 4: The results for Red (Bosnian Mayor) of all Scenario 2 experiments in which Blue's final suggestion was C, Red's was A, and both parties' final intention was Left.