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Testing the relationship between local cue–response patterns and the global structure of communication behaviour

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A central assumption of negotiation research is that organized sequences of cues and responses underlie the dimensions and constructs found to structure interaction. We empirically tested this assumption using a new 'proximity' coefficient, which measures the global interrelationships among behaviours based on their intrinsic local organization within an interaction sequence. An analysis of sequences from 21 hostage negotiations showed that local cue–response dependencies are organized in a way that corresponds with an established structural model of communication. Further analysis of case-specific coefficients showed that criminal, political and domestic incidents involve very different cue–response dynamics, with criminal incidents dividing into two distinct types of interaction. The importance of the proximity concept for unifying local and global accounts of negotiation behaviour, and the avenues of research made possible by the proximity coefficient, are discussed.

While psychologists generally assume that complex sequences of cues and responses underlie the differences observed over independent variables and dimensions of communication, few studies have directly addressed this connection. Probably this neglect reflects not a lack of interest but an absence of appropriate method and theory for studying the global interrelationships among individuals' immediate behavioural choices. For example, methods are available for identifying local cue–response dependencies (e.g. log-linear analysis; Gottman, Markman, & Notarius, 1977), but these do not typically show how such short sequences come together to structure interaction. However, a clear theory about the relationship between local connections and the global structure of behaviour is essential if researchers are to develop a detailed understanding of the interaction process (Olekalns & Weingart, 2003).

The purpose of this paper is to define and test a possible theoretical link between local and global dynamics. Common to both approaches, we argue, is the assumption of proximity: behaviours that occur close together in dialogue have more in common than those that occur further apart. We operationalize this concept by means of a new

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'proximity' coefficient whose mathematics were developed elsewhere (Taylor, 2006) but whose application is reported here for the first time. We use the coefficient to test a structural model of behaviour from observations of cue–response dependencies in negotiation. We then develop this analysis to show how differences in cue–response proximities enable (among other things) systematic comparisons across speakers and among single cases. Thus, our focus in this paper is to explore the value of proximity to understanding negotiation dynamics. This should serve as a good example of what proximity and the proximity coefficient may offer studies of other types of interaction.

The relationship between local dynamics and global structure

Efforts to study interpersonal interaction have advanced in one of two ways. One approach has been to investigate how interaction unfolds over interpersonal dimensions or constructs. This approach to research, captured in frameworks such as facework (Rogan & Hammer, 1994), relational order theory (Donohue, 1998) and the cylinder model (Taylor, 2002a), emphasizes the structure of the communicative process. For example, studies using relational order theory have revealed that conflict negotiations typically involve quite stable levels of affiliation but oscillating levels of interdependence as negotiators struggle for power and position (Donohue & Hoobler, 2002). Similarly, research on trust as a construct has shown that negotiators often begin with intense periods of trust development before moving on to share information and make deals (Giebels, de Dreu, & van de Vliert, 2003). This focus on the global structure of interaction, which others have referred to as a focus on macroprocesses (Collins, 1981) or dimensions of conflict (Pruitt & Rubin, 1986), underlies the majority of existing theory.

A second, rather different approach has been to examine the dependencies among cues and responses with the goal of identifying the 'building blocks' that individuals use to move interaction forward (Taylor & Donald, 2003). For example, negotiators have been shown to respond to cues in a variety of ways, including reciprocation of the other's message, complimenting of their orientation and competing against their general position (Brett, Shapiro, & Lytle, 1998; Putnam & Jones, 1982). A range of papers examining the different types of cue–response interactions or 'interacts' that individuals use, and the processes that these interacts create (Donohue, 2003), illustrate the growing importance of this approach to understanding interaction. These papers relate to the local organization of behaviour, which others have called a focus on microprocesses (McGinn & Keros, 2002), interactional issues (Donohue, 2003) and, quite ingeniously, beads on a multiple-strand necklace (Brett, Weingart, & Olekalns, 2004).

These two levels of analysis offer distinct but undoubtedly connected views of the same interaction process. As has often been recognized, dynamic patterns of cues and responses underlie the dimensions and constructs that researchers use to conceptualize interaction behaviour. In turn, these constructs provide useful conceptual summaries of the ways in which individuals organize their cues and responses over time. Yet, in spite of this recognition, there is little known about how local cues and responses produce the longer-term trends observed over global frameworks. For example, research has shown that conflict negotiations move through oscillating patterns of relative power and that this may, in part, be the result of negotiators using shrewd counter-demands and influence tactics (Donohue & Hoobler, 2002). However the exact nature of the behaviours that underlie different stages of this ebb-and-flow in power dynamics, and exactly how these behaviours organize to form the eventual path of interaction, is less understood. This gap in knowledge is unfortunate for at least two reasons. First, understanding the connection is critical to ensuring that our theoretical explanations correspond with the observable behaviour processes they are supposed to represent. Second, and perhaps more importantly, research is best placed to inform practice and policy if it can be illustrated through direct examples of how cues and responses come together.

The importance of bridging the gap between local and global dynamics is illustrated in several existing lines of research. One prescient example is the issue of turning points in negotiation (Druckman, 1986, 2004). A turning point is a relatively local process in which a brief sequence of behaviours has a dramatic effect on the overall direction and focus of the negotiation. This makes the theory of turning points particularly exciting, because it allows researchers to see how a small dialogic sequence – examinable in considerable detail – shapes the overall direction of a negotiation. A second important exception is the series of studies by Olekalns and Smith (1999, 2000, 2003). Using a detailed coding of behaviour, these studies have considered how the frequencies of particular sequences (e.g. reciprocated cooperation, complementary information exchange) relate to the degree of integrative potential realized by negotiators. For example, their research has shown that cooperative reciprocation and direct information exchange leads to high joint gain (Olekalns & Smith, 2000). By looking at the ways in which cue–response contingencies are associated with different external criteria, this research begins to uncover how local behaviours relate to the outcome of negotiation.

Both the work on turning points and the contingency–outcome relationship illustrate the kinds of detailed understanding that can emerge from examining global aspects of negotiation through the language of local dynamics. However, the two examples represent specific instances of a more general, fundamental connection between local and global dynamics. Their confined focus stems in part from the absence of a unified approach to conceptualizing negotiator behaviour and, perhaps more importantly, the absence of a methodology that enables this connection to be examined directly. We now turn to defining such a theoretical and empirical connection between the local organization and global structure of behaviour.

Behavioural proximity as a unifying concept

The starting point for a common theoretical language between local and global processes is the notion that co-occurring behaviours play a similar role in interaction. At the global level, co-occurring behaviours take the form of strategies and arguments that are created by bringing together behaviours that emphasize a common objective or issue. The result is a commonality or connection among adjacent periods of interaction. At the local level, co-occurring behaviours form cue–response sequences whose changing meaning is gradual and coherent rather than random and haphazard. The result is a path of interaction in which the substance of dialogue unfolds gradually. This connectedness among co-occurring behaviours provides conceptual common ground for analysing local and global dynamics. We state this connection more formally as a concept of *proximity*: behaviours located close together in a sequence contribute to the same part of the interaction and have more in common – in terms of the speaker's motivating concerns, strategies and cognitions – than those that occur apart in the sequence.

The concept of proximity may be seen to underlie both global and local accounts of negotiation. At a global level, the major dimensions of negotiation have gained support from evidence showing that theoretically similar behaviours occur together more frequently than theoretically dissimilar behaviours. For example, the distinction between distributive and integrative bargaining is accepted because the behaviours associated with each bargaining approach typically occur in closer proximity to themselves than to behaviours exemplifying the other approach (Donohue & Roberto, 1996; Olekalns & Smith, 2000). Similarly, at a local level, the suggestion that 'utterances are generated by other utterances' (Argyle, 1969, p. 115) and the general principle of 'limitation' (Watzlawick, Beavin, & Jackson, 1968, p. 131) both speak to the idea of behaviours shaping the meaning and impact of other nearby (i.e. proximal) behaviours. The result is a moving window of connectedness or proximity.

The concept of proximity may also be seen in previous approaches to analysing interaction. For example, one popular approach has been to divide an interaction into a series of subsequences wherein the frequencies of behaviours may be measured and compared over time (Donohue & Roberto, 1996; Taylor, 2002a). Proximity in this case is created by imposing artificial boundaries beyond which no similarity or association among behaviours is assumed. This is also the case in other techniques, such as phase analysis, which examines proximity through a stricter criterion that considers only uninterrupted sequences of identical behaviours to be related (Holmes & Sykes, 1993). Interestingly, the limit of such boundaries is the focus of other methods such as Markov or log-linear analysis. By measuring the extent to which one behaviour can be used to predict future behaviour, these methods consider directly the affect of proximal behaviours on the development of an interaction sequence (Olekalns & Smith, 2000; Taylor & Donald, 2003).

From a broader perspective, the notion of proximity is consistent with current social–cognitive theories of social interaction (Anderson, 1996; Mischel & Shoda, 1995; Rumelhart & McClelland, 1986). These theories conceptualize behaviour as emerging from the distributed set of units whose 'activation levels' are triggered by recent (i.e. proximal) as well as current events. These activations decay over time, such that behaviours with a high proximity to the current action have a much greater effect on the state of the system than behaviours with low proximity. Conversely, those behaviours associated with high levels of proximity would be predicted to have strong positive connections linking their representative units in the theoretical system.

This collection of evidence suggests that proximity may serve as a powerful explanation of the connection between local and global accounts of interaction. However, evidence to support this proposal is limited because researchers have not yet developed a way of examining the overall pattern of local level connections. As the above examples demonstrate, most existing efforts examine the global pattern of connections indirectly in terms of co-occurrences among behaviours in subsections of interaction (e.g. Taylor, 2002a). What is needed is a more direct way of measuring the overall structure of an interaction from information about the underlying pattern of cues and responses; that is, a more flexible tool for measuring proximity is required.

Measuring proximity

A method for measuring proximity has recently been developed in the form of a proximity coefficient (Taylor, 2006). The coefficient, which varies between 0.00 and 1.00, expresses the relationship between two types of behaviour as a direct function of their relative placements in a sequence. The coefficient equals .00 if the behaviours occur only once at the first and last position of the sequence. It equals 1.00 if one of the behaviours immediately precedes the other without exception. Values between these two extremes reflect differing amounts of proximity between the two behaviours being examined. Specifically, the proximity coefficient decreases monotonically as more behaviours are found on average to separate the two behaviours being examined (i.e. proximity reduces). It does this in a manner that is independent of the number of times a behaviour occurs in the sequence, and independent of the length of the sequence (see Appendix 1 for more details).

To illustrate the proximity coefficient, suppose we observed the interaction sequence shown in the left-hand side of Table 1. The 11 behaviours of this sequence are denoted by letters, with different letters indicating the occurrence of a different type of behaviour. The proximity coefficients for this sequence are shown on the right-hand side of Table 1. An inspection of the sequence shows that behaviour E and behaviour D occur only once and at opposing ends of the sequence, such that their proximity is the minimum possible. In contrast, behaviour B always occurs directly after behaviour A, such that the proximity of these behaviours is the maximum possible. Consistent with these two limits, the coefficient matrix reports a perfect association between A and B (1.00) and a complete non-association between E and D (.00). All of the other relationships among the codes have intermediate values that are dependent on their distances apart in the sequence. For example, behaviour A is associated with descending values of the coefficient when moving from its relation to B (1.00), to C (.67) through to D (.50). Examining the sequence confirms that behaviour A is closest on average to behaviour B, is slightly less close to the two occurrences of behaviour C and is furthest away from the concluding behaviour D.

Table 1. An example behavioural sequence with resulting proximity coefficient matrix

	Resulting proximity coefficient matrix					
		Behaviour-type (v_q)				
Behavioural sequence	Behaviour-type (v_p)	A	B	C	D	E
E A B A B A B C C A D	A	81[a]	100	67	50	–
	B	93	89	78	44	–
	C	94	–	100	83	–
	D	–	–	–	–	–
	E	100	89	33	00	–

[a]Decimal point omitted.

The undefined value of the coefficient measuring the relationship of A to E is appropriate because E never follows A. While missing coefficients are an inevitable consequence of short sequences, missing coefficients within longer sequences provide an indication of the relative distribution of a behaviour within the interaction. A large number of missing values in a variable row (or column) indicates that most observations of the behaviour occurred toward the end (or beginning) of the sequence. At the extreme, a row of missing values indicates that the associated code occurs only at the last position in the sequence (e.g. behaviour D). A column of missing values indicates a code that occurs only at the beginning of a sequence (e.g. behaviour E).

It is worth highlighting two other properties of the matrix in Table 1. First, a coefficient appearing on the diagonal of the matrix measures the extent to which a behaviour precedes itself. Specifically, these coefficients are a measure of reciprocity (Putnam & Jones, 1982) that quantifies the number of codes that occur before reciprocation, rather than simply the frequency of immediate reciprocation. The higher the value of the coefficient, the more immediate the reciprocation within the interaction. At the upper limit, a coefficient of 1.00 indicates immediate reciprocation for every occurrence of the behaviour. These coefficients may therefore be used to test hypotheses about the nature and breadth of reciprocity, such as the possibility that reciprocation may not necessarily occur immediately but as a result of a response to several intermediate behaviours (Putnam & Jones, 1982).

A second important feature of the matrix is an asymmetry in the coefficient values. For example, the coefficient for behaviour A preceding B (i.e. 1.00) is higher than the coefficient for behaviour B preceding A (i.e. .93). In general, matrices of proximity coefficients will be asymmetrical, reflecting the possibility that one code occurs before the second on the majority of occasions. The difference between the two coefficient values indicates the extent to which one code precedes the second, with large differences suggesting significant asymmetric relations. For example, the sequence in Table 1 has no immediate occurrence of behaviour C after the occurrence of behaviour A, but an immediate occurrence of behaviour A after the occurrence of behaviour C. This asymmetry in the occurrences of A and C is reflected by a large positive difference in the coefficients (i.e. $.94 - .67 = .27$). At the extremes, a difference in coefficients of $+1.00$ would indicate that A always occurred immediately after C and that C never occurred before A (i.e. absolute asymmetry). A difference of -1.00 would indicate the opposing asymmetry that C never occurred before A.

Such differences may provide a flexible way of testing stage theories of interaction. These theories, which exist in many disciplines (Abbott, 1992), predict the order in which a set of events will occur over time. For example, Gulliver (1979) predicts that negotiations move through periods of agenda and issue identification, issue exploration and issue narrowing, and final bargaining and agreement execution. His theory anticipates some deviation from this order, such as a skipping of stages or the reoccurrence of stages, but it expects the majority of interactions to follow this autonomous, common sequence of events. In proximity terms, a perfect series of stages would be reflected by a (rearranged) matrix in which the upper off-diagonal coefficients were missing (since previous phases should not occur again), the diagonal coefficients equalled 1.00 (since phases are defined as uninterrupted occurrences of a particular code) and the lower off-diagonal coefficients decreased monotonically in a way that corresponded with the predicted order of stages. When the interaction involves a recycling or separation of stages, the coefficients on the diagonal of the matrix would have a value of less than 1.00. In this case, a detailed analysis of the lower matrix should give an indication as to whether or not the reoccurring stages have a common predecessor.

Testing the relationship between structure and local cue–response patterns

To demonstrate the importance of proximity as a unifying concept, we use the new coefficient to test a model of the structure of communication behaviour in conflict negotiation (Taylor, 2002a; Taylor & Donald, 2004). By structure we refer to the theoretical dimensions that summarize the similarities and differences, or interrelationships among behaviours. The problem of proposing fruitful ways to differentiate behaviour is well-known for non-sequence data, where it has led to developments such as the interpersonal circumplex (Lorr, 1996). The structure of negotiation dialogue has recently been addressed by Taylor, who integrated existing theoretical perspectives (e.g. relational, Donohue, 1998; facework, Rogan & Hammer, 1994) into a comprehensive model of the ways in which negotiators bring together their cues and responses. Taylor demonstrated that this model is consistent with the different emphases of negotiators' messages over the course of actual police crisis negotiations. In a replication, Taylor and Donald found that the model is consistent with the organization of messages in police-simulated negotiations, despite the simulations involving a less diverse set of interactions to fit training requirements.

In deriving support for the model, however, both Taylor (2002a) and Taylor and Donald (2004) analysed the occurrence of behaviours within artificially created subsections of dialogue, and not directly by measuring the interconnections among cues and responses. As a consequence, it was only possible to assume that the supporting findings reflected the organization of negotiators' local cue–response sequences. This assumption is exactly the type of hypothesis open to statistical test through the proximity coefficient. We therefore reanalyse data from Taylor (2002a) and Taylor and Donald (2004) to determine whether the organization of behaviour in sequences of interaction, as measured in terms of proximity, leads to the cylindrical structure found in the previous analyses.

The structure proposed by the cylindrical model is comprehensively described in Taylor (2002a). Briefly, the model distinguishes both the negotiators' overall approach to interaction (Avoidance, Distributive or Integrative) and the predominant concerns or issues they address while taking this approach (Identity, Instrumental or Relational). These two distinctions interact to form nine different modes of interaction. These modes, and the way in which they are structured within the model, are presented in Figure 1. Each of these modes may be adopted by a negotiator during a particular period of interaction. Consequently, each is expected to be associated with a subgroup of behavioural counterparts, where support for a mode comes from evidence that the

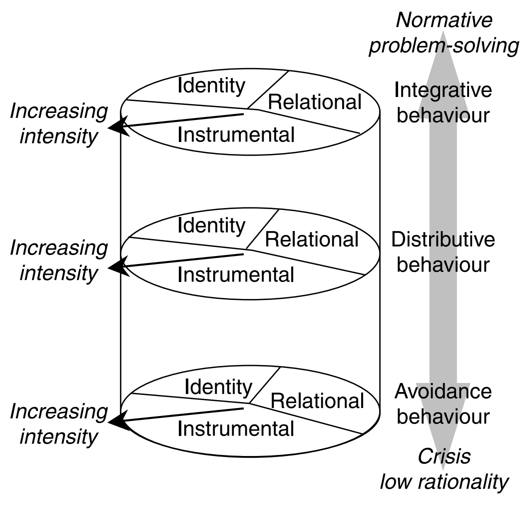

Figure 1. A schematic representation of the cylindrical structure of negotiation behaviour.

counterparts occur together consistently over the negotiation. In other words, if negotiators do focus on the predicted modes of interaction, then there will be evidence that behaviours instantiating the same mode have a higher proximity within the sequence than behaviours associated with different modes.

The behaviours predicted to form the nine modes of interaction are shown in Table 2, and are derived from previous theory and research (see Taylor, 2002a). The three distinctions are represented by the first three columns of Table 2. The first differentiates negotiators' level of interaction and whether a behaviour reflects withdrawal from interaction (Avoidance), a competitive approach to the other party (Distributive) or an effort to develop cooperation with the other party (Integrative). The second distinction concerns what goal or issue a negotiator focuses on while adopting a particular orientation. Negotiators may adopt an avoidant, competitive or cooperative orientation to substantive demands (Instrumental), to issues of trust and affiliation (Relational) or to concerns about self or other's identity (Identity). Finally, the third distinction aims to capture the important role of escalation and de-escalation in negotiation, with some behaviours predicted to act as commonplace fabric to the negotiation (Low intensity) while others have a functionally discrete purpose (High intensity).

These predictions relate to a specific pattern of proximities among behaviours. Specifically, to support the cylinder model, the behaviours that are predicted to exemplify the same mode of interaction should appear closer together (i.e. more proximal) in the interactions compared with behaviours associated with different modes of interaction. Moreover, not only should the relative proximities match the predicted subgroups, but the subgroups themselves must interrelate in a way that corresponds to the cylinder structure. For example, the behaviours predicted to instantiate Avoidance interaction should hold higher proximities with behaviours denoting Distributive interaction than those associated with Integrative interaction. Thus, in general, the greater the conceptual similarity between two modes of interaction, the more likely their behavioural counterparts should be found to occur together within the sequences of interaction.

These kinds of hypotheses are most appropriately tested using a multidimensional scaling technique such as Smallest Space Analysis (SSA-I). SSA-I will represent the proximities among behaviours in an intrinsic manner as points arranged in a spatial plot. The greater the average proximity of two behaviours in the interactions, the closer their representative points will appear on the spatial plot. This approach is useful because it allows the underlying organization of the behaviours to be compared directly with the similarities and differences predicted by the cylinder model. If the arrangement of points in the plot may be partitioned into regions that correspond with the groupings of behaviours predicted in Table 2, then this will support the model as a representation of the structure of communication behaviour in crisis negotiation (for more details about this approach see Donald, 1985; Donald & Cooper, 2001; Taylor, 2002a).

Method

Transcript sample

Data were interactions from 9 actual hostage negotiations and 12 hostage negotiator training simulations. The negotiations were transcribed from audiotape recordings made available by various US police departments. In each interaction, a police negotiator interacted with one or more hostage takers, which in the case of the

Table 2. Predicted correspondences between 9 modes of interaction and 41 communication behaviours

Level of interaction	Motivational source	Behaviour	Definition
Integrative	Identity	Allure	An attempt to show how conciliation will please others (e.g. family) and bring personal satisfaction
		Compliment	Explicit praise for the other party's attitude or behaviour
		Empathy	Expression of sympathy for the circumstances, explanations or feelings presented by the other party
		NegSelf	A reflective criticism of personal behaviour or ability
		Apology	Explicit remorse for a previous action
		Common	Allude to a similarity between the other party and a personal attitude, behaviour or belief
	Instrumental	Offer	An offer of sentiments or goods that precedes any request
		Integrative	Proposition of a solution or approach to interaction that is beneficial to both parties
		Compromise	Suggestion of a mutual concession as a substitute to directly conciliating to the other's demand
		Comply Demand	Concession to a demand or request
		Promise	Explicit assurance that a previous action was sincere or that a future action will occur
		AcceptOffer	Acceptance of a conciliatory offer from the other party
	Relational	Reassure	Attempt to play down troublesome aspects of the situation or confirm a fact about the situation
		Agree	Express agreement without explicitly offering praise (Compliment) or conciliating (e.g. ComplyDemand)
		Confidence	Conveyance of trust or belief in the other party's ability
		Encourage	An attempt to persuade the other to take a particular action or adopt a viewpoint
		Discourage	Reasoned argument aimed at pointing out the negatives of a particular viewpoint or action
		Humour	Attempt to use humour or make a joke
Distributive	Identity	Criticism	A condemnation of the other party's behaviour or ability where an explanation is given for the evaluation
		Commitment	An expression of dedication to a particular statement, position, or attitude
		PosSelf	Boasting about personal superiority over the other party in terms of ability or situation
		Insult	An abusive or humiliating comment directed at the other party
		Profanity	The use of swearing or indecent language
	Instrumental	Reject Demand	A refusal to comply with a demand of the other party
		RejectOffer	A rejection of an offer without suggestion of an Integrative agreement, Compromise or Alternative
		Demand	An expression of a wanted concession
		ThreatAction	Threat to take retaliatory action if the other party does not comply with a demand or promise
		Alternative	Proposal of a concession or solution that involves something not previously considered

Table 2. (*Continued*)

Level of interaction	Motivational source	Behaviour	Definition
	Relational	Justify	Explanation in which the speaker admits responsibility but rejects the notion that the behaviour is negative
		Excuse	Explanation in which the speaker admits responsibility but suggests there are exonerating circumstances
		Appeal	Request for the other to comply with the individual's desire with no suggestion of personal sacrifice
Avoidance	Identity	Denial	Refusal to accept or acknowledge an accusation made by the other party
		Accuse	Challenge the other party's assertion or fault them for performing (or not performing) a desired action
		Provoke	An overt attempt to aggravate the other party into taking some aversive action
	Instrumental	Avoidance	Attempt to avoid substantive interaction through either a direct request or subtle withdrawal
		Shift	The termination of dialogue by using a message that communicates about an unrelated issue
		Retract	Renunciation from a previously acknowledged agreement or decision
		Inaction	Failure to respond despite having the opportunity. Scored when a speaker fails to respond on three consecutive occasions
	Relational	NegReply	Short retorts with an unenthusiastic or uncaring tone
		Submissive	Statement that express apathy or a lack of appreciation for events of the conflict
		Interrupt	Continuous disruption of the opposing party, scored as positive after occurring on two consecutive occasions

Note. Behaviours in each mode are listed in order of predicted increasing intensity.

simulated incidents were impersonated by trained actors. The negotiations varied in scenario from suicide intervention, to criminal-barricade incidents, to those centred on psychological or domestic issues. This range of settings is sufficiently broad to embody what police officers perceive as the distinguishing types of hostage crises (Donohue & Roberto, 1996). The actual hostage negotiations contained an average of 2,157 utterances, of which an average of 46% ($SD = 7.5\%$) were spoken by the police negotiator, 43% ($SD = 14.0\%$) were spoken by the hostage taker and 12% ($SD = 10.1\%$) were spoken by other parties. The simulated hostage negotiations contained an average of 718 utterances of which an average of 50% ($SD = 9.1\%$) were spoken by the police negotiator, 46% ($SD = 10.4\%$) were spoken by the hostage taker and 4% ($SD = 10.0\%$) were spoken by other parties.

Coding procedure

The sequence data were generated by dividing the interactions into behavioural units and then coding these units as one of 59 behaviours.

Division into thought units

Each negotiation was initially divided into thought units (Gottman, 1979). A thought unit conceptually relates to a complete idea that a speaker wishes to express and occurs in actual speech as a main clause (i.e. subject–verbpredicate combination) together with any dependent and coordinate clauses. Coding at this level therefore minimizes the possibility of analysis overlooking smaller but psychologically meaningful components of dialogue. The reliability of unitizing was assessed by having two coders parse approximately 10% of dialogue from both the real and simulated negotiations. For the hostage dialogue, the coders agreed on the placement of 95% of the units and achieved a unitizing reliability of .04 (Guetzkow, 1950). For the simulated negotiation dialogue, coders agreed on the placement of over 99% of the units and achieved a unitizing reliability of .004. All errors in unitizing were addressed before the transcripts were coded.

Coding of thought units

The thought units were coded using the categories identified in Taylor (2002a). These categories reflect 59 variables that reflect the behaviour of negotiators during conflict. Coding involved a considered application of the categories to the content of hostage taker, police negotiator and third party thought units as they occurred in the flow of dialogue. For each transcript, the series of assigned codes were used to generate a single sequence. To remain consistent with previous analyses (Olekalns & Smith, 2000; Taylor, 2002a), these sequences were then refined so as to include only those behaviours that possess a clear psychological function. This resulted in each of the 21 sequences containing occurrences of 41 behaviours, which are given in Table 2.

Reliability of the coding was assessed by having one rater code approximately 5% of the thought units from the hostage negotiations, and a second rater code approximately 5% of the thought units from the simulated negotiations. Agreement with the first author's coding, measured using Cohen's kappa (Cohen, 1960), was .73 (range .63–.81) for the hostage data and .70 (range .60–.89) for the simulated negotiation data. These values suggest a satisfactory level of coding (Bakeman & Gottman, 1997).

Results

For each sequence, we computed proximity coefficients measuring the relationship of each behaviour with every other behaviour. The coefficients were computed from all speakers' behaviour to allow an examination of the overall structure of communication. These coefficients were then averaged across the 21 sequences and the resulting association matrix made symmetrical by taking the mean of the coefficient for each pair of behaviours. For example, because the coefficient for Accuse preceding Allure was .84 and the coefficient for Allure preceding Accuse was .90, a mean value of .87 appeared in the matrix for the relationship between Accuse and Allure. This aggregation enabled the relative proximities among behaviours to be modelled using the same multidimensional scaling approach as used in previous studies. The resulting matrix contained 1,640 (41 variables × 40 variables) comparisons measuring the average proximity of any two behaviours within the negotiations. This matrix was submitted to a SSA-I (Lingoes, 1973) in three dimensions.

Figure 2 shows the first and second dimensions of the SSA-I solution. Each point on this plot represents one of the 41 behaviours defined in Table 2. The labels given to the points correspond with the variable names defined in Table 2. The distance between two points on the plot reflects the extent to which the corresponding behaviours occurred together in the negotiations. Specifically, the closer two points appear, the greater the average proximity of the two behaviours in the interaction sequences. For example, at the top of Figure 2, the adjacent location of accepting the other party's offer (i.e. the point labelled AcceptOffer) and making a promise (Promise) indicates that these behaviours were typically found in close proximity to one another in the interactions. In contrast,

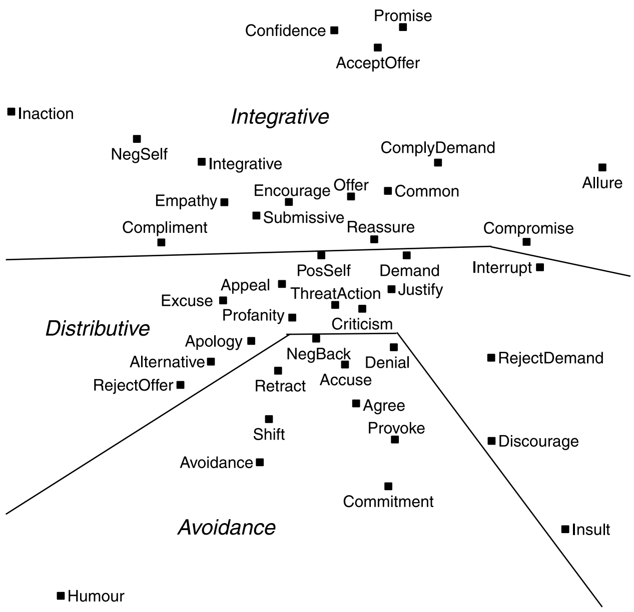

Figure 2. Smallest Space Analysis of negotiation behaviour across 21 interaction sequences. Coefficient of alienation = 0.23 in 26 iterations. The plot is overlaid with regional interpretations showing Avoidance, Distributive and Integrative levels of interaction.

making a promise (Promise) and insulting (Insult) the other party were not typically used together in dialogue, as shown by their placement at opposing ends of the SSA-I plot.

Does the cylinder model still exist when the interrelationships among behaviours are measured in terms of proximity? To answer this question, the configuration of behaviours on the SSA-I plot may be examined for evidence of regions that are consistent with the predictions in Table 2. Support for a particular distinction comes from being able to partition the behaviours predicted to exemplify the distinction into a discrete region of the plot. Support for the complete model requires evidence of all three facets, where the relationships among the regions formed by each facet support the arrangement of regions hypothesized in Figure 1.

Levels of interaction

Figure 2 also shows partitions that correctly divide 33 (81%) of the behaviours into their predicted Avoidance, Distributive and Integrative regions. As predicted, these regions are ordered from bottom to top of the plot according to an increasing normative, problem-solving emphasis. The six behaviours in the bottom region support the prediction that, on some occasions, negotiators are reluctant to take an active role in dialogue (Avoid, Denial), retract from previous developments (Retract) and reinforce this withdrawal through disruptions (NegReply, Shift) and irrelevant challenges (Accuse, Provoke). In comparison, behaviours in the middle of the plot have a Distributive emphasis that is characterized by aggressive bargaining (Demand, RejectOffer) threats (ThreatAction) and personal attacks of the other party (Criticism, Insult). Finally, behaviours located in the top region depict a more cooperative approach to interaction. In this approach, negotiators communicate an awareness of the others' situation (Encourage, Empathy), a willingness to accept responsibility (Apology, NegSelf) and a desire to tackle the disagreement by proposing solutions (Integrative, Offer) and making sacrifices (ComplyDemand, Promise). The likelihood of observing this patterning by chance may be tested by comparing the number of behaviours occurring in their predicted region with the number of behaviours that might be expected to occur in the predicted regions by chance. The correspondence between the predicted and observed regioning of behaviour is unlikely to have occurred by chance ($\chi^2 = 15.2$, $df = 1, p < .01$).

Motivational source

Since there is an interpretable structure to negotiators' overall approach, it is appropriate to test for variations in the motivational emphasis of behaviours. These distinctions relate to differences in the circular faces of the cylinder and so are most evident when adopting a 'birds-eye' view of the SSA-I plot. Figure 3 shows the second and third dimensions of the SSA-I solution, which for clarity are separated into the Avoidance, Distributive and Integrative levels of interaction. The three configurations are overlaid with partitions that support the qualitatively distinct subgroups of behaviour predicted by the motivational facet (see Table 2). For example, the left region of the plot for Avoidance interactions (Avoidance–Instrumental) contains behaviours that seek to draw back from previous progress (Retract) and move away from the current issue (Avoidance, Shift) or from interaction entirely (Inaction). In contrast, the occurrence of the variables Accuse, Denial and Provoke within a region situated towards the bottom-right of the plot (Avoidance–Identity) suggests that these behaviours have a different application, focusing on removing personal self from the

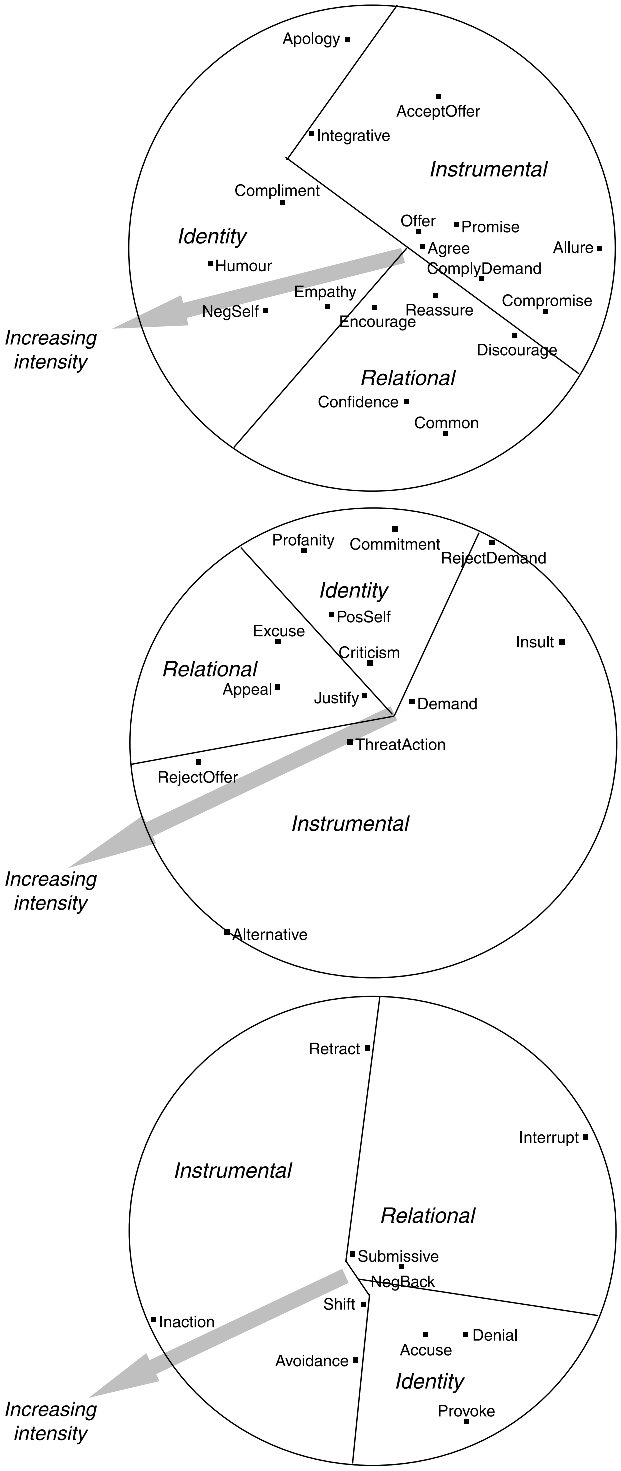

Figure 3. Dimensions 2 and 3 of the SSA-I configuration showing the motivation facet and the modulating intensity facet. The configuration is divided into the Avoidance (bottom), Distributive (middle) and Integrative (top) levels of interaction.

interaction. Note that the partitions among the different motivational emphases retain the major distinction between Instrumental goals and Identity and Relational goals. This regioning substantiates the widely held assumption that communication is comprised of both instrumental and expressive acts, with the latter formed by identity and relational issues (Wilson & Putnam, 1990). In total, 37 (90%) behaviours are located in their predicted regions, which is unlikely to have occurred by chance ($\chi^2 = 26.6$, $df = 1$, $p < .01$).

Intensity

As shown by the arrows in Figure 3, the distribution of behaviours also supports the predicted intensity facet (see Table 2). At each level of interaction, increasingly intense behaviours are found to occur with movement towards the edges of cylinder faces. For example, in the Integrative–Relational region, intensity spirals from expressions of empathy (Encourage) and assurances (Reassure), to messages that reveal similarities with the other party (Common) or express confidence in the relationship (Confidence). Similarly, the left region of the plot for Integrative behaviours (Identity region) depicts increasing efforts to support the other's identity, from empathizing with their situation (Empathy) to praising their ability (Compliment) to highlighting instances where their actions were more appropriate than personal behaviour (Apology, NegSelf). This substantive evidence may be tested statistically by correlating the rank order of behaviours' distances from the regions' origin and the ranks predicted in Table 2. The observed positive average correlation of .73 ($SD = 0.23$) supports the predicted association of intensity with movement to the edge of each level of interaction.

Comparisons across role

In the previous section, the data were analysed without reference to the speakers in order to capture the overall structure of communication behaviour. An analysis of this kind, and the cylinder model that it is designed to test, provides a useful depiction of the ways in which negotiators organize their cues and responses over time. However, what it does not do is distinguish the unique contribution that each negotiator makes to the overall structure of interaction. To examine this aspect of the data, it is necessary to compute speaker-specific proximity coefficients that capture both the within-speaker and between-speaker proximities among behaviours. This is achieved by including speaker information in the coding of the sequence, such that separate coefficients are computed for instances of the same behaviour spoken by different individuals. The result is a detailed matrix of proximity coefficients that reveal a great deal about the differences in behaviours across role.[1]

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[1] *Because the current data were divided into thought units, the sequence of coded units did not alternate between speakers in a regular manner. This often causes problems when examining role differences because the contingencies among behaviours reflect a combination of within- and between-speaker observations (i.e. the next behaviour in a sequence may be part of the same speaker's utterance or part of the other speaker's response). To resolve this problem, it is common to reduce the data using a method that standardizes the transitions among observations (see Taylor, 2002b for three examples). This approach is less than ideal, however, because it moves the data further away from their original form. Using the proximity coefficient largely avoids this problem, because inherent in the coefficient is the view that behaviours have less of an impact on current interaction if they occur further in the past. In proximity terms, when a speaker's message (e.g. thought unit) is succeeded by other messages, its impact on the other party is regarded as less than would have been if the behaviour occurred directly before the other's speaking turn. Thus, our solution in this paper was to retain the natural unevenness of interaction on the basis that this falls in line with the proximity approach, and the fact that the other negotiator may have interrupted the current speaker had he or she wished to do so.*

To illustrate this approach, Table 3 shows a subsample of the coefficients derived from a speaker-specific analysis of the current data. The table contains proximity coefficients for the five instrumental behaviours Inaction, Demand, Threaten Action, Offer and Promise.[2] The table is divided into four quadrants of coefficients that reflect different forms of proximities among the behaviours. The top-left and bottom-right quadrants show proximities for behaviours spoken by the same speaker (i.e. within-speaker proximities). For example, the coefficient .87 in the top left of Table 3 reflects the extent to which hostage takers follow Inaction with further instances of Inaction (e.g. self-imitation). In contrast, the top-right and bottom-left quadrants of Table 3 show the proximities of negotiators' responses to the cue of the other party (i.e. between-speaker proximities). For example, as indicated by the value .98 towards the bottom left of Table 3, a police negotiator's overwhelming response to a hostage taker's Inaction is to make an Offer, presumably in an effort to re-engage the hostage taker in dialogue. Finally, note the absence of proximity coefficients for police negotiators using Inaction. This is consistent with police negotiators' practice of always responding to hostage takers' dialogue (McMains & Mullins, 2001).

An examination of speaker-specific coefficients such as those in Table 3 may provide significant insights into the role dynamics that underlie the structure of communication. The within-speaker coefficients (top-left and bottom-right quadrants of Table 3) provide a way of comparing the propensity of negotiators to take a competitive or cooperative orientation to interaction. For example, police negotiators are more likely than hostage takers to follow their Demands with an integrative behaviour such as Offer (.94 compared with .84) or Promise (.81 compared with .71). In contrast, hostage takers are more likely than police negotiators to maintain a competitive orientation, as indicated by the relatively high coefficient values for the repetition of Demands (.96 compared with .93) and Threats of Action (.91 compared with .87). This difference in temperament is consistent with the distinction in orientations predicted in Table 2, and exemplifies the baseline or 'set point' (Cook *et al.*, 1995) on which negotiators centre their arguments and efforts at persuasion. The coefficients therefore reveal how the tendency of hostage takers to frame their messages in distributive terms (and police negotiators' tendency to frame in integrative terms) makes an important contribution to the levels of interaction distinction observed in the cylinder model.

In contrast to the within-speaker coefficients, the between-speaker coefficients (top right and bottom left of Table 3) provide insights into the types of cue–response patterns that dominate the discussion of instrumental issues. One of the most striking patterns is apparent in negotiators' responses to the other party's promises. Hostage takers invariably respond to a Promise with a Demand (.98) or Threat of action (.92). In contrast, police negotiators most proximal response to a Promise is invariably an Offer (.97). The two negotiators thus react to promises in different ways, although interestingly, neither party is particularly inclined to respond by reciprocating the other's Promise (.54 and .84, respectively). In more general terms, the pattern of cue–response proximities across the speakers serves as an illustration of the link between global distinctions and local contingencies. For example, hostage takers are more likely to respond-in-kind (i.e. higher proximity) to Demands and Threats of action than to Offers and Promises (average coefficient = .92 and .74, respectively). In contrast,

[2] *The coefficients presented in Table 3 fall at the higher end of the range of coefficients derived from the data (range 0.10–1.00), which is to be expected because the behaviours share a common focus on instrumental issues.*

Table 3. Role-specific proximity coefficients for five instrumental behaviours

	Speaker									
	Hostage taker (v_q)					Police negotiator (v_q)				
Speaker	Inaction	Demand	ThreatAction	Offer	Promise	Inaction	Demand	ThreatAction	Offer	Promise
Hostage taker (v_p)										
Inaction	87[a]	95	94	84	75	–	90	92	98	85
Demand	73	96	86	84	71	–	90	84	91	80
ThreatAction	64	95	91	87	69	–	91	82	91	82
Offer	75	97	89	85	72	–	93	82	92	82
Promise	60	98	89	90	92	–	89	90	97	84
Police negotiator (v_p)										
Inaction	–	–	–	–	–	–	–	–	–	–
Demand	74	94	89	83	72	–	93	83	94	81
ThreatAction	69	97	86	93	70	–	95	87	95	85
Offer	75	93	84	83	68	–	92	85	93	84
Promise	70	98	92	91	54	–	96	83	96	86

[a]Decimal point omitted.

although to a lesser extent, the opposite is true of police negotiators, who give more proximal responses to Offers and Promises than they do to Demands and Threats of action (average coefficient = .89 compared with .87). Extending the within-speaker observations, these differences indicate that negotiators, on average, respond-in-kind more immediately when the other's cue corresponds with their predominant level of interaction.

As well as considering individual contingencies, an analysis of the overall trends in between-speaker coefficients provides some indication of the dynamics between the negotiators and how this might contribute to the observed cylindrical structure of behaviour. For example, the average value of the coefficients for hostage takers' responses is much less than the average value of the coefficients for police negotiators' responses (79.3 vs. 91.6). This suggests that police negotiators are typically quicker at responding to hostage takers' instrumental messages than hostage takers are at responding to police negotiators' messages. As per their training, police negotiators seek to mirror or repeat the hostage taker's message in an effort to engage with their concern and to demonstrate a willingness to listen and act in their interests (Vecchi, Van Hasselt, & Romano, 2005).

Comparisons across sequences

By comparing each act to every other act, the proximity coefficient makes efficient use of the information within a sequence. This opens up the possibility of conducting analyses that have traditionally remained impossible due to insufficient data. A researcher may compare matrices of proximity coefficients computed from a number of sequences and, in doing so, uncover differences among transcripts, across speakers and even across different sections of the same sequence (e.g. before and after intervention).

To illustrate the kinds of analyses that are possible, we used the coefficient to examine variations in the interaction process of the 21 transcripts. Differences in the proximities across transcripts reflect variations in the content and sequencing of negotiators' dialogue, and we expected systematic differences among the various types of conflict included in the current data. The comparison was achieved by computing a matrix of proximity coefficients for each transcript. These matrices were then compared for similarity using Pearson's correlation. The resulting intercorrelations among the transcripts' proximity scores were submitted to an SSA-I in three dimensions.

Figure 4 shows the first and second dimensions of the SSA-I solution. Each of the points represents one of the 21 transcripts and may be identified by the associated labels, which correspond to the descriptions given in Table 3. Specifically, the labels indicate whether the negotiation was related to criminal, domestic or political issues, and whether the negotiation was an actual hostage crisis (denoted using a letter) or a simulation (denoted using a number).

An examination of Figure 4 reveals a substantial amount of variation in the proximity structure of the transcripts. For example, the close placement of Political I and Political 11 in the plot suggests that these incidents involved a similar organization of cues and responses over time. This is arguably consistent with the scenarios of the incidents, which for case Political I was interaction with activists for a religious sect and for Political 11 was interaction with activists for animal rights. Both of these interactions evolve around proclaiming a message and justifying the necessity of personal actions. In contrast to these cases, Criminal B and Domestic 6 involved very different patterns of cues and

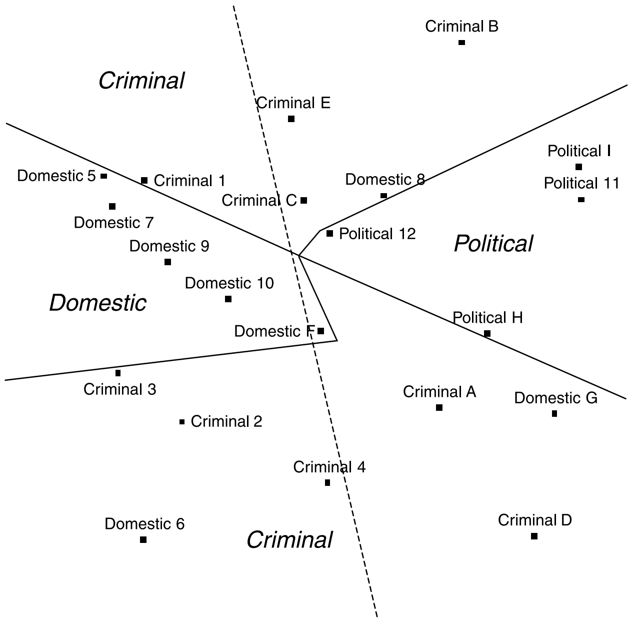

Figure 4. Smallest Space Analysis of proximity matrices for 21 interaction sequences with regional interpretations showing Criminal, Domestic and Political incidents. The dotted-line divides actual hostage crises from the majority of simulated hostage crises. Coefficient of alienation = .18 in 14 iterations.

responses, as indicated by their position at opposing corners of the SSA-I plot. Criminal B involved a violent, aggressive male who had taken an elderly couple hostage after shooting an officer during an attempted bank robbery. Domestic 6 involved a young, drug-dependent and clinically depressed suicidal female who quietly contemplates whether it is worth carrying on in life. The way negotiators approach these scenarios and the type of dialogues that ensue are likely to be different. Interestingly, while set within the context of a bank robbery, Criminal A also centred on issues of the perpetrators committing suicide, which may explain this case's high association with Domestic 6.

As the examples above illustrate, there is a systematic pattern to the variation in structural proximity among the transcripts. This pattern is summarized by the solid lines in Figure 4. This regioning reflects the major types of hostage crises encountered by law enforcement (Donohue & Roberto, 1996; McMains & Mullins, 2001). Specifically, the four cases situated towards the right-hand side of the plot are incidents in which the perpetrator seeks to promote an extreme socio-political or religious agenda, such as the supremacy of the African race as God's chosen people (Political 12). In contrast, incidents situated in the left region of the plot are centred on psychological or domestic issues, where the hostage taker's focus is on attracting empathic attention for a personal cause. Finally, incidents in the top and bottom regions have a criminal emphasis, in which an individual negotiates to extort money or gain some other personal benefit, typically after being caught in the act of committing a crime. The character of this variation among the incident types is unordered, with the regions emanating in different directions from the centre of the SSA-I space. This suggests that the three incident types are characterized by qualitative differences in dialogue.

The division of criminal incidents into two separate regions of the SSA-I plot suggests that some criminal incidents involve very different dynamics to other criminal incidents. This is not consistent with the widely held view that hostage takers may be divided into three types of situation, namely, criminal, domestic or emotionally disturbed and political or terrorist (Cambria, DeFilippo, Louden, & McGowan, 2002). A theoretical justification for why behaviour in criminal incidents may be organized in different ways is important for further understanding the factors that structure the interaction process. This justification is likely to come from in-depth qualitative examination of the transcripts and is not forthcoming from the current analysis. However, it is possible to rule out plausible alternatives. For example, as the dotted line in Figure 4 suggests, the division does not seem to result from a distinction between the actual and simulated hostage crises. The nine actual hostage crises are located to the right of the dotted line while nine simulated incidents are located to the left of the line. Since this division is almost perpendicular to the two criminal regions, and since both simulated and actual incidents occur in each of the criminal regions, it is unlikely to be the case that the division of criminal incidents into two regions depends on whether or not the negotiation was a simulation.

Discussion

This paper uses a new empirical (mathematical) method of drawing together theories about the conceptual dimensions of interpersonal dialogue and the underlying complex organization of behaviour over time. Most existing research has tackled this relationship indirectly, either by imposing extrinsic divisions on the data (e.g. Taylor, 2002a) or by focusing on consistencies in local cue–response contingencies (e.g. Gottman *et al.*, 1977). However, to directly explore how negotiators 'act locally to pursue their global objectives' (Olekalns & Weingart, 2003), it is beneficial to introduce a precise way of measuring the overall structure of localized connections among behaviours. The approach taken here was based on a concept of proximity: the closer two behaviours occur in dialogue the more they have in common conceptually. We operationalized proximity by using a coefficient that expresses the interrelationships among behaviours as a direct function of their relative placements in a sequence.

Results of three different analyses demonstrated the importance of proximity as a concept for linking local and global processes. An analysis of the average proximities among cues and responses established that negotiators' messages are shaped around three interpersonal facets (Level of interaction, Motivational source, Intensity). When negotiators responded to each other's messages, they did so using behaviours that were proximal in their function on these three facets. Specifically, at any one point in time, negotiators' behaviour was found to take on a withdrawn, emotional or more rational orientation (Avoidance, Distributive, Integrative) to one of three issues (Identity, Instrumental, Relational) with varying intensity (Low to High intensity). The result of such local interrelations was a coherence that corresponded with the distinctions observed in previous analyses of communication structure (Taylor, 2002a). Thus, the proximity coefficient was able to provide initial support for the assumption that dynamic cue–response patterns underlie the conceptual structure of communication in conflict negotiation.

To explore further the dynamics underlying the cylinder model, our second analysis considered the micro-organization of cues and responses across the negotiators.

By separating out the behaviour of each speaker, it became possible to explore in detail the ways in which negotiators link together their own messages, and construct their responses to the messages of the other party. An examination of the within-negotiator proximities revealed differences in the behaviours that act as the 'set points' (Cook *et al.*, 1995) on which negotiators base their arguments. For example, in line with previous accounts of role dynamics (Donohue & Taylor, 2003), hostage takers were found to invariably include demands in their utterances, even in instances when the cue was a cooperative offer or promise. This finding exemplifies what communication accommodation theory describes as maintenance (Gnisci, 2005), whereby a person persists in his or her original style regardless of the behaviour of the other party. As the range of coefficients in Table 3 suggests, different behaviours are associated with different degrees of maintenance, and the proximity coefficient may play a useful role in identifying such differences among behaviours.

The examination of between-negotiator coefficients was equally revealing, exposing the different types of cue–response patterns (e.g. reciprocation) that underlie instrumentally framed periods of interaction. The findings showed that differences in negotiators' typical level of interaction are reflected in their tendency to respond to distributive and integrative behaviours. Thus, it is in studying between-speaker coefficients that the relationship between local contingencies and global structure is most exposed, with differences in the response patterns of negotiators corresponding to the global distinctions proposed in the cylinder model. Moreover, at a more general level, the coefficients also showed how police negotiators are more willing to accommodate the hostage taker's instrumental framing of interaction. Police negotiators make deliberate efforts to facilitate convergence, which among other things may be the first step to the police negotiator developing entrainment with the hostage taker (see Taylor, 2002a).

The final analysis compared the structure of individual negotiations by exploiting the fact that coefficients can be calculated from single interaction sequences. Results showed empirically what practitioners have long observed, namely, that criminal, domestic and politically motivated hostage crises involve very different interpersonal dynamics. These differences exist in the interplay of local behaviours but may be examined in a collective manner by measuring interrelationships through proximity. Indeed, by measuring behavioural dynamics through proximity, we found that criminal incidents come in two contrasting types, involving different psychological emphases and paths of development. Discovering the differences that underlie these two types and developing strategies to address these differences is likely to be useful for law enforcement negotiators.

Applications of proximity

The analyses in this paper represent specific examples of the proximity coefficient in action. Its true scope of application, however, is far greater. The coefficient is able to capture the organization of events in sequences that are coded and recorded in a variety of ways. For example, when studying interactions with asymmetric roles (e.g. teacher–student, prosecutor–defendant), it is often useful to apply different category systems to each party's behaviour. This is handled quite naturally by the coefficient because it provides values for only those contingencies that exist in the sequence. An analysis of a sequence coded with two schemes would produce a set of within-speaker coefficients that measure the proximities among behaviours of the same scheme, and between-speaker coefficients that measure the proximities among behaviours across the schemes. The coefficient is also not limited to examining thought units, but may be applied to sequences that are parsed in any consistent form (e.g. utterances, 30-second intervals).

As well as different coding, it is also possible to use the proximity to examine different types of sequence data. One of the most interesting applications are the data in which the duration and relative timing of events is known. These data, often referred to as 'timed event sequence data' (Bakeman & Quera, 1995), may be analysed in proximity terms by using the difference between offset and onset times as a measure of $d(s_i = v_p, v_q)$. Specifically, a modified coefficient is needed that replaces the index i with a count of seconds elapsed from the beginning of the sequence, such that $d(s_i = v_p, v_q)$ reflects the gap in seconds between the offset of v_p and the onset of v_q. This approach produces a coefficient that reflects the gap between the offset and onset times as a proportion of the sequence's total length in seconds. When calculated in this way, a proximity coefficient on the off-diagonal of a matrix will have a similar interpretation to that described above, with lower values indicating lower proximity among the relevant behaviours. In contrast, a coefficient on the diagonal of the matrix will have a different interpretation, which relates to the average duration of occurrence of the relevant behaviour.

The coefficient is also amenable to forms of statistical test other than multidimensional scaling. It is possible to envisage a range of circumstances in which a researcher needs to determine whether or not the proximity observed between two behaviours is likely to have occurred by chance. To provide this form of inferential statistic requires a comparison of the coefficient's value to the range of possible values that might exist if the behaviours were distributed randomly in the sequence. An established solution to this problem is to permute the observed sequence many times (e.g. 10,000 times) while calculating $P(v_p, v_q)$ for each permutation (Efron & Tibshiarani, 1986). This procedure provides the empirical distribution of $P(v_p, v_q)$ under the condition of randomness, from which a p value for the observed $P(v_p, v_q)$ may be estimated by locating its value in the empirical distribution. The nearer the observed $P(v_p, v_q)$ to the tails of the derived distribution, the more confident a researcher can be that the proximity between v_p and v_q did not occur by chance.

Finally, it is also possible to use the coefficient in cases in which the units of interaction are assigned codes from more than one coding scheme. By computing a product of the proximity of occurring codes from each scheme, it is possible to compute a single coefficient that reflects the proximity of behaviours occurring together in the sequence. The possibility of measuring the interrelationships among several levels of behaviour should be particularly useful for those interested in mapping the organization of negotiators' self-reported 'stream of thought' to behaviour use over time (Sillars, Roberts, Leonard, & Dun, 2000). Other extensions might combine an analysis of dialogue with an analysis of non-verbal cues (Beattie & Shovelton, 2002) or examine the interplay between facework and relational aspects of dialogue by simultaneously employing the relevant coding schemes (Donohue, 1998; Rogan & Hammer, 1994).

Conclusions

Proximity may be seen as a common language for theories about the conceptual dimensions of interpersonal dialogue and the complex organization of cues and responses that bring about this structure. This paper has developed the concept of proximity and established its empirical counterpart in the form of a proximity coefficient. The coefficient is a general, computationally simple measure of local interrelationships in a sequence, which avoids the extrinsic assumptions or arithmetic manipulations of existing techniques. Perhaps the coefficients biggest advantage is that it remains constant across different computations, such that it becomes meaningful to make comparisons across speakers, among transcripts and even across different sections of the same sequence (e.g. before and after intervention). Future work may therefore use the coefficient to test detailed theories about how contextual factors affect both the global and local dynamics of interpersonal interaction.

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Appendix

This appendix summarizes the mathematics needed to derive a set of proximity coefficients from a single sequence of observations. We denote such a sequence by s_i ($i = 1, 2, \ldots, n$), where $i = 1$ for the first observation in the sequence and $i = n$ for the final observation in the sequence. We denote the codes used to categorize the sequence as $v_1, v_2, \ldots, v_m$, where m is the number of different codes applied to the sequence. If s_i is a specific occurrence of v_p (where p can be $1, 2, \ldots, m$), then we write $s_i = v_p$. Finally, n_p denotes the number of times a particular behaviour occurs in the sequence.

The proximity coefficient seeks to identify the greatest proximity (i.e. smallest distance) between any two codes v_p and v_q. This is achieved by asking, for each v_p, to what extent must one move through the sequence to observe v_q. To find the first instance of v_q that follows v_p, the coefficient identifies the minimum difference in indices associated with v_p and subsequent instances of v_q. This is achieved through

$$d(s_i = v_p, v_q) = \min\,[j - i] - 1; \quad \text{for all} \quad s_j = v_q, \quad j > i. \tag{1}$$

where $d(s_i = v_p, v_q)$ is the distance between an occurrence of code v_p at position i and the first occurrence of code v_q occurring at a position j greater than i. Since v_p may occur many times within a sequence, we may derive a best estimate of the minimum distance $d(s_i = v_p, v_q)$ by averaging across every occurrence of v_p:

$$\frac{1}{n_p} \sum_{s_i = v_p} d(s_i = v_p, v_q). \tag{2}$$

The proximity coefficient (P) restates equation (2) in a standardized form, as a proportion of the $n - 2$ distances that are possible between the first and last code:

$$P(v_p, v_q) = 1 - \left(\frac{\sum_{s_i = v_p} d(s_i = v_p, v_q)}{n_p(n-2)} \right). \tag{3}$$

This derivation ensures that the coefficient has a number of useful properties. First, the denominator of equation (3) ensures that the coefficient provides a relative index of proximity that is independent of sequence length. For example, $P_{(A,B)} = .90$ indicates that the distance between occurrences of behaviour A and subsequent occurrences of behaviour B is on average 10% of the overall sequence length. Second, because $d(s_i = v_p, v_q)$ is a search for the minimum distance between codes and derived independently from other occurrence of v_p, the value of $P(v_p, v_q)$ is independent from the number of times v_p occurs in the sequence. This would not be the case if the coefficient was based on a behaviour's proximity to all following behaviours, since the tendency for frequently occurring behaviours to be positioned closer together in the sequence would result in an artificially higher coefficient. Third, the coefficient is not affected by the number of categories used to code the sequence, since $d(s_i = v_p, v_q)$ and the value of $P(v_p, v_q)$ are derived without reference to the number of codes used to categorize the sequence.

Equation (3) presents a proximity coefficient that gives a relative measure of proximity within a sequence. When comparing across sequences, however, it is often important to use a measure that treats a specific $d(s_i = v_p, v_q)$ as equivalent across the sequences. Consider the 3-code sequence 'A B A' and the 11-code sequence 'A B C C D C D B B D A'. For both of these sequences $P_{(A,A)} = .00$. However, the proximity of A to A is arguably proximal in the 3-code sequence but far less so in the 11-code sequence. To determine absolute proximities regardless of sequence length requires that distances are measured relative to the longest possible distance, using

$$P(v_p, v_q) = 1 - \left(\frac{\sum_{s_i = v_p} d(s_i = v_p, v_q)}{(n_{k_{\max}} - 2)} \right). \tag{4}$$

where $n_{k_{\max}}$ is the number of codes that appears in the largest sequence of the data set. This produces a set of proximity coefficients that reflect the absolute distance among codes and whose values may be directly compared. The coefficient remains comparable across transcripts so long as the same division of speech is applied.

A full derivation and analysis of the proximity coefficient is given in Taylor (2006). An executable program for calculating the coefficient is available from the author. It runs in Windows and accepts ASCII files in which the observation codes (e.g. behaviours) appear one per line. It calculates proximity coefficients for individual files (sequences), provides an average across all input files and allows the user to use relative and absolute weighting.