Chapter 2

Interactive Deception in Group Decision-Making: New Insights from Communication Pattern Analysis

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Abstract

Interpersonal deception is a dynamic process in which participating individuals adjust and adapt their behaviors as the deception proceeds. Using THEME, we demonstrate that deceptive communication in group settings is highly patterned. We further examine patterning behavior using the strategy-focused lens of Interpersonal Deception Theory (Buller and Burgoon, Commun Theory 6(3):203–242, 1996). Correlation and regression analyses suggest that (1) deceivers tend to be strategically assertive as they carry out deception in group settings, and (2) individuals suspicious of deception tend to engage in probing behavior, ostensibly attempting to confirm their suspicions. Our findings demonstrate the value of analyzing deceptive behavior in terms of patterning to gain greater insight into the complex deception process.

Key words Deception, Group decision-making, Nonverbal communication, Pattern analysis, THEME

1 Introduction

Interpersonal deception is a complex and dynamic interaction between two or more people in which messages are knowingly sent by a deceiver in order to foster a false belief or conclusion by the receiver [1]. Deceptive interchanges, like other forms of interpersonal message exchange, are an iterative process of sending, receiving, and updating messages in response to the messages and feedback of interlocutors. During a deceptive exchange, deceivers attempt to manipulate the interchange in order to accomplish their goals while evading detection and may do so by resorting to a variety of different strategies, such as obfuscating, becoming reticent, or distancing themselves from what they are saying [2] or alternatively, taking a more assertive and persuasive approach in order to win over their targets [3, 4]. In turn, potentially deceived interactants, if made suspicious, may adopt strategies of their own to uncover the truth. For example, suspectors might make their suspicions manifest by probing for more information, or they might

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quietly monitor the target of their suspicion but maintain an impassive exterior that masks their own skepticism. Because interpersonal communication is an adaptive and dynamic process, the emergent communication between deceivers and their targets may take a variety of forms and evolve as the deception progresses. The strategic, adaptive, and dynamic nature of communication thus poses significant challenges to its analysis. Simple aggregate measures or analyses conducted in the opening seconds of an interaction may be highly misleading about the trajectory of a deceptive interchange, and what happens early may bear little resemblance to what happens later. This analysis becomes even more complex when applied to group interactions, inasmuch as the web of relationships and message exchanges increases exponentially the potentialities for message transmission and receipt. Senders may produce one-to-one or one-to-many messages to recipients who may or may not transmit feedback to the sender and who may opt to remain a passive observer or who may take up the sending role. These complexities may account for why knowledge of deception in group interaction is sparse [5]. Because of this challenge, the current investigation attempted to uncover regularities in deceptive communication episodes by applying the pattern discovery and analysis tool THEME [6, 7]. Specifically, we applied it to group interactions in which both deception and suspicion were present to determine whether this analytical tool would deliver more insight into deception in interpersonal and group interactions.

THEME is a commercially available program designed to detect subtle temporal patterns in a set of data. It can be used to discover and analyze any data that is composed of discrete events that are arranged according to some temporal indicator. This flexibility has allowed the software to be used in such diverse contexts as team interactions [8], behavior of autistic children [9], and family conflict [10]. The current investigation, in which one deceiver attempted to deceive two other group members, one of whom was induced to be suspicious and one of whom remained naïve to the deception, offered an excellent test bed to examine the utility of THEME to uncover patterning of interaction in nonverbal behavioral data identified by trained observers. The patterning uncovered by this analysis grants a novel angle from which to view the strategic and dynamic nature of group deception interactions.

In what follows, we first articulate the theoretical underpinnings and research questions guiding the investigation, as informed by Interpersonal Deception Theory (IDT; [1]). Next, we briefly describe the experiment and behavioral observation procedures from which we derive the coded data used by the THEME software. We then describe the THEME analysis approach before turning to our report of the results of our analysis within the context of our IDT lens. We end with a discussion of our findings, including some limitations of our approach and opportunities for future deception research using THEME.

It is important to note at the outset that both the participant sample size and the nonverbal behaviors that are coded are limited and far short of the ideal for either. Nevertheless this corpus—as one of the first derived from lengthy group interactions—offers the temporal scale and unconstrained discourse among group members to permit a first glimpse of THEME's ability to uncover interesting regularities in truthful, deceptive, and suspicious behavioral patterns.

1.1 Theoretical Background

As already noted, with rare exceptions (e.g., [5, 11, 12]), little prior research has considered deception in groups or its detection in groups [13], the lion's share of work having focused on dyadic deception [14]. For this investigation, our focus was on group interactions in which one deceiver attempts to deceive two other group members. This type of interaction is particularly well-informed by the perspective that deception is interactive and dynamic [1], since group communication processes are typically much more complex than dyadic interactions and require deceivers to manage the perceptions and communication of two or more receivers at once [11]. The demands on deceivers to manage this process, especially in the face of a suspicious interactant, are therefore likely to call forth diverse schemes for successfully achieving their ends while allaying suspicions. It is well understood that human communication tends to be highly patterned, and these patterns have been the subject of much empirical effort (e.g., [15–17]). In addition to turn-taking and similarly obvious communication patterns, interactions also follow patterns that are sometimes subtle and imperceptible to the casual observer [18]. These patterns, perhaps especially those which cannot be easily observed, could provide important insights, especially under the assumption that behavioral patterns are fluid over the course of a deceptive interaction [19–22].

IDT [1, 23] was proposed as a "merger of interpersonal communication and deception principles designed to better account for deception in interactive contexts" ([1], p. 203). The theory places deception in the context of interactive communication, and proposes that deceivers exhibit both strategic and nonstrategic behavior. Strategic behavior in this context refers to intentional, deliberate activities that are not necessarily manipulative but rather goal-directed. Thus, deceivers may orchestrate and adapt their deception to put forward the most successful self-presentation, to allay receiver suspicions and to achieve their desired ends (such as to persuade another to accept their advocated position). Additionally, they also display inadvertent indicators of discomfort, true emotional state, cognitive taxation, and attempted behavioral control that result in impaired communicative performance. These are what IDT regards as nonstrategic behaviors.

The notion that deception is strategic is not unique to IDT. The original four-factor theory of Zuckerman, DePaulo and Rosenthal

[23] recognizes that deceivers engage in behavioral control. The later self-presentational perspective of DePaulo [24] and the alternative models of deception advanced by Vrij [25] all acknowledge, implicitly or explicitly, that deceivers are goal-oriented and adapt their communication to achieve their deceptive goals. However, the strategic nature of deception is particularly salient in the context of an ongoing interaction. The deceiver must monitor the reactions of the other interactant(s) in order to guide the downstream interactions to further convince them, fill in exposed holes in the deception, and so on.

Though IDT broadly addresses many facets of interactive deception, the focus of our research here is on two interaction-focused factors that should be particularly evident in our pattern analysis approach: *behavior patterns associated with deception* and *behavior patterns associated with suspicion*.

1.2 Behavior Patterns Associated with Deception

We have noted that during deceptive interchanges, deceivers may display both strategic and nonstrategic behavior. Considerable empirical work has identified that certain kinds of behaviors such as adaptor gestures (scratching, face-rubbing, fidgeting, and the like) are signs of discomfort or nervousness [26] and are unlikely to be displayed intentionally. Understudied are the ways in which deceivers might behave strategically. In the context of group deception, this strategic behavior might be manifested as the deceiver attempting to control the interaction, either dominating the conversation or, at a minimum, soliciting desired responses with carefully constructed speaking actions that initiate patterns of communication. Research has shown that the initiation and control of conversation are dominant strategies, as is using highly expansive and expressive gestural patterns that convey strength [27]. Thus, initiating patterns by adopting the speaker role and displaying patterns that entail illustrator gestures would constitute strategic activity. Other forms of strategic behavior are also conceivable. For example, deceivers might opt for a more submissive “lying low” strategy after introducing deception, letting other group members initiate lines of discussion and further develop the deceptive ideas without his or her intervention. One way this pattern would manifest is through the use of backchannel head movements—nods, shakes, and other head movements—while in the listener role that encourage the speaker to continue talking [28]. Because there is no clear-cut prediction of what strategies a deceiver might adopt, we left as a research question whether and in what form strategic patterns might emerge. If no repeated patterning involving deceivers were to emerge, or if patterns only entailed adaptor behavior, that would be suggestive of a lack of strategic activity on their part.

RQ1: To what extent and in what ways do deceivers exhibit strategic communication patterns when engaged in group deception?

1.3 Behavior Patterns Associated with Suspicion

Research related to IDT has shown that receivers often become aware of the presence of deception, even if they do not label it as such; when their suspicions are piqued, their own behavior often telegraphs their suspicions to senders [2, 29]. In turn, IDT contends that senders perceive suspicion when receivers signal disbelief, uncertainty, or a desire for more information, and such suspicion, whether perceived or actual, prompts senders to increase their own strategic activity to mitigate such suspicion [1].

To ensure that suspicion would be invoked in the current experiment and have some degree of homogeneity in its cognitive representation, we experimentally induced suspicion but did not indicate who might be engaging in deceit or even how certain such a possibility might be. Just as deceivers are active rather than passive interlocutors who may engage in deliberate, strategic actions of their own, suspectors possess a range of alternative strategies for attempting to unmask duplicitous team members. Sensing that deception is taking place may spur them to probe for further information or evidence to confirm or disconfirm that suspicion. Employing this strategic information-seeking behavior [30], they might engage in verbal or nonverbal behavior that encourages suspected deceivers to talk more and in so doing to betray their duplicity verbally through what they say or nonverbally through "tells" of malicious intentions. In the context of patterned interactions, this probing behavior might manifest as an increase in interdependent interaction, i.e., patterns that include other members of the group. However, suspectors might also adopt a cagier strategy of increased watchfulness while remaining on the interaction sidelines, allowing other group members to lead the conversation and elicit diagnostic indications of a suspect's hidden agenda. Thus, we posed as a research question,

RQ2: To what extent do suspicious individuals exhibit regularities in their interaction patterns and what is the complexion of those patterns?

2 Method

2.1 Overview

The experiment consisted of Reserve Officers' Training Corps (ROTC) cadets participating in a simulated operations task called StrikeCom, a serious multi-player strategy game developed by the University of Arizona Center for the Management of Information [31]. StrikeCom is designed to investigate factors affecting teamwork and communication and to elicit the kinds of interdependencies and interaction patterns that typify decision-making in scenarios that resemble real-world conditions, incorporating the kinds of decisions military personnel must make in searching out and destroying enemy weapons caches. Although the game was introduced to participants as an exercise in collaboration, in reality it was intended to test for the effects of deception and suspicion on group processes and outcomes.

2.2 Sample

Participants ($N = 42$; 31 males, 11 females) were undergraduate ROTC cadets recruited from the university's local ROTC chapter who participated as part of their curriculum in a simulation of an air operations center decision-making activity. Participants were randomly assigned to one of three roles—defined by the intelligence assets they would control—to search territory in an enemy country, to locate caches of missiles, and to destroy the weapons. As an incentive to boost motivation, cadets were informed they would be observed by their superior officer during performance of the task and would receive a special reward if they were the most successful team in destroying all of the missiles. The sample ranged in age from 18 to 24 years ($M = 19.69$, $SD = 1.52$) and included 33 Caucasian, 7 Hispanic/Latino, and 2 Asian/Pacific Islander individuals.

2.3 Independent Variables

The independent variables of deception and suspicion were delivered through the random role assignment. Those assigned to the role of *Space* (e.g., satellite imagery), were instructed to introduce faulty information that would steer the group *away from* the missile silos. They were to act as though they had friends and family members still living in the vicinity of the missile sites and their true allegiance was to the enemy cause. Their task was also to evade detection. They were thus induced to become *deceptive*. Those assigned to *Intel* (e.g., spies on the ground) were induced to be *suspicious* by being told that other team members might or might not introduce inaccurate and misleading information into the team deliberations. The third member of each team controlled *Air* (e.g., surveillance planes) and was naïve to the deception and suspicion inductions. Air served as the control group against which to compare the other two manipulations. This within-group design permitted examining the dynamics resulting from having both deception and suspicion present in the group. Table 1 summarizes the three roles, their associated manipulations, and the different instructions given to each participant.

2.4 Experimental Procedure

Participants reported to a research site and were randomly assigned to three-person groups and to one of three roles within their group: Space, Air, or (Human) Intel. Through a succession of five turns, teams were to utilize their respective assets to locate targets hidden on a computer-displayed map overlaid with a 6×6 grid. After sharing search results with each other, they were to arrive at a consensus strike plan to destroy the missile launchers (see Figs. 1 and 2). Instructions were delivered by video on the same computers to be used during the simulation. Prerecorded instructions assured that they were uniform for all groups and players. Participants completed a practice run through the simulation individually before undertaking the team version so that all participants were familiar with the game.

Table 1
Independent variable manipulations

Role	Manipulation	Excerpts from manipulated instructions
Air	Naïve	Standard game instructions. Served as control group
Intel	Suspicion	"In group deliberations, there is always the possibility of faulty or inaccurate information. You are strongly advised to discuss your teammates' search results and recommendations in detail…This faulty or inaccurate information can come from ANY source internal to this simulation, such as the players"
Space	Deception	"Although most of us typically think that 'honesty is the best policy,' there are times when being truthful is not in the best interest… Your real task is to deceive your team members about the true location of the enemy camps… You must prevent your teammates from discovering the true location of the enemies and must convince your team to destroy empty territory"

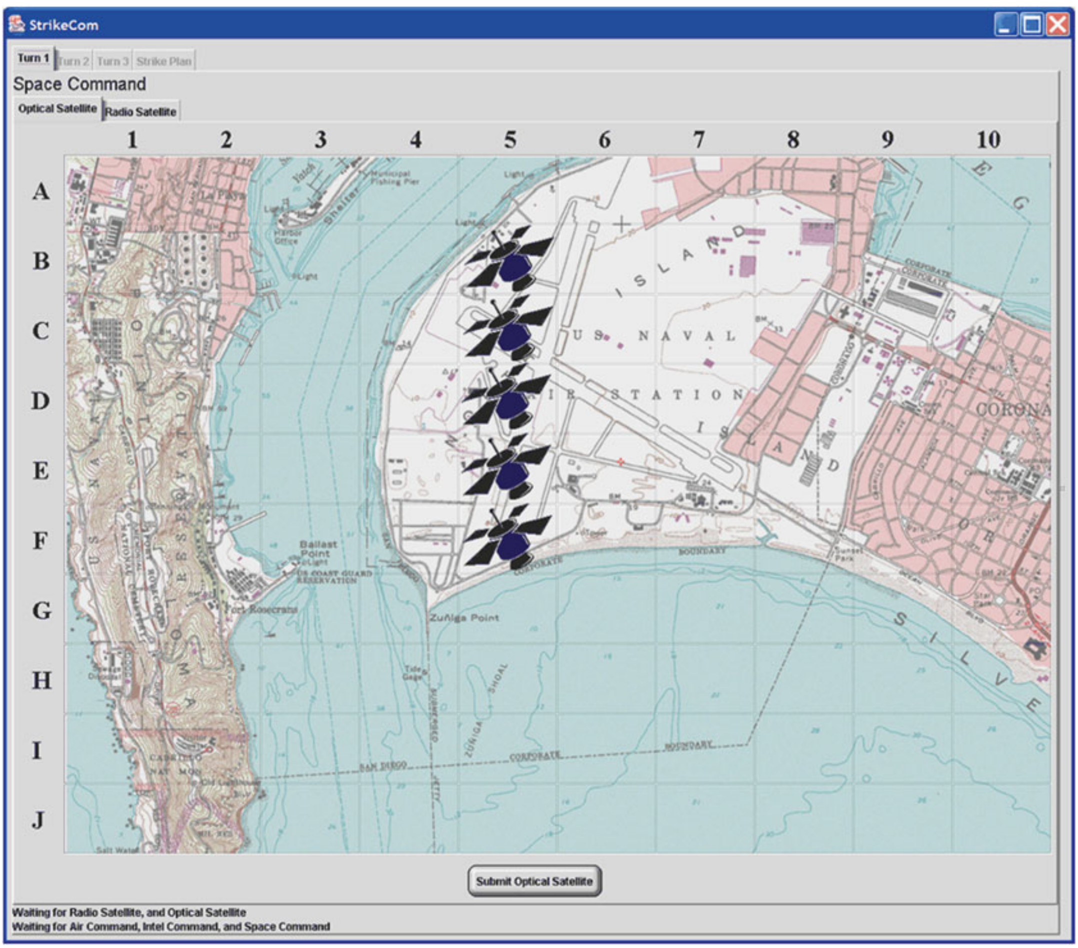

Fig. 1 Sample of 10×10 StrikeCom grid and map showing search selection for satellite intelligence

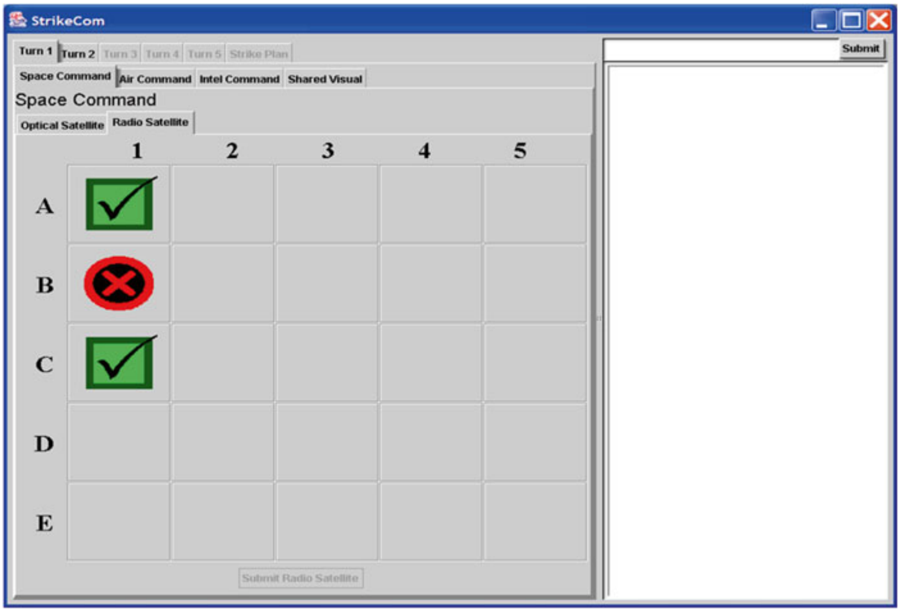

Fig. 2 Sample return of results after a search turn

Teams were seated at round tables so that they could communicate face-to-face but with computer screens in front of each player on which were displayed the map and grid. Privacy screens prevented players from seeing one another's computer; they had to rely on team members' oral reports for the information returned by their assets. Teams would complete a search turn, share information, plan their strategy for the next search and then undertake the next search. Results displayed to other group members consisted of green checks, indicating a grid location was apparently clean, a yellow question mark signifying uncertainty about the intelligence from that area or a red icon suggesting a high probability (but not certainty) that weapons were present. Players were informed in advance that different information assets had varying degrees of reliability and that their single asset could only check one grid cell at a time. This instruction introduced the needed uncertainty about the accuracy of the assets.

Participants proceeded through five search rounds, presenting and discussing their ostensible search results after each round and strategizing about where to search next, before proceeding to the strike round, during which they were to arrive at a single consensual decision on three areas to strike with bombs. After five search turns, the group developed a strike plan, choosing the territories to be bombed to destroy the weapons caches. After submitting their strike plan, the computer returned a report of their success in hitting the three grid areas where the weapons had been located.

The search and strike discussions averaged 25 min (range = 15–51), thus providing much longer and richer interaction than is typical of interpersonal communication experiments and far longer than the brief utterances that typify most deception studies [14].

2.5 Self-Report Measures

Participants first completed a pretest survey to assess demographics and prior computer experience. Following the simulation, they completed a posttest survey asking about their experiences playing the game and their personal motivation during the game. Manipulation checks were also collected to assess whether those in the Space role (deceivers) misreported information during the game and those in the Intel role (suspectors) actually were suspicious of their team members. Following the posttest survey, the participants were fully debriefed and discussed the task as part of their ROTC curriculum on decision-making and the impact of new technologies on such decision-making.

2.6 Nonverbal Behavioral Observation

Video recordings of the groups' discussions during the exercise were manually time-coded using a software tool called C-BAS [32]. The kinesic nonverbal behaviors that were coded for analysis are summarized in Table 2. Using C-BAS, trained coders watched each session's video, pressing and holding a key each time a specific behavior began, then releasing the key when the behavior ended. This allowed the software to record both frequencies and durations of each behavior in very granular (down to individual frames at 30 frames-per-second) increments, thus providing fine-grained data of behavior during the interactive sessions.

Table 2
Nonverbal behaviors coded for THEME analysis using C-BAS

Behavior	Description
Illustrator gestures	Movements used to accompany speech. They can be used to clarify speech and aid in listener understanding [34]
Adaptor gestures	A broad category of kinesic behaviors used to "satisfy physical or psychological needs" [26]. These adaptors in our classification schema refer to adaptors *using the hands*
Lip adaptors	Adaptor behavior limited to the mouth: pursing, licking, or biting lips, tongue-showing, and other related mouth movements indicating concentration, consternation, confusion, or nervous activity [26]
Speaker head movements	Head movements used during speech to illustrate and complement what is being said, to punctuate speech, or signify tense [35, 36]
Backchannel (listener) head movements	Nods and shakes while listening, which provide visual feedback and/or encouragement to the speaker, showing that they are being heard and understood [28]

Table 3
Summary statistics for frequencies of nonverbal behaviors included in THEME analysis (*N* = 14)

Behavior	Air		Intel		Space	
	M	SD	*M*	SD	*M*	SD
Illustrator gestures	53.0	46.2	63.4	26.3	47.1	39.6
Adaptor gestures	50.6	53.5	33.7	40.9	38.1	36.7
Lip adaptors	17.7	18.7	26.9	18.9	38.2	25.6
Speaker head movements	22.3	21.2	20.3	20.2	22.3	17.8
Backchannel (listener) head movements	52.1	39.5	41.0	23.8	46.5	36.7

Note: Means and standard deviations are aggregated across all 14 interactive sessions

The means and standard deviations for each of the coded behaviors are summarized in Table 3. They reveal that participants engaged in quite a few illustrator gestures. Head movement was also quite frequent, especially backchannel nods (listener head movements). Although the amount of speaker head movement did not differ by role, such movement was featured differentially in the initiation patterns that emerged. Thus, aggregate data may mask an important behavior, while THEME analysis can expose its importance. One other noteworthy statistic is the frequency of lip adaptors. Those in the space (deceiver) role used more than twice as many as those in the air (naïve) role. Although this is evidence of nonstrategic behavior by deceivers, it does not obviate the presence of strategic behavior, as the analyses to follow reveal.

These frequency data were the input for our THEME analysis, described in the next section. Each behavior's beginning and end was also marked.

2.7 THEME Analysis

The THEME software program is designed to discover and analyze patterns among discrete events within time-oriented data [7, 6]. The software uses specially coded data to build a timeline of events, then searches for patterns within the timeline that meet very stringent statistical significance thresholds and other criteria. Each occurrence of an event is signified by a text-based code that specifies the type of event that occurred along with a timestamp of when it occurred. In our dataset, a sample event type that occurred would be coded as "Space,b,SpeakingNods," signifying that the individual in the Space role began a speaking nod at the associated time. These coded data are aggregated by the software into a time sequence that includes each distinct event type and the times at which that event type occurred.

2.7.1 Pattern Search Parameters

THEME allows the researcher to specify various parameters when searching for patterns. We used a maximum search level of four to find complex patterns yet stay within operational bounds of our system. Variability in group discussion length necessitated adjusting the pattern recognition parameters for each session. To overcome potential bias because of this variability, we chose to dynamically weight the minimum occurrences according to the length (in seconds) of each interaction session. In this way the minimum occurrences threshold was set lower for datasets with shorter interactions and higher for datasets with longer interactions, with a maximum threshold of ten occurrences. This dynamic threshold assured that we were only analyzing truly recurrent events, but that we did not artificially deflate the number of patterns discovered for datasets from shorter interactions.

2.7.2 The T-Pattern

A t-pattern is defined as a set of event types that occur either concurrently or sequentially with significantly invariant time differences between the pairs [6]. When THEME detects a t-pattern, a string of event types is provided. This string reports the pattern structure observed. An example t-pattern discovered in our dataset is the following:

((Intel,b,BackchannelNods (Intel,b,Left,Adaptors Space,b,Left, Adaptors)) (Space,e,SpeakingNods Intel,b,BackchannelNods))

This pattern shows an interaction between the Intel and Space roles, with Intel demonstrating backchannel nods and adaptors while the Space role is speaking (indicated by the end of speaking nods during this pattern). A representation of where this pattern appeared during an interaction is shown in Fig. 3.

It is possible, especially given the large number of events in each session, that some or all of the patterns discovered by THEME are the result of chance. To ensure that this is not the case, THEME also compares the results of the pattern discovery process to randomized results. To accomplish this, THEME randomizes the order of the event types to produce a new sequence of events. Pattern discovery is then performed on the randomized data using the same parameters previously selected, and the resulting discovered patterns are compared against those patterns which were discovered using the original data. This procedure is repeated several times to get an average number of patterns from the random data. As shown in Fig. 4, which is produced from the coded data from one of the team discussions, the communication patterns from the original dataset occur much more frequently than can be attributed to chance. In the figure, which represents the counts of different lengths of discovered patterns, we see substantially more observed patterns of lengths three, four, and five in the real data than in the randomized data (which are represented by the smaller bars only visible at patterns of lengths two, three, and four). Take,

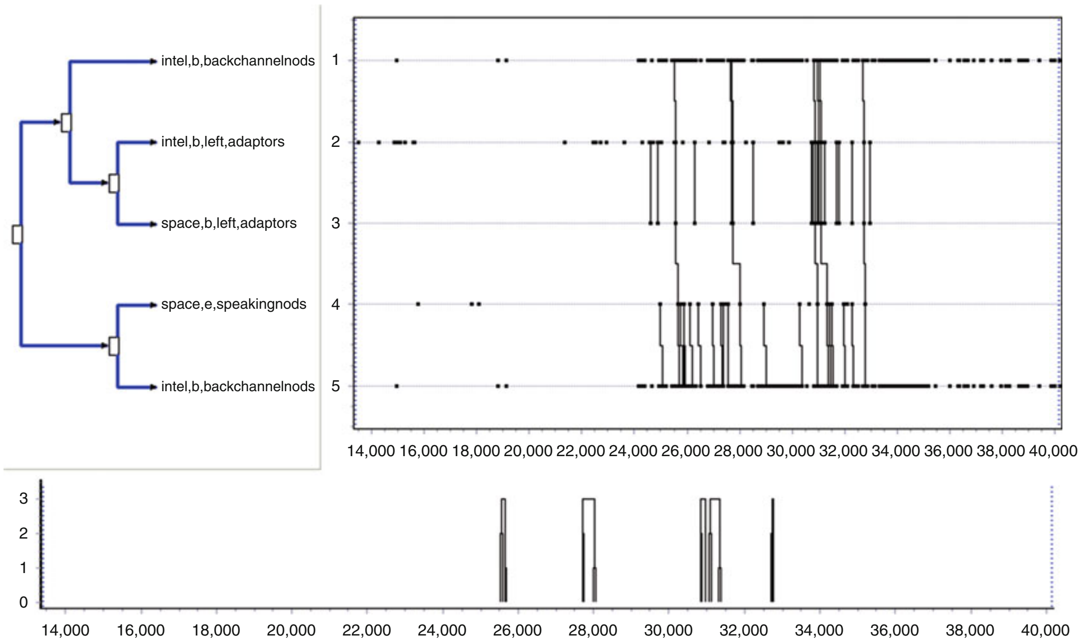

Fig. 3 Sample pattern identified in interaction data

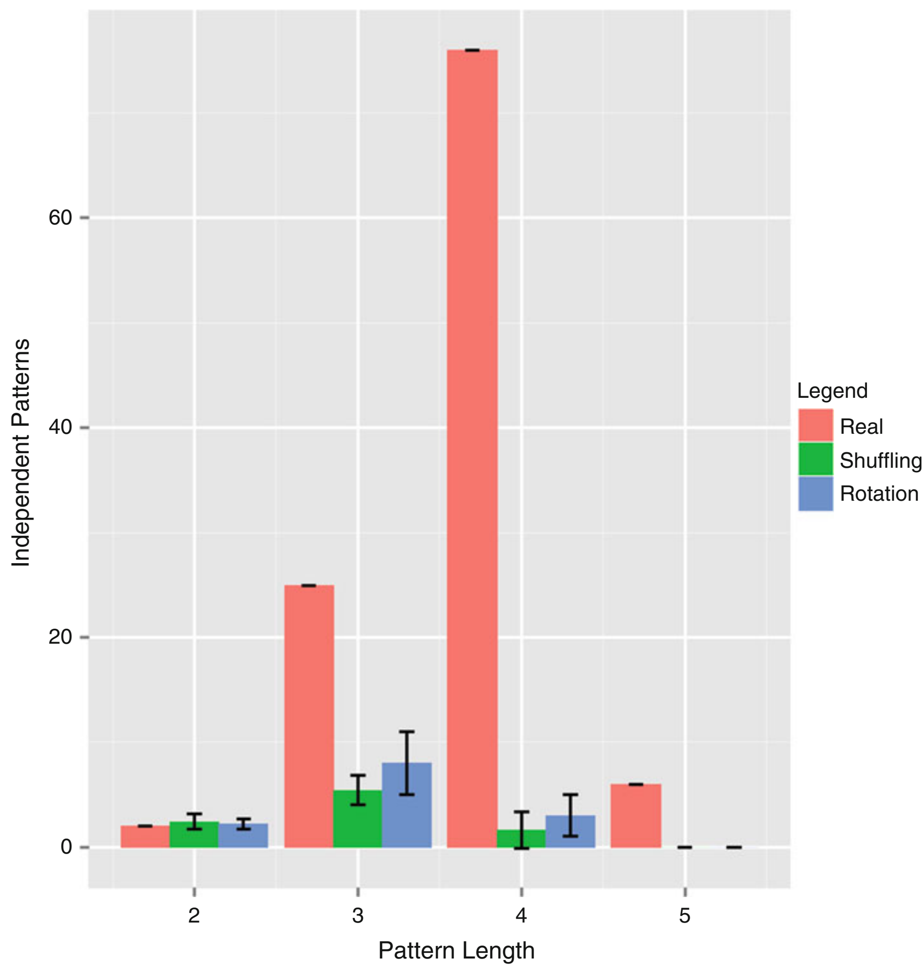

Fig. 4 T-Patterns from original vs. randomized data

for example, the bars representing patterns of length four. In the real, unshuffled dataset (the red bar), THEME discovered 76 independent patterns that included exactly four different or repeating event types. The randomized data produced an average of three patterns of this length.

3 Results

3.1 Manipulation Checks

Prior to testing hypotheses, manipulation checks were conducted to confirm that those in the Space role actually deceived, those in the Human Intel were actually suspicious, and that their suspicion level differed from those in the naïve Air role. On the rating of "I was accurate in reporting my asset's information to the group," those in the Space role ($M = 2.36$, SD = 2.10) were significantly less accurate than those in the Intel ($M = 6.86$, SD = 0.36) and Air ($M = 6.43$, SD = 1.09) roles, $F(2, 39) = 45.29$, $p < 0.001$, $\eta^2 = 0.70$. Space participants largely misled their group, although the large standard deviation indicates that not all were equally compliant. Less accurate reporting also tended to be related to a poorer team game score ($r = 0.22$, $p = 0.08$, one-tailed)—an indication that Space's deception produced an objectively quantifiable impairment of team performance.

Suspicion failed to differ by role, $F(2, 39) = 0.89$, $p = 0.47$, $\eta^2 = 0.04$, in part because Space also reported being suspicious of Air, making both Intel and Space somewhat more suspicious than Air of their team members. However, suspicion ratings were quite low, indicating that these cadets, who were acquainted with one another, were largely unswayed by the suspicion manipulation. These self-report results warrant caution in over-interpreting findings related to suspicion. Interestingly, suspicion was strongly and inversely related to measures of interaction, relationship and task communication quality ($r = -0.48$, $r = -0.67$, and $r = -0.41$, respectively; $p < 0.001$). It was also negatively related to team performance: Those with poorer game scores reported being more suspicious ($r = -0.25$), implying that suspicion may have registered at a more subconscious level and resulted in reduced acceptance of team members' reports of their assets' findings.

3.2 Overview of THEME Analysis

With the THEME software configured as described previously, we conducted the pattern recognition analysis on each of the coded interaction sessions. THEME provides a plethora of pattern-related data which can be used in analyses. THEME discovered many patterns in the interactions, ranging from a low of 48 to over 1600 patterns in a given group. These data were then exported to Microsoft Excel® for the full analysis of the pattern data. Using Excel®, we filtered the patterns according to a number of different criteria described below (for example, excluding all patterns in which a certain role was not a participant, or limiting results to

Table 4
Summary of pattern discovery using THEME

Session	Session length (min)	Unique patterns	Total patterns	Actor switches per pattern		Actors per pattern		Pattern level			Pattern length		
				M	SD	*M*	SD	Max	*M*	SD	Max	*M*	SD
1	17	305	2593	0.70	0.70	1.59	0.56	5	3.34	0.73	3	1.96	0.43
2	25	239	2576	0.71	0.71	1.59	0.54	5	3.27	0.77	3	1.90	0.47
3	34	408	5715	0.60	0.72	1.47	0.50	5	3.27	0.69	4	1.88	0.37
4	15	416	2307	1.39	1.01	2.10	0.70	6	3.55	0.80	4	1.98	0.46
5	28	349	4468	0.54	0.67	1.45	0.51	5	3.27	0.67	3	1.89	0.35
6	51	146	3530	0.29	0.53	1.26	0.44	5	2.84	0.65	3	1.72	0.48
7	24	101	966	0.43	0.59	1.38	0.49	4	2.99	0.69	2	1.76	0.43
8	19	903	7126	1.32	0.90	1.86	0.47	5	3.64	0.64	3	2.01	0.33
9	17	1603	8804	1.43	0.89	2.11	0.62	5	3.63	0.56	3	1.98	0.20
10	21	71	567	0.21	0.48	1.20	0.43	5	2.93	0.70	3	1.75	0.47
11	33	76	967	0.45	0.60	1.42	0.55	4	2.78	0.67	2	1.64	0.48
12	29	198	2567	0.82	0.73	1.74	0.61	4	3.15	0.65	2	1.85	0.35
13	17	356	2436	0.73	0.82	1.56	0.55	6	3.55	0.77	4	2.02	0.44
14	15	48	304	0.40	0.57	1.40	0.57	6	3.17	1.02	3	1.81	0.64

only those initiated by a particular event). The results of the pattern discovery process are summarized in Table 4.

THEME produces a vast amount of potential data for exploration. We narrowed our focus to the issues raised by IDT and the research questions set forth earlier. For the purposes of this exploratory investigation into the patterned behavior of deceptive group interactions, we conducted three types of analysis. First, we conducted a descriptive analysis. Second, we completed an exploratory, zero-order correlation analysis. Third, we conducted a hierarchical regression analysis.

3.3 Descriptive Statistics

The 14 sessions analyzed produced significantly varying metrics. One session, for example, produced 416 patterns, while another produced only 76. Rather than skew our results comparing, for example, the number of patterns in which one particular role participated (227 vs. 38 patterns), we converted the counts to percentage of total patterns in the session, which yielded a better comparison of relative differences (55 % vs. 50 %). Such adjusted percentage-based comparisons were used for all pattern analyses in

Table 5
Means and standard deviations of behaviors and general pattern statistics ($N=14$)

		Air		Intel		Space	
Variable	**Description**	***M***	**SD**	***M***	**SD**	***M***	**SD**
% Illustrator gestures	Percent of total illustrator gestures in a session performed by this role	20.6	15.6	32.6	12.0	46.9	23.1
% Adaptor gestures	Percent of total hand adapt or behaviors in a session performed by this role	27.4	15.4	43.9	16.1	28.7	12.7
% Lip adaptors	Percent of total lip adaptor behaviors in a session performed by this role	36.0	20.6	29.0	12.0	35.0	17.5
% Speaker head movements	Percent of total speaking head movements in a session performed by this role	34.2	21.4	30.4	16.0	35.4	19.5
% Listener head movements	Percent of total listener head movements in a session performed by this role	42.4	29.7	26.6	17.4	31.0	18.5
% of speaking activities	Percent of total speaking activities in a session performed by this role	29.8	16.9	31.2	11.4	39.1	19.4
% Total patterns	Percent of total session patterns in which this role participated	46.2	21.2	41.3	23.2	54.1	19.3
% Total patterns solo	Percent of total session patterns in which this role was the sole actor	21.3	13.5	25.8	18.6	27.9	17.5
% Total patterns initiating	Percent of total session patterns which this role initiated with some behavior	34.5	17.0	26.7	13.4	38.8	19.0
% Total patterns with switches	Percent of total session patterns in which this role participated and in which there was at least one switch between actors	25.0	16.8	25.9	22.8	28.2	16.4
Pattern length (complexity)	Number of consecutive event types (length) of patterns in which this role participated	1.42	0.7	1.31	0.8	1.67	0.6

Note: Each percentage represents the average percent of a session's patterns in which the specified role participated with the specified behavior

this report. Table 5 summarizes means and standard deviations of the metrics used in our analyses, both for the percentages of raw behaviors (i.e., without considering patterned behavior), and for the percentages of patterned behavior as calculated using THEME.

The descriptive statistics produced some noteworthy observations. First, group interactions were lengthy, averaging almost 25 min, indicating that groups were, for the most part, engaged in the task and devoted a fair amount of time to discussion. This is in sharp contrast to many laboratory group tasks that are only a few minutes in length.

Second, the number of unique patterns was quite high ($M=373$, SD = 417) but the large standard deviation indicates that there was substantial heterogeneity across groups. The same was true of the total number of patterns ($M=3209$, SD = 2522). Another interesting finding was the number of patterns that were repetitive (not unique) for each group. Calculated as a percentage of the total number of patterns, the groups averaged 88.7 % redundancy in patterning; that is, their interactions showed a high degree of structure and repetition. Some of this can be attributed to the fact that the beginning and ending of some behaviors would constitute a pattern. However, patterns went beyond simple beginnings and ends of single behaviors and tended to be interactive. Pattern level averaged 3.2 behaviors, and number of actors per pattern averaged 1.6, indicating that the patterns more often than not involved two actors.

3.4 Bivariate Correlation Analysis

Next, we examined intercorrelations among pattern features such as the number of patterns that each role *initiated*, the number of patterns in which the role was simply *included*, the average complexity (length of patterns) of each role's patterns, the number of patterns which *excluded* a given role, the number of patterns in which a given role was the *sole* actor (i.e., self patterns rather than interactive patterns), and various measures of interactivity in patterning, such as the average number of turn-switches between actors in a given pattern (i.e., when event types from one actor triggered event types from another actor), or the number of patterns which included one, two, or all three actors. These metrics represent a fraction of the pattern-related data that can be produced by the THEME software.

The interdependent nature of group interaction data meant that independent analyses could not be conducted between roles. Instead, we conducted analyses on patterns in which the Air, Space, or Intel player participated. For the measure of complexity, which concerned the length of patterns, Space—the deceiver—was involved in the longest patterns ($M=1.67$, SD = 0.6), whereas Intel—the suspicious role—participated in the shortest patterns ($M=1.31$, SD = 0.8), and Air—the naïve role—fell in between ($M=1.42$, SD = 0.7). Thus, rather than being reticent or removed from the interactions, Space's behavior was part of the most complex patterns.

For diversity of patterns, we used the total percentage of group patterns in which the individual was involved. Space was involved in the largest percentage of patterns ($M=54.1$ %, SD = 19.3 %), with Intel involved in the least ($M=41.3$ %, SD = 23.2 %), and Air again in the middle ($M=46.2$ %, SD = 21.2 %). This further suggests active engagement by Space, whereas Intel acted as an observer during interactions between Space and Air.

We also examined the percentage of patterns in which a role was the sole participant. These patterns constituted self-patterning. Once again, Space was most active ($M=27.9$ %, SD = 17.5 %), Intel was second ($M=25.8$ %, SD = 18.6 %), and Air was the least likely to be in a pattern alone ($M = 21.3$ %, SD = 13.5 %). This implies that Space's communication was not random but rather produced systematic and repeated patterns.

A summary of the zero-order correlation analysis is given in Table 6. We highlight several relationships that relate to our research questions. First, deceivers could opt for two distinctly different strategies—either opting for reticence, in which the deceiver largely lets other group members do the talking and occasionally hitch-hikes on their misstatements, uncertainties, and erroneous conclusions, or a persuasive deception strategy, in which they take a more active and assertive role in misleading the group. The former better fits a flight or defensive response pattern whereas the latter better fits a fight or offensive stance. The results, though showing both types of patterns, more often fit the latter characterization in that there was an extremely high correlation, $r(12) = 0.92$, $p < 0.01$, between the deceiver (Space) initiating communicative patterns and the deceiver starting patterns with speaking actions (either illustrators or speaking nods). Put differently, nearly all interactions initiated by the deceiver were done so with him or her presumably controlling the situation by initiating lines of talk and guiding the conversation. Importantly, neither the Air nor the Intel role had a significant correlation between these two factors, $r(12) = 0.46$, $p = 0.10$ and $r(12) = 0.23$, $p = 0.43$, respectively. Across all groups the deceiver tended to initiate more patterns with speaking activities than did the other members of the group. These findings inform RQ1. Deceivers were more inclined to tilt in favor of active, persuasive deception than more passive, opportunistic deception.

Given IDT's proposition that suspectors also behave strategically and may telegraph their suspicions through their behavior, we might also expect some effects to emerge in the behavior of the group members other than the deceiver. This is the focus of RQ2. In our case, the Intel role was given a suspicion manipulation in which he or she was notified that others in the group may not act in the best interest of the group. Accordingly, we might expect to see probing activities from the Intel role as he or she attempted to uncover the deception and confirm suspicions. The zero-order correlation analyses reveal several interesting findings in this regard. The Intel role tended to be highly interactive in the patterning. For instance, nearly all patterns that included Intel also included a switch between actors, $r(12) = 0.96$, $p < 0.01$. Patterns that included a single actor were very negatively correlated with involvement from Intel, $r(12) = -0.84$, $p < 0.01$, while patterns with two or three actors were very positively correlated with involvement from Intel, $r(12) = 0.81$, $p < 0.01$ and $r(12) = 0.62$, $p = 0.02$, respectively. Thus, when Intel was implicated in patterned behavior, he or she tended to draw another actor into the pattern, which could be interpreted as investigative behavior. Perhaps more intriguing, however, is the tendency of Intel's interactive behavior to focus on the Space role.

Table 6
Select intercorrelations of session-level patterning behaviors ($N = 14$)

Percent of session patterns	Speaking behavior			Interactivity				Specific roles					
	Began by air talking	Began by intel talking	Began by space talking	With at least one switch	With one actor	With two actors	With three actors	No air	No intel	No space	With air	With intel	With space
Started by air	0.46	0.17	**–0.65**	–0.04	–0.05	–0.11	0.36	**0.76**	**–0.66**	0.29	**0.74**	**–0.57**	–0.52
Started by intel	–0.17	0.23	–0.48	**0.74**	**–0.57**	**0.65**	0.20	–0.06	0.27	**–0.61**	–0.29	–0.07	**0.89**
Started by space	–0.30	–0.31	**0.92**	–0.49	0.45	–0.37	–0.46	**0.59**	–0.40	0.35	–0.46	**0.91**	–0.17
with air	**0.55**	0.34	**–0.63**	0.03	–0.19	0.04	0.45	**–0.56**	0.37	**0.58**	–	0.01	**–0.74**
With intel	–0.08	0.26	–0.51	**0.96**	**–0.84**	**0.81**	**0.62**	**0.66**	**–0.59**	**0.59**	–	–	–0.11
With space	–0.52	**–0.58**	**0.74**	0.03	–0.09	0.15	–0.08	0.45	0.11	–0.53	–	–	–
No air	–0.39	–0.32	–0.06	**0.68**	**–0.58**	**0.72**	0.08	–	–	–	–	–	–
No intel	0.27	–0.07	0.10	–0.52	0.16	–0.16	–0.10	–0.47	–	–	–	–	–
No space	0.35	0.48	–0.53	**0.61**	**–0.56**	0.42	**0.65**	–0.12	–0.32	—	—	—	—

Note: Correlations in bold are significant at $p < 0.05$

Patterns that included Intel, but were not necessarily initiated by Intel, were highly correlated with patterning that *excluded* Air (and often included Space), $r(12) = 0.66$, $p = 0.01$, while patterns initiated by Intel tended to be highly correlated with patterns that *included* Space, $r(12) = 0.89$, $p < 0.01$. These results reveal that far more of Intel's patterning involved Space than Air, which could be an indication that Intel was engaging with Space because of his or her suspicion of deception. These findings shed light on the probing behavior of suspicious individuals. Rather than adopt a passive observer role, Intel was actively engaged in threaded, interdependent communication with Space and far more so than with Air.

3.5 Multiple Regression Analysis

While our exploratory zero-order analysis yielded several interesting insights, simple correlations must be interpreted with caution inasmuch as they merely indicate an association, without measuring or controlling for possible alternate explanations. To assess more adequately the strategic nature of deception in our group setting and possible joint influences on group conduct, we chose to also employ an exploratory multiple regression analysis.

A first analysis focused on the deceiver, specifically on the extent to which the deceiver tended to control and manage the interaction in order to guide the conversation as desired, and so is directly related to RQ1. For this analysis, the criterion measure was the number of patterns initiated by performing speaker-related actions (illustrators or speaking nods). The chief predictor variable of interest was whether the role (i.e., deception condition) affected this strategic speaking patterning. Included as covariates were gender, age, ethnicity, and a measure of general computer experience. We also controlled for differences in motivation between the different people assigned to the different roles. Motivation was a general measure of self-reported monitoring of others and vigilance for anything being amiss. Individuals who were more motivated to attend to others' communication could be expected to be either more strategic or more active in terms of speaking (or both), and controlling for this possibility allowed us to better understand the effect of the deception manipulation on strategic patterning behavior. Table 7 summarizes the descriptive statistics, including reliabilities where appropriate, for each of the variables included in the regression model.

The multiple regression was conducted hierarchically using SPSS version 20. Because of the small sample size and the exploratory nature of this investigation, we used a more relaxed criterion of $p < 0.10$ for entry into the model, and $p < 0.20$ for removal. Predictors were added in steps, with stepwise regression as the entry method at each step, beginning with inclusion of the demographic variables (gender, age, dummy-coded ethnicity categories) and computer experience. We then added motivation in step 2 to additionally control for differences in participant engage-

Table 7
Means, reliabilities, and intercorrelations among variables ($N=42$)

Variable	*M*	SD	α	1	2	3	4	5	6	7	8	9
1. Male	—	—	—	—								
2. Hispanic / Latino	—	—	—	0.12	—							
3. Asian/Islander	—	—	—	−0.12	−0.10	—						
4. Age	19.69	1.52	1.00	0.24	0.22	0.10	—					
5. Computer experience	3.53	0.94	0.71	0.52	0.04	0.11	−0.18	—				
6. Individual motivation	4.59	1.36	0.69	−0.06	0.06	−0.13	0.06	0.06	—			
7. Intel dummy code	—	—	—	0.08	0.09	0.08	0.08	0.23	−0.01	—		
8. Space dummy code	—	—	—	−0.04	−0.04	0.08	0.01	−0.12	−0.07	—	—	
9. Speaking Initiation	14.47	13.70	1.00	0.03	−0.21	0.17	0.07	0.18	0.20	−0.19	0.42	—
10. Relational quality	5.92	0.62	0.79	0.00	−0.21	−0.02	0.05	−0.30	−0.06	−0.12	−0.05	−0.41*
11. Interaction quality	5.99	0.66	0.73	0.01	−0.07	0.17	−0.18	−0.12	−0.07	0.10	−0.05	−0.48*
12. Task quality	6.21	0.66	0.59	0.11	0.02	0.10	−0.01	−0.02	−0.15	0.15	−0.26	−0.44*

Note: Correlations with absolute value of 0.31 and greater are significant at $p < 0.05$

ment and effort. Lastly, step 3 included dummy variables for Intel and Space (with Air as the reference group because it best served as a control group for comparing the two manipulated roles). The only significant predictor in the model was the Space role, $\beta = 0.41$, $F(1,40) = 8.45$, $p = 0.006$, $R2 = 0.17$, adjusted $R2 = 0.15$. Regardless of demographics or motivation, the Space (deceptive) role initiated significantly more patterns with speaking actions than did the reference group (the Air role), and Intel did not differ from Air. These patterning data increase our understanding of the strategic deception processes. Relative to a naïve group member, deceivers tended to initiate more observed patterns, whereas suspicious group members did not differ significantly from the naïve group member.

One of the ways in which a group member can eschew active participation and encourage others to talk instead is through the use of backchannel head movements. We also explored this measure as a criterion, specifically considering the number of patterns that began with this behavior. The multiple regression model produced three predictors. In step 1, computer experience entered as a predictor; in step 2, gender entered as a predictor; and in step 3, age entered. The total three-variable model was significant, $F(3,38) = 4.55$, $p = 0.008$, $R2 = 0.26$, adjusted $R2 = 0.21$. Those with less computer experience, males, and younger students were more likely to start interaction patterns with backchanneling. The role did not factor into this pattern.

On the other hand are indications of nonstrategic behavior such as adaptor behavior. We examined two criterion measures, percent of total session patterns beginning with adaptor gestures and patterns beginning with lip adaptors. In the model analyzing adaptor gestures, three predictors emerged: ethnicity, the Intel role and the Space role. The total three-variable model was significant, $F(3,38) = 5.67$, $p = 0.003$, $R2 = 0.31$, adjusted $R2 = 0.25$. Those of Hispanic descent exhibited more adaptors, whereas those in Intel and Space roles exhibited fewer patterns beginning with adaptors than those in the Air role. For lip pursing, only a single predictor emerged: the Intel role. Those in the Intel role initiated more patterns beginning with lip pursing than those in the Air role, $F(1,40) = 8.01$, $p = 0.007$, $R2 = 0.17$, adjusted $R2 = 0.15$, possibly as a telltale sign of uncertainty or concentration.

4 Discussion

Deception in group contexts is complex, and relatively little work has been conducted to understand the intricate communicative processes within group deception. Using IDT [1] as a guiding framework, we addressed two research questions regarding the strategic behavior of deceptive individuals and the tendencies of deceived individuals who are suspicious of their deception. Using

THEME [7, 6], we extracted and analyzed the interactional patterns evident in 14 different experimental group sessions in which both deception and suspicion were introduced. In a two-stage approach, we first used zero-order correlation analysis to investigate tendencies within the patterning behavior. We then used regression analysis to more accurately model the strategic speaking behavior of the deceptive group member.

4.1 Answering RQ1: The Actively Strategic Deceiver

RQ1 attempted to explain the strategic behavior of deceptive individuals, following the logic of IDT [1]. Though IDT states that deceivers will be strategic as they carry out their deception, there are at least two ways in which such strategic behavior might surface. The first possibility is a "lying low" strategy in which the deceiver strategically withholds information or allows group members to entertain false possibilities in order to achieve the desired outcome. Such behavior would be shown in our pattern analysis by, for example, a lack of participation in patterned interactions or a tendency toward backchannel encouragement (i.e., backchannel nods).

The second possible strategy a deceiver might employ would be a more active—perhaps even manipulative—role in guiding the group interaction, leading the group astray by actively working to engender false assumptions or conclusions. This type of behavior would be supported in our dataset by the deceiver being more engaged in interactional patterns, particularly with behaviors associated with active speaking actions (e.g., illustrators and/or speaking nods).

The exploratory correlation analysis supports the latter of these two possibilities. The patterning behavior of the deceptive Space role was found to be generally correlated with presumably strategic initiation of interactional patterns, more so than that of the other two roles. The regression analysis furthered this line of discovery, focusing on the strategic actions of the deceiver, in which the dependent variable was operationalized as the extent to which interactional patterns were initiated by speaking behaviors (which could be expected from someone who is trying to strategically manipulate the direction of the interaction). Our analysis revealed that, even after controlling for salient individual characteristics that might affect patterned speaking behaviors, the deceptive role initiated significantly more interactional patterns with speaking behaviors than did the other two roles.

While these findings are very preliminary, they indicate that deceivers in group settings may attempt to actively and strategically guide the interaction in order to successfully achieve their deception. The deceivers in our sample tended to be actively engaged in interactional patterns, and they tended to initiate patterns with speaking-related behaviors, as compared to the suspicious or naïve group members.

4.2 Answering RQ2: The Investigative Suspector

RQ2 focused on the behavior of the suspicious individual. IDT proposes that individuals who become aware of deception will attempt to uncover or, at a minimum, confirm the deception taking place. Like the behavior of deceivers, however, suspectors' behavior might also take different forms. One strategy might be a less active, watchful approach in which suspectors carefully examine the other members' behaviors without initiating much interaction in order to identify the deceiver. A second, more active strategy would be one in which the suspector engages in probing behavior, initiating interactions with other group members and attempting to discover the deceiver.

The Intel role that was made to be suspicious during the interaction produced substantial evidence that indicated probing behavior. The interactions with the suspicious role tended to show signs of interactivity and, most tellingly, a focus on the deceptive Space role in that interaction. These results intimate that suspicious individuals in groups where deception has been introduced may actively engage rather than passively observe the other members of the group in order to uncover the deceiver.

It is important to note that while some of the above conclusions could be drawn from other forms of analysis such as summary statistics of the individual coded behaviors, such analyses would in no way reveal the interdependencies and evolutionary character of the interaction patterns that are evident in our pattern analysis. For example, although the speaking behavior of the Intel role could be inferred somewhat from summary statistics, simply counting the number of speaking behaviors for each role and comparing those totals would not reveal their importance to specific roles and their embeddedness in overall patterns of behavior associated with a given role, and the tendency of the Intel role to be interactive and focused on the deceiver role would be overlooked. Put differently, it is the structure and relatedness among behaviors that would not be evident in simple summary statistics, and the strength of the THEME pattern analysis approach lies in detecting and analyzing those structures.

Moreover, a particular value of THEME is revealed in the study of interactions between the group members, which interactions are modeled in patterns using THEME. Using THEME to detect subtle, even imperceptible patterns during these group interactions, we were able to uncover tendencies of deceivers and the other group members as they interact with one another. These tendencies could be aggregated and studied in an objective way, and the findings extracted therefrom expand our understanding of the intricacies of deception in group settings. Further opportunity exists to better understand the patterns that surface during deceptive group communication.

Also offering new insights were the results on pattern length. The THEME software was able to discover and analyze patterns that ranged in length from two to as many as six different or repeated behaviors. As we have demonstrated, these patterns occur much more frequently than those that could be expected to occur by chance. That deceptive behavior is so intricately patterned suggests the need to drill deeper into the full gamut of patterns exhibited by each dyad or group. Such exploratory work would lead to more insights into how variable each dyad or group is in the enactment of deception and whether these patterns that are imperceptible to the unaided observer are associated with judges' intuitive notions of suspicious or deceptive communication.

4.3 Future Use of THEME

The current analysis only begins to exploit some of the potential of THEME analysis in uncovering the intricacies of human interaction. For example, IDT posits that interactions are dynamic and iterative, which implies that behaviors and their patterning may change over time. In the case of interpersonal deceit, there is evidence that behavioral displays do not remain constant; what is displayed early in an interaction is not the same as what is displayed later [21, 33]. Thus, one might expect that behavioral patterns themselves are subject to change. Some that are present at one juncture may disappear later, while other new patterns may emerge. It is also possible that deceivers, being focused on attaining their ulterior ends, may lose the routinized character of their communication patterns and show greater heterogeneity than truth tellers, whose patterning might show greater stability over time. THEME can answer this question by analyzing whether more patterns emerge prior to or following a particular juncture in the interaction. Other forms of statistical analysis only reveal whether the trajectories of particular behaviors change over time but not whether entire patterns of behavior change their frequency and complexion over the course of an interaction. THEME has the potential to reveal whether interdependence deepens or attenuates over time as well as whether patterns distribute themselves relatively equally over time or are more bunched early or late in an interaction. Questions such as whether more strategic or nonstrategic behavior is evident early or late in an interaction can also be answered by THEME, thus going beyond superficial understanding of group interaction to unpack some of its complexities.

4.4 Limitations

As with any study, our work is not without limitations. As stated, our analyses have been highly exploratory in nature. While we believe the discovered patterning behavior to be both valid and novel, the relationships observed among these behaviors and with other measured variables remain tentative. As such, there exist several opportunities for future research to further explore the tendencies observed in this work. Our correlation and regression analyses also suffered from small sample sizes ($N = 14$ and 42, respectively), and the risk of error due to sampling error should be considered while interpreting our results. These (and other) limitations notwithstanding, we believe that our findings provide a convincing argument regarding the value of pattern discovery and analysis afforded by the THEME software.

5 Conclusion

We have demonstrated the use and value of a novel pattern discovery and analysis tool in studying the complex interactions that take place in the context of group deception. The interactional patterns discovered, together with their general tendencies as uncovered in our exploratory analyses, provide additional insight to the knowledge base of group deception. Our hope is that the findings in this paper will spur other analysis and discovery in this fertile area of research.

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