CULTURAL VARIABILITY IN CREW DISCOURSE

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ABSTRACT

Four studies were conducted to determine features of effective crew communication in response to errors during flight. Study One examined whether US captains and first officers use different communication strategies to correct errors and problems on the flight deck, and whether their communications are affected by the two situation variables, level of risk and degree of face-threat involved in challenging an error. Study Two was the cross-cultural extension of Study One and involved pilots from three European countries. Study Three compared communication strategies of female and male air carrier pilots who were matched in terms of years and type of aircraft experience. The final study assessed the effectiveness of the communication strategies observed in Study One.

The essential thrust of Crew Resource Management (CRM) is to promote team work among pilots and thus to reduce human error. In addition to performing their individual tasks, crew members are expected to support each other by monitoring the situation as well as each other's performance and to intervene if a problem is detected. Analyses of aviation accidents and incidents, on the other hand, have implicated failures of crew members to do so in many instances (NTSB, 1994; Jentsch et al. 1997). The present research project was designed in an effort to guide crew training by identifying effective communication strategies pilots could use to mitigate errors or problems on the flight deck. Based on previous research we hypothesized that pilots' communications will be influenced by five variables: (1) the status of the speaker relative to the status of the addressee; (2) the risk inherent in the situation; (3) the degree of "face-threat" involved in challenging an error; (4) culture-specific norms for interacting with superiors and subordinates; and (5) the gender of the speaker.

Previous analyses of crew discourse found that captains were more direct in addressing first officers than first officers were in addressing captains. However, for both crew positions communications were more direct during problem and emergency situations than during normal flight segments (Linde, 1988; Orasanu & Fischer, 1992). In addition to risk pilots' communications were expected to be sensitive to the social implications of incidents. If others have made an obvious error, calling it to their attention may involve a direct challenge to their status, judgment or skill. According to politeness theory, in situations like these speakers will seek to protect their addressee's face and use more indirect speech as compared to situations that are less face-threatening (Brown & Levinson, 1987). Moreover, norms that define polite and socially appropriate behavior vary across cultures and were found to foster distinct conversational styles (Gudykunst, W. B., Ting-Toomey, S., & Chua, E., 1988; Hall, 1976; Holtgraves, T., & Yang, J-N., 1992) and attitudes toward leadership (Merritt & Helmreich, 1996; Redding & Ogilvie, 1984). These findings suggest that pilots from different cultures may favor distinct

communication strategies. An issue related to cross-cultural differences in communication style concerns gender differences. In recent years sociolinguists have advanced the position that women talk differently than men (e.g., Tannen, 1990). Men were found to be more explicit, directive and task-oriented than women. Female speech, in turn, has been characterized as indirect and concerned with relational aspects of interactions (Lakoff, 1975; Tannen, 1990, 1994). The present research sought to determine whether similar differences characterize crew discourse.

Four studies were conducted. Study One examined whether US captains and first officers use different communication strategies to correct errors and problems on the flight deck, and whether their communications are affected by level of risk and degree of face-threat involved in challenging an error. Study Two was the cross-cultural extension of Study One and involved pilots from three European countries. Study Three compared communication strategies of female and male air carrier pilots who were matched in terms of years and type of aircraft experience. The final study assessed the effectiveness of the communication strategies observed in Study One.

STUDY ONE

The aim of this study was to determine whether captains and first officers use different communication strategies to correct an error or problem on the flight deck. The effects of two situation variables were also examined: (a) level of risk inherent in a situation and (b) the degree of "face-threat" involved in challenging an error. 157 pilots (69 captains and 88 first officers) from three major US airlines participated. All participants were male.

Participants received eight written problem scenarios and were asked to state how they would correct various pilot errors. For participating captains, low- and high-risk incidents were described from the perspective of the captain and involved errors or oversights on the part of the first officer, the pilot-flying. For first officer participants,

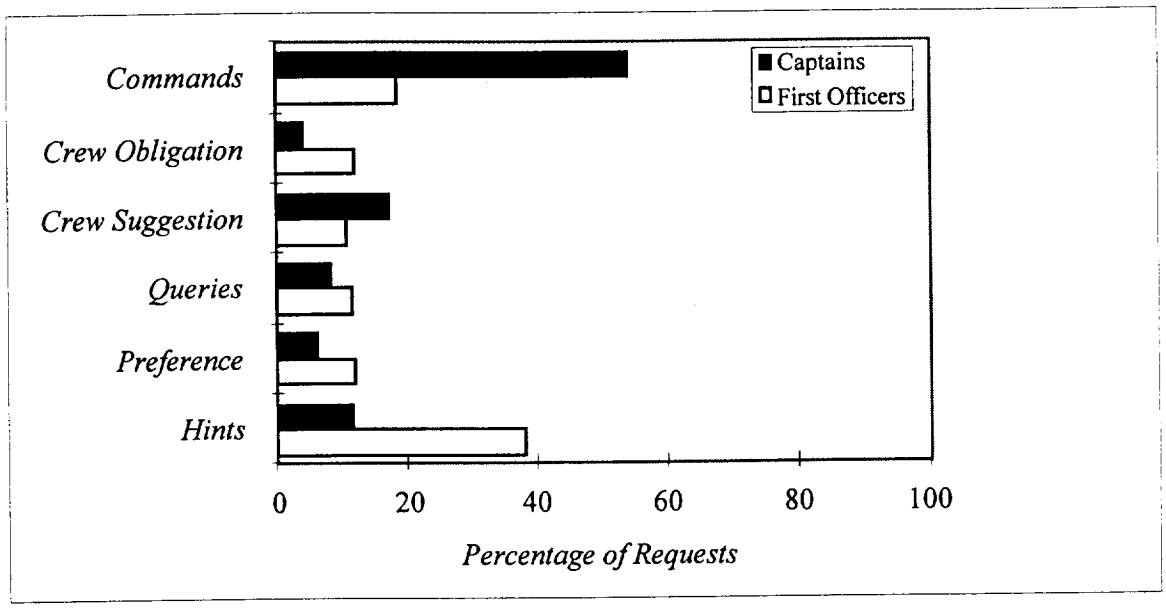
incidents were identical except that they described captains making errors and oversights. Participants' responses were assigned to six classes of requests and two classes of speaker-centered communications differing in terms of explicitness and directness (Blum-Kulka, House & Kasper, 1989).

Table 1. Classes Of Requests And Speaker-Centered Communications

REQUESTS	
Commands	*Turn 30° right.*
Crew Obligation Statements	*I think we need to deviate right about now.*
Crew Suggestions	*Let's go around the weather.*
Queries	*Which direction would you like to deviate?*
Preferences	*I think it would be wise to turn left or right.*
Hints	*That return at 25 miles looks mean.*
SPEAKER-CENTERED COMMUNICATIONS	
Self-Directives	*I am going to get a clearance to deviate around these storms.*
Permission-seeking Questions	*You want me to ask for clearance to deviate around this weather?*

As can be seen in Figure 1, captains predominantly used commands to correct first officers while first officers most often used hints (i.e., problem- or goal statements) to get action from the captain. That is, captains were more likely than first officers to specify the action that should be taken, and to express their intentions more forcefully than first officers; i.e., there was a stronger obligation for first officers to comply with captains' requests than vice versa. Similar status differences were observed for communications that concerned actions by the speaker. First officers were likely to assure that the captain agreed with their planned action (57% of their speaker-centered communications) while captains almost never used permission-requests relying instead on self-directives (91% of the time).

Figure 1. Distribution of Captains' and First Officers' Request Strategies



In addition to status, request strategies were also influenced by the risk level inherent in a situation. As predicted both crew positions became more direct when risk increased. Nonetheless status differences persisted. Captains adjusted to higher risk levels mainly by issuing even more commands than in low-risk situations. First officers used more crew obligation statements. However, hints remained their predominant strategy, even in high risk situations.

Pilots' responses to the degree of face-threat involved in correcting an error were not consistent with the predictions made by politeness theory. Pilots did not generally shift to more indirect request strategies when they had to correct highly embarrassing mistakes. Instead, captains used more hints but also more commands in high face-threat situations while first officers were likely to increase commands, crew suggestions and crew obligation statements. Captains apparently focused either on the social implication of an error thus preferring indirect interventions for high face-threat errors, or they responded to the magnitude of the error correcting serious mistakes more decisively than minor ones. First officers seem to have appreciated either aspect dependent on the risk

level. In low-risk situations, they became more direct when they challenged big rather than small captain errors. However, when risk levels were high, errors judged to be highly embarrassing to the captain, were handled more indirectly than errors assumed to involve less face-threat.

STUDY 2

This study was conducted to determine whether there are cross-cultural differences in pilots' communication strategies. 376 pilots (180 captains and 196 first officers) from three European countries participated in a study identical to Study One. Pilots who were non-native speakers of English, received all experimental materials translated into their native language.

As shown in Figures 2 and 3, the European pilots replicated the findings from the US sample. However, some cross-cultural variations were apparent. Most notably, status-differences between European captains and first officers were less pronounced than those observed for US pilots. European captains were more likely than US captains to correct a first officer's action by simply pointing out the problem to him or by reminding him of a goal. Conversely, European first officers were more likely than their US counterparts to issue commands.

Figure 2. Cross-Cultural Comparison of Captains' Request Strategies

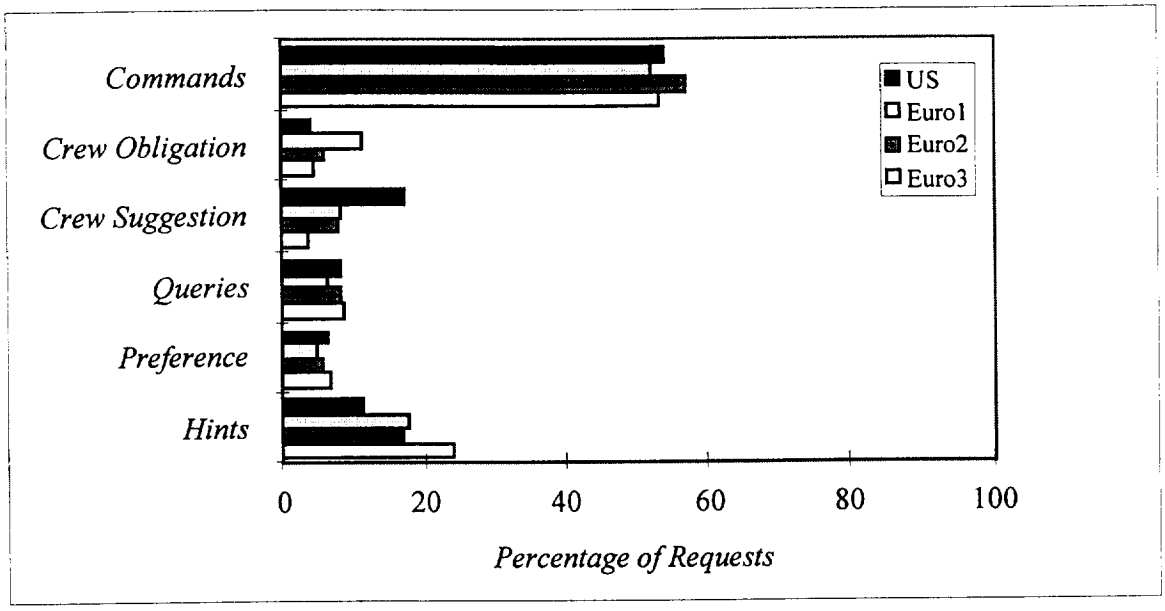
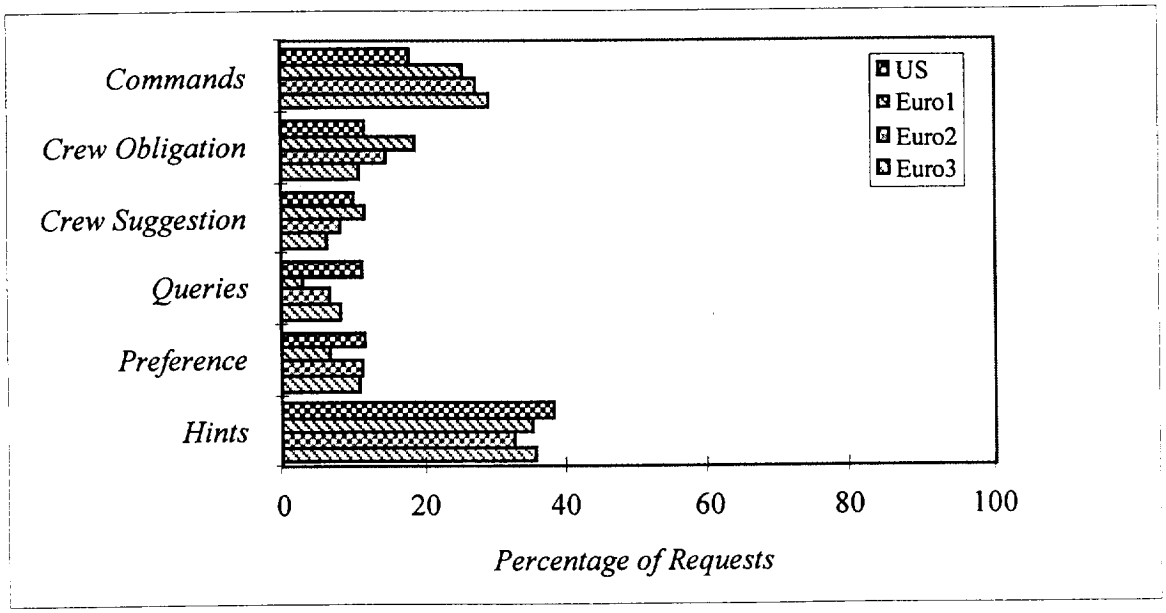


Figure 3. Cross-Cultural Comparison of First Officers' Request Strategies



Cross-cultural differences were also found concerning first officers' responses to varying levels of risk and face-threat. First officers' responses to high-risk situations fall into three distinct models. The first one entails an increase in crew obligation statements

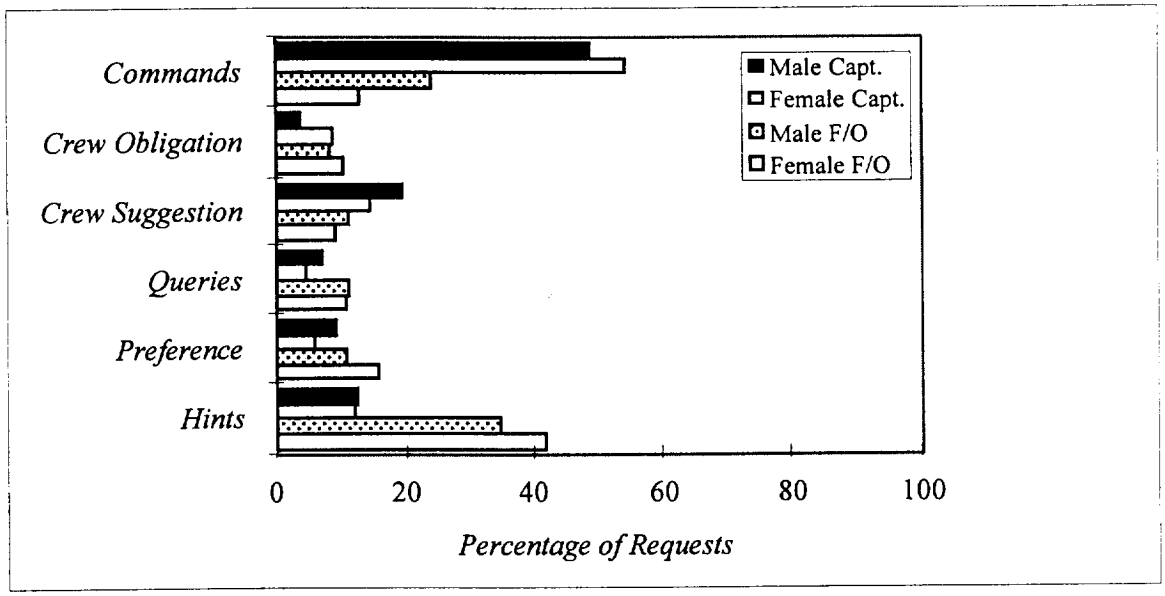
while leaving the preponderance of hints intact. The second model involves no significant changes from low- to high-risk situations with hints as predominant strategy. The third model is characterized by a switch to a more captain-like request style insofar as commands become the dominant strategy in high-risk situations. Varying types of pilot error again yielded three distinct responses from first officers. For two groups request strategies were not significantly affected by error type. The remaining two groups either increased both hints and commands, or they used only more direct requests in response to high face-threat errors by the captain.

STUDY 3

This study examined whether sociolinguistic findings of gender differences generalize to crew discourse as well. 28 female US pilots (12 captains and 16 first officers) participated in a task identical to Study One. Communications collected by female pilots were then compared to responses obtained from male pilots who matched the female sample in terms of years and type of aircraft experience.

We found that status rather than gender influenced pilots' communication strategies. All captains, regardless of gender, were more controlling when they requested action from first officers than first officers were in directing captains. However, female pilots, in particular female captains, were more likely than male pilots to justify direct requests with problem or goal statements. Supportive statements may, on the one hand, decrease the imposition speakers place on their addressee. In addition, speakers who mention a problem and a corrective action make their thinking transparent and may thus facilitate a crew's shared problem solving (Orasanu, 1994).

Figure 4. Comparison of Male and Female Pilots' Requests Strategies



STUDY FOUR

This study had several objectives. We wanted to determine which of the communication strategies discerned in Study One are effective in mitigating pilot error, and whether supporting statements enhance the effectiveness of strategies. Moreover, we wanted to see whether the perceived effectiveness of strategies varied for captains and first officers, as well as with the risk level and degree of face-threat inherent in an incident.

63 pilots (31 captains and 32 first officers) from a major US airline received the incident descriptions used in Study One and one example for each of the major communication strategies discerned. Participants were asked to rate the effectiveness and directness of each communication. Participating captains were told that the communications were from first officers. First officer participants received the same communications, and were told that these were captains' communications. Half of the participants in each pilot group received communications unsupported by a problem- or goal statement while the remaining participants received the communications with supporting statements.

Effective communication strategies were found to be neither too direct nor too indirect, but instead to appeal to the crew's shared responsibility for coping with problem situations. Both pilot groups gave high effectiveness ratings to crew obligation statements, preference statements, crew suggestions and hints, and consistently rated commands, the most direct communication strategy, as less effective. Even in high-risk situations, commands were judged to be less effective than crew obligation statements. Moreover, communications that were supported by a problem or goal statement received higher effectiveness ratings than unsupported communications. Both constructions, however, were perceived as equally direct. That is, pilots apparently attributed the increased effectiveness of complex communications to their cognitive benefits rather than to differences in politeness.

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PRESENTATIONS

Say it again, Sam! Effective communication strategies to mitigate pilot error. Paper presented at the 10th International Symposium on Aviation Psychology, Columbus, OH, May 1999

How to challenge the captain's actions. Paper presented at the 9th International Symposium on Aviation Psychology, Columbus, OH, April 1997

The effect of status and gender on pilots' communication strategies. Paper presented at the Aviation Communication Symposium, Embry Riddle University, Prescott, AZ, March 1997.

Experience and role effects on expert pilots' judgments of problem situations. Paper presented at the International Congress of Psychology in Montréal, August 1996.

PUBLICATIONS

Fischer, U., & Orasanu, J. (unpublished manuscript). Crew communication strategies to mitigate pilot error: A cross-cultural comparison of US and European pilots.

Fischer, U., & Orasanu, J. (in press). Say it again, Sam! Effective communication strategies to mitigate pilot error. In *Proceedings of the Tenth International Symposium on Aviation Psychology*. Columbus, OH.

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APPENDIX

(selected publications)

CREW COMMUNICATION STRATEGIES TO MITIGATE PILOT ERROR: A CROSS-CULTURAL COMPARISON OF US AND EUROPEAN PILOTS

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ABSTRACT

A study was conducted to determine whether captains and first officers use different communication strategies to correct an error or problem on the flight deck. The effects of two situation variables were also examined: (a) level of risk inherent in a situation and (b) the degree of "face-threat" involved in challenging an error. Pilots from the US and three European countries participated. They received written problem scenarios and were asked to state how they would correct various pilot errors. Participants' responses were then assigned to eight classes of communications differing in terms of request perspective, explicitness and directness. Analyses revealed that captains were generally more direct in addressing first officers than first officers were in addressing captains. This effect was particularly pronounced for the US pilots. Moreover analyses showed a significant effect of perceived risk on pilots' communications. Captains and first officers, except for one first officer group, were more direct with increased risk. Responses to high- and low-face threatening errors were more varied. Some pilot groups used both hints and commands to correct serious pilot errors, while the remaining pilot groups did not significantly change their communications as a function of face threat. Training implications of our findings are also discussed.

157 US pilots (69 captains and 88 first officers) participated in a study conducted by researchers of the Georgia Institute of Technology and NASA-Ames Research Center. This project is part of an ongoing effort to determine features of effective crew communication, especially in response to errors during flight. Specifically, this study was designed to answer the following questions: (1) What communication strategies do first officers use when they have to challenge the actions of a captain, and vice versa, what are captains' preferred strategies in this context? (2) How does perceived threat to flight safety and error type affect pilots' choice of strategy? (3) Are there cross-cultural differences in pilots' communication strategies?

Overall the study involved 249 captains and 284 first officers from the US and three European countries. All captains and 280 first officers were male; the four female first officers were from the three European countries. Participants received eight short descriptions of aviation incidents in their native language[1]. The incidents varied in their threat to flight safety (high or low risk) and type of problem (high or low face threat errors). Minor errors, such as an oversight, were considered to be low in face-threat because they did not involve a direct challenge to the pilot's skill or judgment. Big mistakes, such as an altitude bust, were considered to be high in face-threat because correcting them meant a direct challenge to the pilot's skill or judgment. For participating captains, low- and high-risk incidents were described from the perspective of the captain and involved errors or oversights on the part of the first officer, the pilot-flying. For first officer participants, incidents were identical except that they described captains making errors and oversights. The incident descriptions were printed in a test booklet, one description per page.

Participants were asked to complete two tasks: a Discourse Completion Task and then a Judgment Task requiring participants to rate each incident in terms of risk to flight

[1] The foreign language material was translated back into English and compared with the English original to assure equivalence of the study material across languages

safety and how embarrassing it was to the other pilot. In the Discourse Completion Task, participants read the incident descriptions and were asked to imagine themselves in the position of the non-flying pilot (captain or first officer - depending on the crew position of the participant). Each incident description was followed by a goal statement. The participants' task was to write out verbatim what they would say to the pilot flying (the first officer or the captain) in order to achieve the stated goal. For instance, captain participants saw the following description and goal statement:

> While cruising in IMC at FL 310, you notice on the weather radar an area of heavy precipitation 25 miles ahead. First Officer Henry Jones, who is flying the aircraft, is maintaining his present course at Mach .73 even though embedded thunderstorms have been reported in your area and you encounter moderate turbulence.
>
> *You want to ensure that your aircraft will not penetrate this area.*

There are many ways in which the non-flying pilot could achieve this goal. He could either take some action himself or could ask the pilot flying to take a particular goal-consistent action. We categorized the former as speaker-centered communications and the latter as other-centered communications or requests. An example of a speaker-centered communication is, *"I am going to talk to ATC and request a deviation."* Requesting a colleague to act, on the other hand, could be done by saying *"Let's go around the weather."*

Both types of communications could vary in the extent to which speakers were direct and explicit about what action to take and who is to do it. Overall six classes of requests and two classes of speaker-centered communications were distinguished, as shown in Table 1. Commands are the most direct form of request -- they leave little doubt about what action a speaker wants his addressee to perform. Crew obligation statements and crew suggestions are less direct than commands insofar as they do not

explicitly refer to the addressee as the one who is to take the action. Moreover, crew suggestions are less forceful than either commands or crew obligation statements because they simply propose, rather than assert a particular corrective action. Commands and crew obligation statements, in contrast, are more binding, the former by demanding adherence and the latter by appealing to an existing obligation.

TABLE 1. CLASSES OF REQUESTS AND SPEAKER-CENTERED COMMUNICATIONS

REQUESTS	
Commands	*Turn 30° right.*
Crew Obligation Statements	*I think we need to deviate right about now.*
Crew Suggestions	*Let's go around the weather.*
Queries	*Which direction would you like to deviate?*
Preferences	*I think it would be wise to turn left or right.*
Hints	*That return at 25 miles looks mean.*
SPEAKER-CENTERED COMMUNICATIONS	
Self-Directives	*I am going to get a clearance to deviate around these storms.*
Permission-seeking Questions	*You want me to ask for clearance to deviate around this weather?*

Queries, the fourth request type neither call for nor assert a particular corrective action. Instead, speakers inquire about the addressee's willingness to take the action. Similarly, preference statements are indirect requests insofar as speakers do not overtly make a request but rather express their or a third party's (i.e., ATC) preference for a particular

course of action. Hints, i.e., problem or goal statements, are the least direct form of request. Speakers do not specify any course of action; rather they point to a problem or remind of a previously established goal. Similar distinctions were made for speaker-centered communications. Self-directives are the most direct form of speaker-centered communication. Like commands, they leave little doubt about the speaker's intentions and express a strong commitment on his part to a particular course of action. Permission-seeking questions, in contrast, leave it to the addressee to agree with a planned action of the speaker.

Responses were also coded in terms of their structure, either simple or complex. Simple communications involved only a request or a speaker-centered communication. Complex communications consisted of two parts: one that realized the stated goal and a second one that provided a reason for the request or speaker-centered communication. An example of a complex communication is *"I see we have some cells painting on radar. I think we should turn left about 30°."*

To assess the reliability of the coding, 25% of the responses to each scenario were randomly selected and independently coded by two judges. Percent agreement between the raters was high: 90% for coding of the communication strategies and 88% for their structure.

I. DO CAPTAINS AND FIRST OFFICERS DIFFER IN THEIR PREFERRED STRATEGIES FOR CHALLENGING THE ACTIONS OF THE PILOT FLYING?

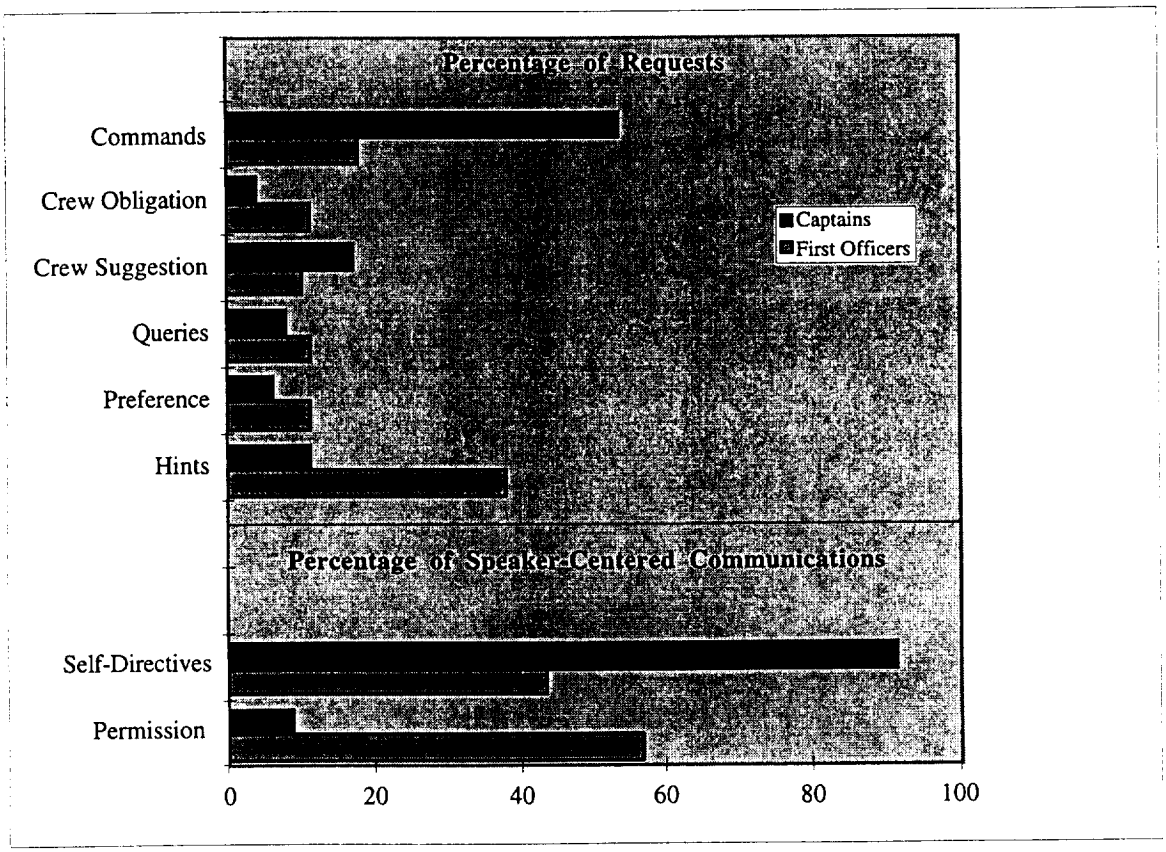
First, we will describe requests or other-directed communications, and then describe speaker-centered communications.

Requests. 78 percent of the captains' and 80% of the first officers' responses were requests for the other pilot to take action. Log-linear analyses revealed that first officers and captains favored different request strategies. Most noticeable is their distinct use of hints and commands, the two most common strategies. Captains most frequently

used commands, while first officers most often used hints, a very indirect approach. First officers did not specify any particular course of action, but instead pointed to a problem or reminded the captain of a previously established goal. Apparently they assumed that the captain would feel committed to a corrective action once he agreed with their assessment of the situation. In so doing, first officers at most questioned the captain's understanding of the situation. But they minimally challenged his status since the decision about how best to respond to the problem was left to the captain.

FIGURE 1.

CAPTAINS' AND FIRST OFFICERS' COMMUNICATION STRATEGIES



While captains also used indirect requests (i.e., hints), they did so less frequently than first officers. As Figure 1 shows, hints were three times more frequent in first

officers' than in captains' communications. Captains, on the other hand, used commands three times as often as first officers. This pattern of findings indicates that while pursuing identical communicative goals, captains take a more direct route than first officers. Captains were more likely than first officers to specify the action that should be taken. Moreover, in issuing more commands and fewer hints than first officers, captains expressed their intentions more forcefully than first officers; i.e., there was a stronger obligation for first officers to comply with captains' requests than vice versa.

However, direct requests, such as commands, were frequently accompanied by justifications as in the following example: *"We are too far left of centerline for parallel approaches - correct right immediately!"* On average, 63% of both captains' and first officers' direct requests (i.e., commands, crew obligation statements and suggestions) were of this kind. As the example illustrates, justifications may serve several social and cognitive purposes. By referring to some problem or goal in addition to making a direct request, speakers decrease the imposition of their communication on the addressee. Since there is some objective event requiring an action, the speaker's request becomes reasonable and his role in requesting is thus minimized. Besides their social function, complex communications also have important implications for crew decision making. Speakers who mention a problem and action make their thinking transparent and may thus facilitate a crew's shared understanding of the situation. By placing their requests into a context, speakers ensure that other crew members are able to see why they are asked to perform a particular action. Moreover, crew members are then in a position to verify for themselves that the speaker's problem understanding is appropriate, and that the requested action is indeed the best response.

Speaker-centered communications. About 21 percent of all communications were speaker-centered rather than other-directed (i.e., requests). Status-based differences were again observed for speaker-centered communications. US captains almost never asked permission-seeking questions, relying instead on self-directive statements like, *I'll call*

ATC and find out if he still wants on this heading." (91% of the time). US first officers, in contrast, preferred permission requests to self-directives. In 57 percent of their speaker-centered communications did they verify that the captain agreed with their planned actions as in the following example: *"Do you want me to ask ATC if they still want us on this heading?"*

Since self-directives are more assertive than permission-seeking questions, we predicted structural differences between these utterance types similar to the ones observed for more and less direct requests. That is, we expected that speakers would feel more inclined to justify self-directives than permission-seeking questions. Contrary to our expectations, complex communications dominated both self-directives and permission-seeking questions by captains and first officers. This finding may either indicate that speaker-centered communications are in general considered to be rather bold communicative moves that require some mitigation. Recall that the speaker in all scenarios is the pilot-not-flying! Or, it may suggest that the speaker seeks to coordinate the activities of the crew and in order to do so, provides the broader context.

Before leaving the discussion of differences between captains' and first officers' communication strategies we need to stress that our analyses concern pilots' <u>initial</u> reactions to errors or oversights of the pilot flying. Our study indicates that first officers are likely to be less forceful when they first attempt to correct an oversight or inappropriate action of the captain than are captains in their responses to errors by first officers. While indirect speech is more polite than direct speech, it also carries the risk of misunderstanding. Listeners may not realize the indirectness of an utterance and may misinterpret the speaker's intention. Or, listeners may mistake politeness for indecisiveness and consequently may not take the implied intention seriously enough. Thus, by being indirect, first officers may not succeed in getting their intention understood or heard.

We do not know how first officers would proceed if their initial attempt turned out to be unsuccessful. It is conceivable that in these circumstances first officers would switch to more direct means of communicating their intentions. As will be seen in our discussion of strategy use in low- and high risk situations, there is reason to suspect that first officers are not invariably indirect but instead will adjust the directness of their communications to situational demands.

II. HOW DO PERCEIVED THREAT TO FLIGHT SAFETY AND ERROR TYPE AFFECT PILOTS' CHOICE OF STRATEGY?

So far, we have addressed pilots' communication strategies in general, across situations, without considering how specific features of situations influenced strategy use. Two situation variables were manipulated in our study: threat to flight safety and type of pilot error. There were four types of scenarios: low-risk and high-risk situations involving either small errors by the pilot-flying or highly embarrassing mistakes. As their ratings in the Judgment Task revealed, 107 of the 157 participants did distinguish between these four types of scenarios[2]. Our next analyses examined whether differences in risk and embarrassment levels were reflected in pilots' communication strategies.

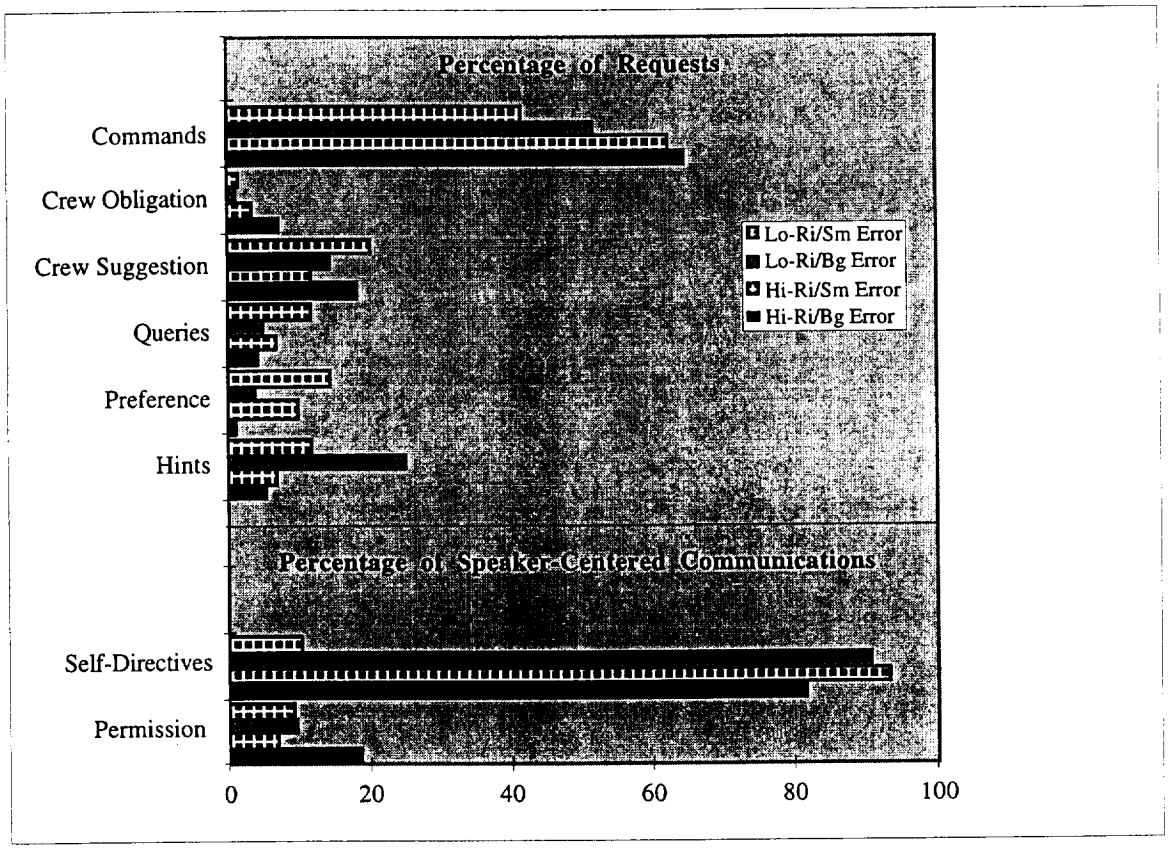
Figures 2 and 3 show that varying risk levels and error types had no significant effect on US pilots' speaker-centered communications. Both variables, however, influenced how US captains and first officers phrased requests.

As indicated by their ratings in the Judgment Task, US captains and first officers agreed in their risk assessment of the incidents. Nonetheless, captains were more direct than first officers in responding to high-risk incidents. Like the captains from other

[2] For the remaining 50 participants, high-risk situations were generally rated to be more embarrassing than low-risk situations. Responses of these participants were consequently excluded from the analyses concerning the effects of risk and type of pilot error on communication strategies.

countries in our cross-cultural sample, US captains adjusted to risk mainly by increasing the number of commands and by decreasing the number of hints.

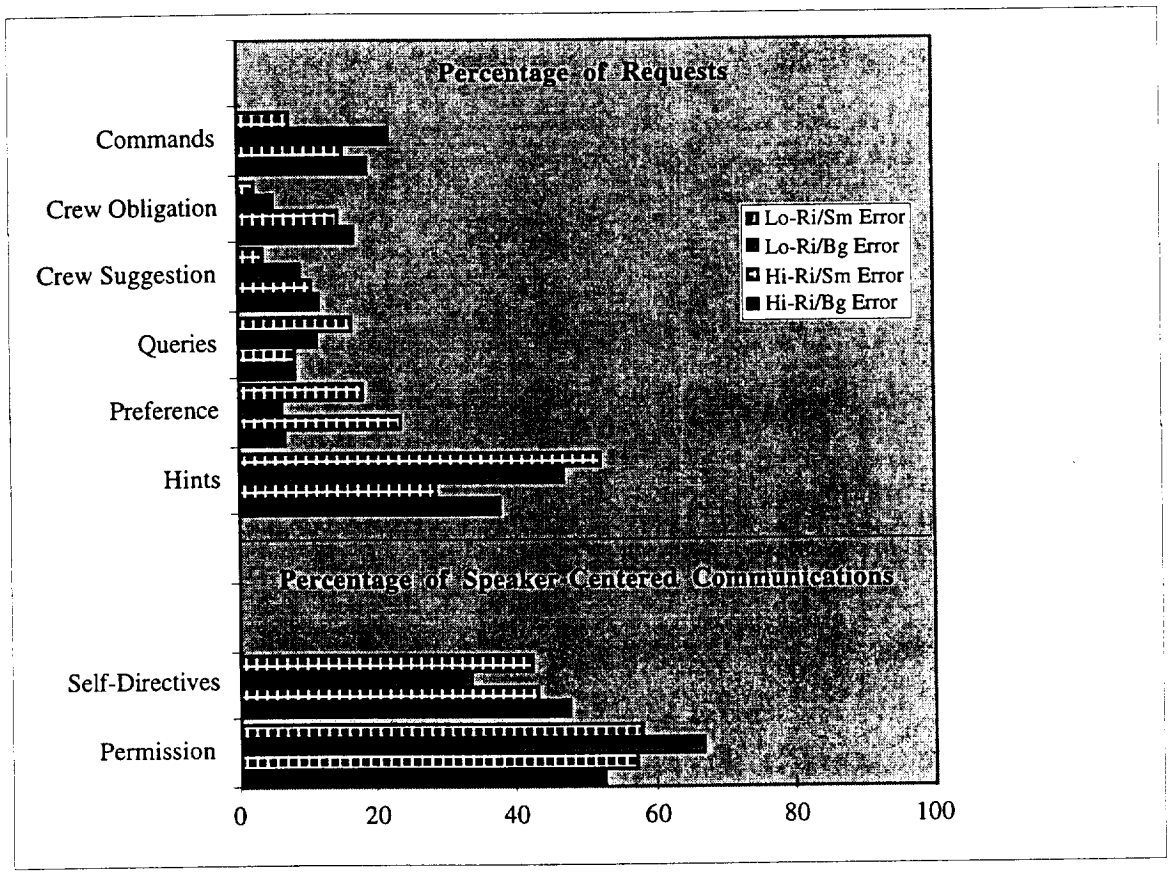
FIGURE 2. CAPTAINS' COMMUNICATION STRATEGIES AS A FUNCTION OF RISK LEVEL AND ERROR TYPE



For US first officers hints remained the single most frequent request strategy, even in high-risk situations. However, their use of direct request strategies, i.e., of commands, crew obligation statements and suggestions, rose from 24% to 47% as risk increased. This increase in direct requests is predominantly due to the fact that first officers used four times as many crew obligation statements in high-risk than in low-risk situations. In this respect, US first officers responded like first officers from European country 1. Their colleagues from the other European countries either did not significantly change

their communications with varying risk levels, or used considerably more commands in high-risk situations, thus becoming more captain-like.

FIGURE 3. FIRST OFFICERS' COMMUNICATION STRATEGIES AS A FUNCTION OF RISK LEVEL AND ERROR TYPE



US captains' and first officers' request strategies not only varied with risk but also changed with error type. US captains used more hints but also more commands in situations in which first officers committed some real error, e.g., an altitude bust, rather than some minor oversight. US first officers tended to increase commands, crew obligation statements and suggestions in these situations. While US captains reacted like most of their European colleagues, US first officers differed from their European counterparts. One European first officer group responded to real errors as the majority of

captains did; the other groups did not significantly shift their request strategies with error type.

Overall our participants' responses to the different types of pilot error is somewhat surprising given the dictum of politeness theory that speakers will usually seek to protect their addressee's "face." Politeness theory predicts that pilots will use more indirect communications when they have to address the other pilot in situations that are highly face-threatening to him or her, i.e., when they have to correct serious errors rather than small mistakes that involve little face-threat. Interestingly, neither pilot showed a strategy shift in the predicted direction, although all of them judged serious errors to be more embarrassing to the pilot flying than small mistakes.

One possible explanation, in particular of US captains' responses is that the situation variable "type of pilot error " allowed two distinct perspectives. Some of the study participants may have focused on the social implication of an error and adjusted their communications to the degree to which their intervention would be a direct challenge to the other pilot's skill and judgment. Other participants may have responded to the magnitude of an error and consequently corrected real mistakes more decisively than minor ones.

Alternatively, this finding may reflect the joint effect of risk level and error type on pilots' request strategies. That is, pilots may have assessed and responded differently to errors as the risk inherent in a situation changed. European captains, for instance, became more indirect, i.e., used more hints, in response to high face-threat errors by the first officer, but only when risk was low. When risk was high, safety considerations apparently took precedence over social considerations and captains used predominantly commands to mitigate errors by the first officer. Risk and error type may have also affected US first officers' strategy choice, albeit in a rather different direction. Figure 3 suggests that in low-risk situations, they became more direct (i.e., used more commands and fewer hints) when they challenged big rather than small captain errors. However in

high-risk situations, their use of direct requests remained the same and the number of hints increased for high face-threat errors. That is, when risk levels were high, errors that were judged to be highly embarrassing to the captain were handled more indirectly than errors assumed to involve less face-threat.

III. ARE THERE CROSS-CULTURAL DIFFERENCES IN PILOTS' COMMUNICATION STRATEGIES?

The answer to this question is yes. Most notably, status-differences between US captains and first officers are more pronounced than those observed for European pilots.

FIGURE 4. CROSS-CULTURAL COMPARISON OF CAPTAINS' COMMUNICATION STRATEGIES

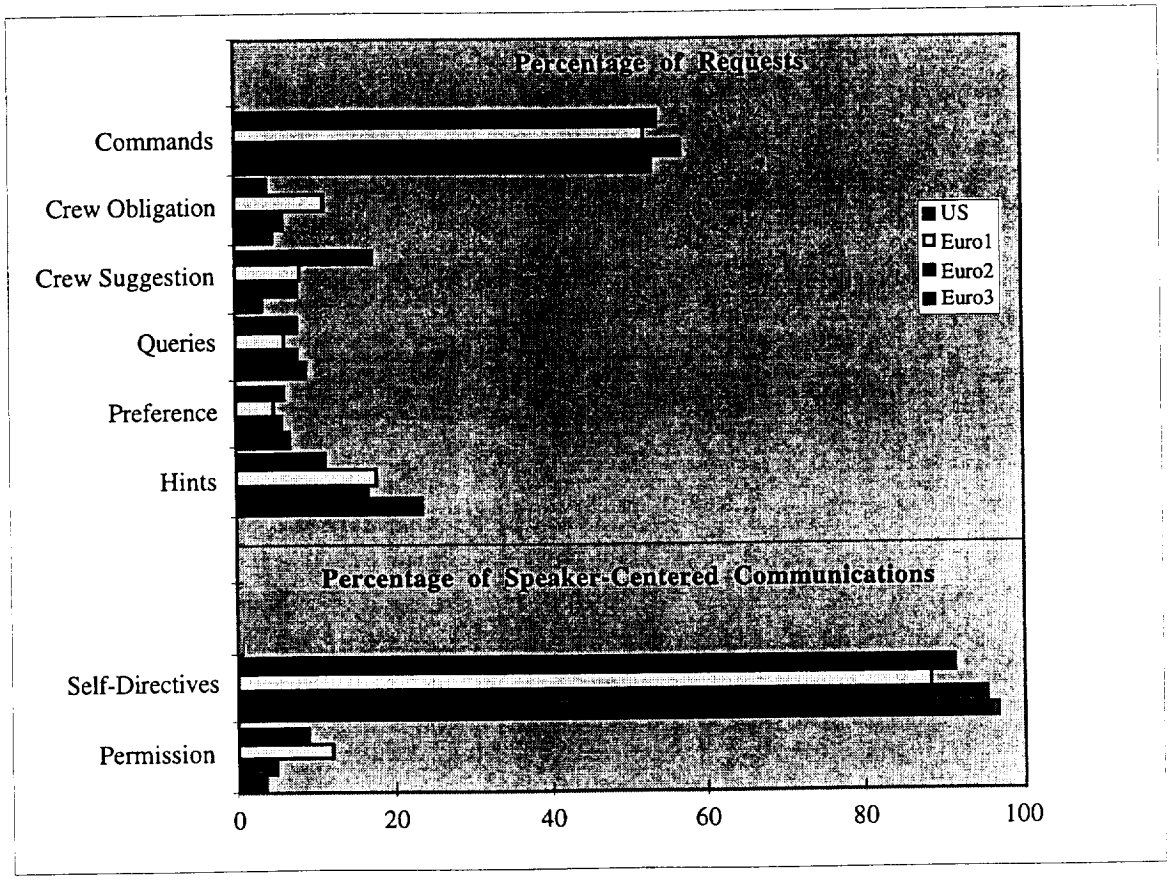
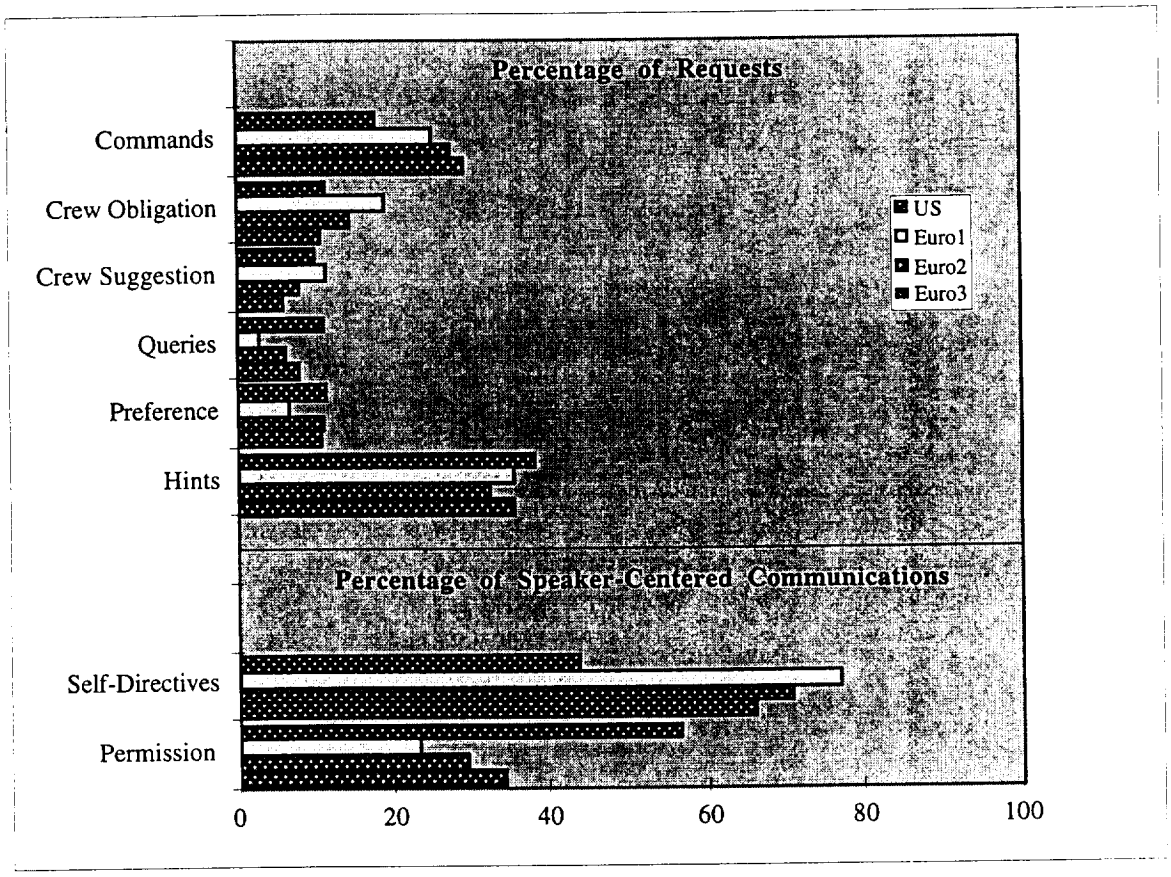


Figure 4 indicates that European captains were more likely than US captains to correct a first officer's action by simply pointing out the problem to him or by reminding him of a goal. Conversely, as can bee seen in Figure 5, European first officers were more likely than their US counterparts to issue commands and to use self-directives.

FIGURE 5. CROSS-CULTURAL COMPARISON OF FIRST OFFICERS' COMMUNICATION STRATEGIES



This finding contrasts with previous research on pilots' attitudes towards leadership. These surveys found low power distance between US captains and first officers, whereas a more hierarchical crew structure was observed for European pilots. Given their attitude data, we expected US and European pilots' communications to differ

in the opposite direction than we found. The discrepancy in findings between our study and the attitude research may be the result of differing methodologies. Attitudes are inferred from the extent to which pilots agree or disagree with generic statements such as "Crewmembers shouldn't question the captain unless the safety of the flight is threatened." Answers to these statements may reflect pilots' assessment of how likely it is that they would display the behavior mentioned. Or, the responses may indicate pilots' judgments of the appropriateness of the behavior. Moreover, attitude studies do not specify how pilots would go about "questioning the captain." Our study, on the other hand, addressed exactly this issue by investigating what specific strategies pilots say they would use and how their strategies correlate with specific aspects of situations.

IMPLICATIONS FOR TRAINING

In this final section we discuss two issues that emerge from our findings that are pertinent to training. The first issue concerns the fact that pilots predominantly rely on one status-consistent strategy to request action of a colleague. One question that comes readily to mind and that could be discussed during training is: To what extent would more flexible strategies be beneficial? In addition, training could address the advantages and disadvantages of captains' and first officers' preferred strategies, i.e., of commands and hints, respectively. For example, captains' commands may lead to complacency by the first officer. In commanding action, captains put considerable pressure on first officers to comply. Consequently, first officers might not verify the appropriateness of the requested action, or they might find it difficult to challenge the captain's judgment. This may especially be a danger when commands are not supported by problem or goal statements. Since these supportive statements shift the motivation for the command away from the captain's status to some objective necessity, they may facilitate input by junior crew members. Likewise, there are advantages and disadvantages associated with hints, first officers' main strategy for requesting captain action. While

first officers' problem and goal statements are certainly task-relevant communications, they entail the risk that captains will not act on them. This is not to say that hints are necessarily ineffective request strategies. Instead, training could identify possible follow-up strategies that first officers could (or should) use if the captain does not respond adequately to their request.

The second training issue that follows from our research concerns pilots' response to varying risk levels and different types of pilot error. With respect to the US sample in our study, relevant findings are: (1) First officers, as did captains, used more direct requests in high-risk than in low-risk situations. However, hints remained the preferred first officer strategy, even in high-risk situations. (2) Captains used either more commands or more hints when they corrected big errors rather than small mistakes of the first officer. First officers responded similarly although their use of commands and hints tended to vary with risk level. In low-risk situations, real errors of the captain elicited more commands than small mistakes whereas in high-risk situations, big mistakes led to an increase in hints.

Our cross-cultural comparison revealed that while captains were a fairly homogenous group, first officers' responses were more varied. European first officers' responses to high-risk situations can be summarized in three distinct models. The first one replicates the response pattern of US first officers and entails an increase in crew obligation statements while leaving the preponderance of hints intact. The second model involves no significant changes from low- to high-risk situations with hints as predominant strategy. The third model is characterized by a switch to a more captain-like request style in high-risk situations as commands become the dominant strategy. Varying levels of pilot error yielded two distinct responses from European first officers. For two groups we found that request strategies were not significantly affected by error type. The remaining group increased their use of hints and of commands in response to big, highly-embarrassing mistakes of a captain, and, unlike US first officers, did so across risk

levels. These cross-cultural variations indicate that pilots atttach different importance to the same situation variables and respond differently to identical incidents. Training could address whether any of the observed communication models is desirable or whether some alternative model may be more effective. For example in subsequent work, we found that pilots generally judged crew obligation statements as more effective than commands, even in high-risk situations.

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SAY IT AGAIN, SAM!
EFFECTIVE COMMUNICATION STRATEGIES TO MITIGATE PILOT ERROR

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ABSTRACT

Study 1 investigated role and status effects on communication strategies, using responses to written problem scenarios. Responses were assigned to eight classes of communications differing in terms of request perspective, explicitness and directness. Analyses revealed that captains predominantly used commands while first officers preferred hints, i.e. problem- and goal statements. Study 2 examined the effectiveness of the eight communication types, using pilots' effectiveness ratings. Both crew positions rated crew obligation statements as more effective than commands. Overall, effective communication strategies were those that made clear what to do while appealing to the crew's shared responsibility for coping with problem situations.

INTRODUCTION

The essential thrust of Crew Resource Management (CRM) is to promote team work among pilots and thus to reduce human error. In addition to performing their individual tasks, crew members are expected to support each other by monitoring the situation as well as each other's performance and to intervene if a problem is detected. However, failures to do so are not infrequent. The National Transportation Safety Board reviewed all flightcrew-involved major accidents of US air carriers between 1978 and 1990 and identified monitoring or challenging errors in 3/4 of these 37 accidents (NTSB, 1994). Similarly, Jentsch et al. (1997) analyzed ASRS reports on junior first officer errors and found that 54% of the cases concerned monitoring/challenging or assertiveness.

Pilots may fail in this critical crew function either because they did not notice a problem, or because they did not succeed in communicating their concerns to the other pilot. Our work addresses the second issue. Study 1 examined pilots' communication strategies to correct an error or problem on the flight deck. Study 2 investigated how first officers and captains could do so effectively.

STUDY 1

This study was conducted to determine which communication strategies pilots are likely to use to mitigate errors by another crew member. Based on previous research we hypothesized that pilots' communications will be influenced by three variables: (1) the status of the speaker relative to the status of the addressee; (2) the risk inherent in the situation; and (3) the degree of "face-threat" involved in challenging an error. Previous analyses of crew discourse found that captains were more direct in addressing first officers than first officers were in addressing captains. However, for both crew positions communications were more direct during problem and emergency situations than during normal flight segments (Linde, 1988; Orasanu & Fischer, 1992). In addition to risk we suspected that pilots' communications are sensitive to the social implications of incidents. If others have made an obvious error, calling it to their attention may involve a direct challenge to their status, judgment or skill. According to politeness theory, in situations like these speakers will seek to protect their addressee's face and use more indirect speech as compared to situations that are less face-threatening (Brown & Levinson, 1987).

METHOD

157 pilots (69 captains and 88 first officers) from three major US airlines participated in the study. All participants were male.

Participants received eight short descriptions of aviation incidents which varied in their threat to flight safety (high or low risk) and type of problem (high or low face-threat errors). Minor errors, such as an oversight, were considered to be low in face-threat because they did not involve a direct challenge to the pilot's skill or judgment. Big mistakes, such as an altitude bust, were considered to be high in face-threat because correcting them meant a direct challenge to the pilot's skill. For participating captains, low- and high-risk incidents were described from the perspective of the captain and involved errors or

oversights on the part of the first officer, the pilot-flying. For first officer participants, the incidents were identical except that they described captains making errors and oversights.

Participants read the incident descriptions and were asked to imagine themselves in the position of the non-flying pilot (captain or first officer - depending on the crew position of the participant). Each incident description was followed by a goal statement. The participants' task was to write out verbatim what they would say to the pilot flying (the first officer or the captain) in order to achieve the stated goal. For instance, captain participants saw the following description and goal statement:

> While cruising in IMC at FL 310, you notice on the weather radar an area of heavy precipitation 25 miles ahead. First Officer Henry Jones, who is flying the aircraft, is maintaining his present course at Mach .73 even though embedded thunderstorms have been reported in your area and you encounter moderate turbulence.
>
> *You want to ensure that your aircraft will not penetrate this area.*

Responses were then assigned to eight classes of communication that differed in terms of their focus, explicitness and directness (Blum-Kulka, House & Kasper, 1989). Other-directed communications or requests referred to an action the addressee was to perform, while speaker-centered communications specified an action by the speaker. Both types of communications could vary in the extent to which speakers were direct and explicit about what action to take and who is to do it. Overall six classes of requests and two classes of speaker-centered communications were distinguished, as shown in Table 1.

Responses were also coded in terms of their structure, either simple or complex. Simple communications involved only a request or a speaker-centered communication. Complex communications consisted of two parts: one that realized the stated goal and a second one that provided reasons for the request or speaker-centered communication. An example of a complex communication is *"I see we have some cells painting on radar. I think we should turn left about 30°."*

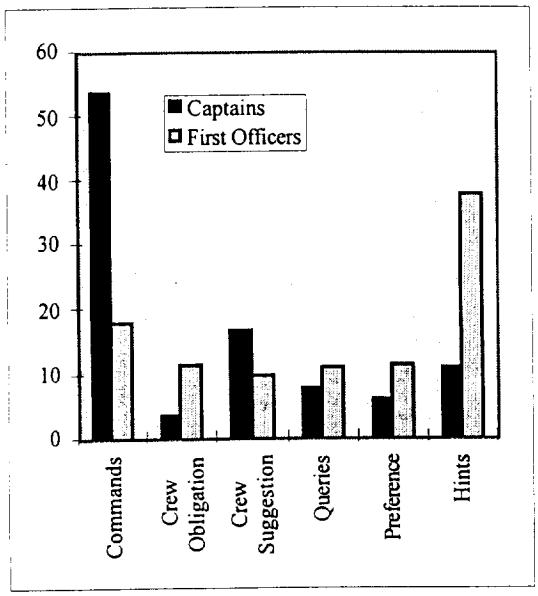
Table 1. Classes Of Requests And Speaker-Centered Communications

REQUESTS	
Commands	*Turn 30° right.*
Crew Obligation Statements	*I think we need to deviate right about now.*
Crew Suggestions	*Let's go around the weather.*
Queries	*Which direction would you like to deviate?*
Preferences	*I think it would be wise to turn left or right.*
Hints	*That return at 25 miles looks mean.*
SPEAKER-CENTERED COMMUNICATIONS	
Self-Directives	*I am going to get a clearance to deviate around these storms.*
Permission-seeking Questions	*You want me to ask for clearance to deviate around this weather?*

RESULTS AND DISCUSSION

Loglinear analyses of the responses revealed that first officers most often used hints to get action from the captain. That is, first officers preferred statements such as *"That return at 25 miles looks mean"* that did not specify any corrective action, but instead pointed to a problem or reminded the captain of a previously established goal. Apparently first officers assumed that the captain would feel committed to a corrective action once he agreed with their assessment of the situation. In so doing, first officers at most questioned the captain's understanding of the situation. But they minimally challenged his status since the decision about how best to respond to the problem was left to the captain. Captains, in contrast, predominantly used commands to correct first officers. This pattern of findings indicates that while pursuing identical communicative goals, captains take a more direct route than first officers. Captains were more likely than first officers to specify the action that should be taken. Moreover, in issuing more commands and fewer hints than first officers, captains expressed their intentions more forcefully than first officers; i.e., there was a stronger obligation for first officers to comply with captains' requests than vice versa.

Figure 1. Distribution Of Captains' And First Officers' Request Strategies



Similar status differences were observed for communications that concerned actions by the speaker. First officers were likely to assure that the captain agreed with their planned action as in *"Do you want me to ask ATC if they still want us on this heading?"* 57% of all first officers' speaker-centered communications were of this kind. Captains, on the other hand, almost never used permission-requests relying instead on self-directives (91% of the time) such as *"I'll call ATC and find out if he still wants us on this heading."*

While both captains and first officers became more direct when risk increased, status differences nonetheless persisted. Captains adjusted to higher risk levels mainly by issuing even more commands than in low-risk situations (from 47% to 63%). First officers, in contrast, quadrupled their use of crew obligation statements (from 4% to 16%) as risk increased. However, hints remained their predominant strategy, even in high risk situations. Captains' and first officers' request strategies not only varied with risk but also changed with error type. Though commands were captains' preferred response to both low face-threat and high face-threat errors, captains tended to use more hints in situations in which first officers committed some real error, e.g., an altitude bust, rather than some minor oversight. First officers were likely to increase commands, crew obligation statements and suggestions in these situations while hints remained their dominant strategy.

Concerning the structure of pilots' communications we found that more direct requests were usually accompanied by justifications as in the following example: *"We are too far left of centerline for parallel approaches - correct right immediately!"* On average, 63% of captains' and first officers' direct requests (i.e., commands, crew obligation statements and suggestions) were of this kind. As the example illustrates, justifications may serve several social and cognitive purposes. By referring to some problem or goal in addition to making a direct request, speakers decrease the imposition of their communication on the addressee. In addition, speakers who mention a problem and action make their thinking transparent and may thus facilitate a crew's shared understanding of the situation. Interestingly, we also observed that captains and first officers generally supported speaker-centered communications with problem- or goal statements. This finding may either indicate that speaker-centered communications are in general considered to be rather bold communicative moves that require some mitigation. Recall that the speaker in all scenarios is the pilot-non-flying! Or, it may suggest that the speaker seeks to coordinate the activities of the crew and in order to do so, provides the broader context.

Before leaving the discussion of differences between captains' and first officers' communication strategies we want to stress that our analyses concern pilots' initial reactions to errors or oversights of the pilot flying. Our analyses indicate that first officers are likely to be less forceful when they first attempt to correct an oversight or inappropriate action of the captain than are captains in their responses to errors by first officers. In our second study we examined how effective their respective strategies would be in getting a colleague to comply with their intended action.

STUDY 2

This study had several objectives. We wanted to determine which of the communication strategies discerned in Study 1 are effective in mitigating pilot error, and whether supporting statements enhance the effectiveness of strategies. Moreover, we wanted to see whether the perceived effectiveness of strategies varied for captains and first officers, as well as with the risk level and degree of face-threat inherent in an incident.

63 pilots (31 captains and 32 first officers) from a major US airline participated in this study. Participants received the eight incident descriptions as well as instances of the different communication strategies that we could distinguish in Study 1. Per

incident we listed one example of each of the request strategies and speaker-centered communications listed in Table 1. Participants were asked to imagine that they had just committed the mistake described in the scenario and that the communications were directed at them. Their task was then to rate on a 9-point scale how effective each communication would be in getting them to carry out the speaker's intent. Communications they judged to be most effective were to receive a rating of "9." These were defined as "highly appropriate to the problem while maintaining a positive crew climate." Least effective communications were to receive a rating of "1" and were defined as "tactless, excessive or inappropriate." In a second task, participants were asked to rate how direct each communication type was; i.e., "how clear it was what the speaker wanted done and how much pressure he put on the addressee to act." The order of effectiveness and directness ratings were counterbalanced across participants

Participating captains were told that the communications were from first officers. First officer participants received the same communications, and were told that these were captains' communications. Half of the participants in each pilot group received simple communications; i.e., the communications consisted only of a request or a speaker-centered communication. The remaining participants received complex communications; i.e., they were asked to rate requests and speaker-centered communications that were supported by problem or goal statements.

RESULTS

Analyses of captains' and first officers' mean ratings of the communication types per scenario revealed the following statistically significant effects: (1) Communications that were supported by a problem or goal statement received higher effectiveness ratings than unsupported communications. Complex and simple communications , however, were perceived as equally direct. That is , both constructions were comparable in the extent to which they specified a corrective action and enforced compliance. (2) For both crew positions, the most effective strategies were neither too direct (i.e., commands) nor too indirect (i.e., permission requests). Captains judged first officers' crew obligation statements, preference statements and hints to be more effective than their commands, self-directives and permission requests. First officers thought that captains were more effective when they used crew obligation statements rather than commands, queries, hints, self-directives and permission requests. (3) The judged effectiveness of communication strategies varied with the level of risk inherent in a situation. In high-risk as compared to low-risk situations, the effectiveness rating of more direct communication strategies increased, while it decreased for less direct strategies. However, even in high-risk situations crew obligation statements were rated as more effective than commands. (4) Social implications of an incident also played a role in pilots' effectiveness ratings. In particular, hints were judged to be more effective when used to correct highly embarrassing mistakes rather than minor errors. In high face-threat situations pilots rated this strategy most highly, together with crew obligation and preference statements.

With the exception of commands, captains' judgments corresponded reasonably well to the frequencies with which first officers in Study 1 used the various request strategies. Overall, a medium strong rank order correlation between captains' effectiveness ratings and observed frequency of first officers' strategies was observed (rho = .46). That is, hints, crew obligation and preference statements were both produced frequently by first officers and were judged by captains to be very effective. In contrast, first officers' effectiveness ratings of captains' strategies did not correlate as strongly with captains' strategy use in Study 1 (rho = .30). The low correlation coefficient indicates a mismatch between first officers' opinions about effective captain strategies and captains' actual responses. Crew obligation statements, crew suggestions and preference statements, the top three captain strategies according to first officers, were rarely used by captains (4%, 17% and 6% of all captain requests, respectively). On the other hand, commands - captains' dominant request strategy - received a considerably lower effectiveness rating.

CONCLUSIONS

Together, studies 1 and 2 suggest that the strategies pilots indicated they would use to mitigate pilot errors, may not be the most effective ones. While we obtained striking differences in captains' and first officers' communication strategies, there was considerable agreement between captains and first officers on what constitutes effective communication. Both pilot groups gave high effectiveness ratings to crew obligation statements, preference statements, crew suggestions and hints, and consistently rated commands, the most direct communication strategy, as less effective. The common element of these strategies is that they address a problem without disrupting the team context. Crew obligation statements, crew suggestions, and preference statements are like commands insofar as they explicitly state what should be done. But unlike commands they do not rely on status differences to assure compliance. Crew obligation statements seek

compliance by appeal to a shared obligation. Crew suggestions and to some extent preference statements do so by referring to the solidarity between speaker and addressee. Hints are similar to crew obligation statements insofar as they too seek compliance by appeal to an external necessity. Many of the hints that first officers produced in Study 1 are problem or goal statements that strongly imply what action should be taken as for example "*Clearance was to 9000!*" or "*I show you 15 kts slow.*" That is, once the addressee acknowledges the problem, he is also committed to the appropriate action.

Effective communication strategies thus appeal to a crew's shared responsibility for coping with problem situations. This characteristic is again reflected in pilots' judgments of complex communications. Requests and speaker-centered communications that were supported by problem or goal statements were rated as more effective than communications without supporting statements. The advantage of complex communications is that they may facilitate the crew's shared understanding of problem situations and their joint problem solving (Orasanu, 1994). Speakers who mention a problem in addition to requesting an action or stating their intention to act ensure that other crew members are able to see why a particular corrective action ought to be taken. Moreover, crew members are then in a position to verify for themselves that the speaker's problem understanding is appropriate, and that the intended action is indeed the best response.

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HOW TO CHALLENGE THE CAPTAIN'S ACTIONS

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On January 13, 1982 an Air Florida Boeing 737 crashed into the Potomac River due to excessive snow and ice on the airplane and a frozen indicator which gave the crew a false engine power reading. The aircraft had been de-iced, but 45 minutes had elapsed before it was cleared for takeoff. The captain had little experience flying in winter weather. While awaiting their takeoff clearance, the following conversation took place between the crew (NTSB, 1982):

First Officer: *Look how the ice is just hanging on his, ah, back, back there, see that?*
(...)
First Officer: *See all those icicles on the back there and everything?*
Captain: *Yeah.*
After a long wait following de-icing, the first officer continued:
First Officer: *Boy, this is a, this is a losing battle here on trying to de-ice those things, it (gives) you a false feeling of security, that's all that it does.*
Shortly after being given clearance to take off, the first officer again expressed his concern:
First Officer: *Let's check those tops again since we've been sitting here awhile.*
Captain: *I think we get to go here in a minute.*
Finally, while they were on their takeoff roll, the first officer noticed that something was wrong with the engine readings.
First Officer: *That don't seem right, does it?* [three second pause] *Ah, that's not right . .*
Captain: *Yes, it is, there's 80.*
First Officer: *Naw, I don't think that's right.* [seven-second pause] *Ah, maybe it is.*
Captain: *Hundred and twenty.*
First Officer: *I don't know.*

The first officer's references to "ice," "icicles," and "false sense of security" indicate that he was apparently quite aware of the dangerous weather conditions. Yet he did not succeed in getting the captain to take his concerns seriously or to act on them. Nor did he succeed in convincing the captain that there was something wrong with the engine power reading.

Why were the first officer's communications unsuccessful? One possible reason might be that he used indirect speech. He only hinted at the possibility of a problem rather than stating explicitly what he suspected and what he thought should be done; nor did he challenge the captain's decision to continue with the takeoff. There are two potential problems associated with indirect language use. (1) While direct, explicit utterances have only one meaning, indirect utterances have at least two: one meaning concerns what speakers explicitly say; the other concerns what they actually mean. Listeners thus have to infer what speakers mean from what is explicitly said (Searle, 1975), and they may err in this point. Most notably, listeners may not realize the indirectness of an utterance and may instead take an utterance at face value, thus misunderstanding what speakers intended. (2) Indirect speech is less forceful and more polite than direct speech. Listeners, on the other hand, may mistake politeness for indecisiveness and consequently may not take the implied intention seriously enough. This problem was prevalent in an analysis of crew discourse by Linde (1988) who observed that captains were less likely to act on first officers' suggestions when they were indirect than when they were direct.

From Linde's (1988) observations we may be inclined to conclude that effective communication between crew members ought to be maximally explicit and direct. The

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demand for explicit and direct communication, however, underestimates the important role that social considerations play in interactions. As Watzlavick, Beavin and Jackson (1967) have pointed out, every utterance has two components: the referential which makes some predication about the world, and the relational, by which we signal something about our social relationship to the addressee. Communication is not just a matter of what we say; it is also how we say it that determines the received message. Moreover, whether or not we are successful in our communications depends critically on the extent to which we can accommodate both the referential and the relational component. This is particularly true in situations in which we place demands at our listeners, for instance when we want them to change their behavior. In these situations we want our listeners not only to understand our intentions but we also want them to act accordingly. How speakers can best assure listener cooperation varies with their relationship. Superiors, by virtue of their social status, may be licensed to give direct commands to their subordinates. However, if subordinates reverted to the same linguistic strategy, superiors may perceive them as threatening and may refuse compliance. To avoid this kind of confrontation, subordinates are likely to use more polite and as such more indirect ways of communicating (Brown & Levinson, 1987). However, as we elaborated above, by being indirect, subordinates run the risk of being misunderstood or of not being heard.

There is thus a tension between informative communication and socially successful ways of communicating. We suggest that effective communication seeks to optimize informativeness and social appropriateness. How this can be achieved in crew discourse was the topic of our present research. In this research project we attempted to understand how first officers could effectively challenge the actions of captains, and how first officers' and captains' strategies differ. In addition, we were interested in determining whether male and female pilots have distinct notions of what constitutes effective behavior in this context. Sociolinguistic studies on gender differences in discourse strategies have reported that men are more explicit, directive and task-oriented than women. Talk by women has been characterized as indirect and concerned with relational aspects of interactions (Lakoff, 1975; Tannen, 1990, 1992). In this research we wanted to see whether these observations generalize to crew discourse.

METHOD

Participants

Female pilots were recruited by placing a call for participation in the ISA newsletter. 21 pilots responded to the ad and completed the experimental material. There were 10 captains and 11 first officers. The captains had on average 3.6 years in this position and had an average of 11 years of experience in Part 121 aircraft. For the first officers, position-specific experience was on average 6.3 years, and experience in Part 121 was 8.9 years.

Male pilots matching the female sample in experience, were taken from a larger sample of 162 male respondents. The 10 male captains that were selected had on average 3.6 years of experience in this position and 14 years of experience in part 121. Position-specific experience and part 121 experience for first officers was on average 5.7 and 8.6 years, respectively.

Material

Eight short vignettes were constructed that described aviation incidents. These incidents varied in type and severity of a problem. For captain participants, incidents were described from the perspective of the captain and involved errors or oversights of the first officer, the pilot-flying. The reverse was true for first officer participants. The vignettes were printed in a test booklet, one vignette per page. There was a captain edition and a first officers' edition. Random orders of the vignettes were created yielding 16 differently ordered captains' and first officers' booklets.

Method and Procedure

Participants were asked to complete two tasks: a Discourse Completion Task and then a Judgment Task. In the Discourse Completion Task, participants received the incident descriptions and were asked to imagine themselves in the position of the captain (or first officer - dependent on the crew position of the participant). Each incident description was followed by a goal statement and the participants were asked to write out verbatim what they would say to the first officer (or the captain) in order to achieve the stated goal. For instance, captain participants saw the following description and goal statement:

> While cruising in IMC at FL 310, you notice on the weather radar an area of heavy precipitation 25 miles ahead. First Officer Henry Jones, who is flying the aircraft, is maintaining his present course at Mach .73.
> *You want to ensure that your aircraft will not penetrate this area.*

The second part of a test booklet consisted of a Judgment Task in which participants rated the scenarios along various scales, such as problem severity. Results from the judgment task will not be reported in this paper.

Analyses

Request types. Recall that each incident description was followed by a goal statement that should be realized by the participants' communications. In coding the responses we therefore noted whether a speaker specified what action should be taken and whether the action is to be taken by him- or herself, the listener, or by the crew (Blum-Kulka, 1987; Clark, 1979). Responses were further classified based on the extent to which they committed the speaker, the listener or the crew to a particular action (Herrmann & Grabowski, 1994). For example, compare "*I'll call ATC*" with "*Do you want me to call ATC?*" In the former utterance, the speaker expresses a strong commitment to calling ATC and virtually takes the listener's acceptance for granted. Speaker commitment is much weaker in the latter utterance with which the speaker seeks the listener's permission to call ATC. Similarly, "*Turn left for the weather*" and "*Do you want to turn right or left around this weather?*" place the listener under different obligations to comply with the speaker's intentions. The major categories that we distinguished are summarized in Table 1:

TABLE 1
Examples of Request Types

Commands & Statements of Intent *3rd Party Commands*	-- Turn right back to the localizer. -- I'll call ATC -- He (= controller) wants us to turn left now.
Suggestions	-- Let's correct back on course.
Confirmation-Seeking Questions	--Didn't you want to fly at V-Ref plus 15 for winds?
Permission_Seeking Questions	-- Should I ask ATC if he'll give us direct?
Alerters	--Watch your speed! -- Altitude!
Strong Hints *Problem Statements & Problem Inquiries* *Goal Statements*	-- We're well left of course and there is parallel traffic. -- Do you think they still want us on this heading? -- We were assigned 9000 ft.
Mild Hints *Observations and Questions*	-- Do we have anyone on the approach for the parallel runway?

Complexity of the communications. Participants could use either one or several utterances to achieve the goal that was stated after each incident description. If there were several utterances we noted their relationship. Typically one utterance was the principal part, or primary move, that realized the stated intention, and the other parts provided justification. Consider for example the following response: "*We've got parallel traffic off our left.* Turn right heading xxx *to intercept the localizer.*" Here the goal of getting the aircraft back on the assigned approach course is realized by the command. The italicized segments provide reasons for the command and are thus supportive moves. We called responses involving primary and supportive moves, complex communications. A variation of complex responses consisted of several primary moves which together realized the stated intention but in which one also gave a rationale for the other. For example in "*What's your plan with regard to the weather? We should turn soon,*" the second part not only constrains what should be done concerning the weather (= the goal) but also justifies why the question has been asked in the first place. Simple communications were responses in which a given goal was realized by a single utterance, i.e., a single primary move, as in "*Level off now!*" or "*Would you like me to request direct?*" Alternatively, simple communications could also involve several primary moves which provided distinct directives, for example when speakers allocated responsibilities as in "*Level off here. I'll call ATC.*"

RESULTS

Reliability of coding. Two coders independently classified responses by 10 participants. Percent agreement was calculated on their ratings and found to be 91%. One coder subsequently classified the remaining responses.

Do captains and first officers use different request types? The answer to this question is yes. Captains used most frequently commands (37%), suggestions of the "Let's type" (19%), or stated their intention to perform some action (14%). The majority of the intention statements, however, were combined with commands (e.g., "*Climb immediately to 12,000. Then I'll check our course!*"), or suggestions (e.g., "*Let's climb back up to xxx feet. I'll call ATC and let them know.*"). First officers, in contrast, most commonly provided goal or problem statements (27%), or asked the captain whether he wanted them to perform some action (14%). A third request type observed for first officers were confirmation-seeking questions (13%) such as "*Do you still want V-Ref + 15?*"

Do female and male pilots use different request types? The answer to this question is no. Our analyses indicate that status rather than gender influenced how pilots phrased requests. 35% of female captains' requests were commands and 20% were suggestions; for male captains the corresponding percentages were 39 and 18. First officers were equally similar: 29% of the female and 25% of the male first officers' requests were problem and goal statements. For permission-seeking questions the percentages were 15% for the females and 14% for the males; for confirmation-seeking questions the percentages were 13% for both groups.

Are there status and gender effects pertaining to the structure of the communications? Gender but no status differences were observed in the way pilots structured their communications. A 2 x 2 between subjects analysis of variance on number of complex responses revealed that the structure of the communications varied significantly with the gender of the respondents, $F(1,38) = 7.9$, $p < .01$), but not with their status, $F(1,38) = 1.48$, ns.; nor was there a significant gender by status interaction, $F(1,38) = 1.23$, ns.

As Table 2 shows, on average 5.3 (from a total of 8) responses by female pilots were complex, i.e., consisted of request and justifications as compared to 3.7 responses by male pilots. Since communications could either be complex or simple, this result also implies that female pilots were less likely than male pilots to state requests without also providing some justification.

TABLE 2
Mean Number of Responses Involving Request plus Justification

	FEMALE	MALE
CAPTAINS	6.00 *(1.25)*	3.70 *(2.45)*
FIRST OFFICERS	4.64 *(1.80)*	3.64 *(1.91)*

Note. Standard Deviations are given in parentheses; Total Number of Responses per Group = 8

DISCUSSION

In this study we examined what linguistic strategies pilots use when they have to challenge the actions of a colleague, and how their communications balance the need for informativeness with the need for assuring the other's cooperation.

Two strategies emerged for captains. They either gave commands or they made suggestions that referred to actions of the crew. Both strategies explicitly state what action should be taken but they differ in their social implications. Commands are direct insofar as they entail a strong obligation for the listener to comply with the speaker's request. Suggestions are less direct in this respect. However, by using the collegial "Let's do," speakers appeal to the solidarity between themselves and their listeners and seek compliance in this way. Commands, in contrast, are inherently authoritative and imply an asymmetry in status. Speakers by giving a command, express their belief that they are socially more powerful than their listeners and that they are thus licensed to command. That is, speakers seek listener compliance by appeal to their status. Status-based commands were more frequent among male captains than among female captains. Female captains instead were likely to shift the motivation for their commands away from their status to some objective necessity by referring to some problem or goal

It remains to be seen, however, how captains' strategies were affected by the severity of a problem situation. Results in a preliminary study involving only male participants, suggests that pilots increased the directness of their utterances in situations that they perceived to be risky (Fischer, 1996). Thus the observation that male captains used complex communications half of the time while female captains did so 75% of the time, could indicate that male captains were more likely than female captains to change their strategies with the severity of situations.

Both male and female first officers in this study were less direct than captains. The most common strategy of first officers was to point to some problem or to remind the captain of a given goal. What corrective action should be taken and by whom was not explicitly stated but implied and left to the captain. In their other strategies, permission-seeking and confirmation-seeking questions, first officers were more explicit about a corrective action. In the first case, they volunteered to do some course of action but left the final decision to the captain. In the latter case, they inquired or confirmed whether the captain wanted some action. Although all three strategies seek the compliance of the listener by appeal to his authority, there are important differences: By asking permission-seeking and confirmation-seeking questions, first officers specify the action for which they want the captain's compliance. Compliance, however, is not demanded but requested. By alerting to a problem or to a goal, in contrast, first officers seek the captain's compliance only with their assessment of the situation but not with a particular course of action. That is, they place the captain under no explicit obligation to initiate a corrective action but do so only indirectly by assuming that a course of action is self-evident once the problem has been acknowledged.

CONCLUSIONS

In line with previous research (Linde, 1988; Orasanu & Fischer, 1992), we found that captains are more direct in their communications than first officers. But unlike previous

work on gender differences in communication strategies (Lakoff, 1975; Tannen, 1990, 1992), we did not find that female pilots were more indirect than male pilots. In our study directness and indirectness were aligned with status not with gender. However, we did find gender differences among pilots with respect to the structure of their communications. Female pilots were more likely than male pilots to motivate their requests by referring to some objective need.

One question that our present analyses have not yet addressed concerns the relation between linguistic strategy and features of the problem situation. In particular, we need to analyze whether our participants responded differently in low-risk and high-risk situations.

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