Symbolic Interaction

Embedded Interactions and Selective Disclosure: Network Effects on Conversations aboard Skylab

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How do absent others influence our interactions? We argue in this paper that interactions are embedded within networks formed by chains of specific relationships between known third parties. The anticipation of future interactions with external others conditions our interpretation of the current situation and affects our behavior in the interaction. We employ embedded interactions to analyze the case of conflicts between the astronauts and ground control during NASA's Skylab 4 missions. Our analysis reveals how anticipation of eventual interactions between uninvolved actors led the crew to withhold important information from ground control, information that would have been shared with ground control if the astronauts had been able to prevent its future transmission. Skylab astronauts were heavily concerned with how their actions would be framed through these chains of interactions and eventually interpreted by Congress and the general public. The astronauts' attempts to save face by controlling information about themselves at these distant sites led them to deviate from protocol and produced the conflicts for which Skylab 4 is best known.

Keywords: conversation, embedded interaction, networks, selective disclosure

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INTRODUCTION

In December 1973, 45 days after beginning their 84-day mission, the three astronauts on NASA's first space station, Skylab, held an unscheduled conference call with ground control to assess their performance and address some concerns about scheduling and workload. Subsequent accounts have since exaggerated the goal of this meeting, characterizing it as "negotiations" in response to a "strike" (Hiltzik 2015) staged by the astronauts (Balbaky and McCaskey 1980). Although this meeting was not actually as dramatic as the beginning of an extraterrestrial labor movement, such a deviation from the otherwise strict mission planning represents a serious breakdown in NASA's organizational functioning. The Skylab program was the culmination of years of meticulous planning, preparation, and training, and had successfully completed two previous missions lasting 4 and 8 weeks. How then did the astronauts and ground control of Skylab 4 have such a dramatic breakdown in communication after only 6 weeks? To answer this question, we need to understand why speakers withhold or conceal information that they would share under more typical circumstances.

There are two types of explanations for such selective disclosure. Situational explanations seek to interpret interactions relative to the cultural and social-psychological contexts of interactions (Emirbayer and Goodwin 1994; Hall 1997). According to this thinking, communication in interaction is dependent upon the motivations of the individuals involved (Cowan 2014; Gibson 2014; Goffman 1969), the character of relationships between speakers (Goffman 1967; McLean 2007), and their cultural understandings (Eliasoph and Lichterman 2003; Mische 2002; Mische and White 1998).

The structural explanation emphasizes broader conditions of interaction that limit the ease or depth of communication and the ability of speakers to adapt and respond to their listeners. Disclosure is contingent on more general factors, such as the relative social position of the interactants (Stryker 2008), the frequency and depth of interaction (Aral and Van Alstyne 2011; Granovetter 1973), the medium of communication (Campos-Castillo and Hitlin 2013; Menchik and Tian 2008), and the actors' knowledge or identifiability of others involved (Horton and Strauss 1957; Tian and Menchik 2016).

In this paper, we argue that neither explanation alone provides a sufficient description of what transpired on the Skylab 4 mission. Instead, we can find a better understanding of the events by situating interactions within both the contextual system of meaning and the structural conditions in which they occur. These cultural structures, sometimes labeled networks (Faulkner 1971; Fine and Kleinman 1983; Hall 1997), social worlds (Becker 1982; Strauss 1978), or fields (Fligstein and McAdam 2012), provide an interpretation of interaction that allows for the influence of relationships beyond the scope of the current interaction.

Our explanation of the conflict aboard Skylab builds on such explanations, but further emphasizes specific external relationships among third parties. Specifically,

we suggest that the interactions aboard Skylab were *embedded* within a network of external relationships which fundamentally altered the character of the interaction. In this view, the definition of a situation is not strictly limited to its immediate characteristics but is intertwined with actors' expected future situations and others' subsequent interactions. Anticipation of future interactions among external actors provides a different context for the current encounter than that provided by either an actor's own future interactions (Tavory 2010; Tian and Menchik 2016) or the diffuse interactions of members of social worlds (Becker 1982). Our use of the term *network* here does not imply some objective structure identified by an outside analysis, but a cognitive network consisting of chains of relationships as known to the actors involved (Krackhardt 1987). Thus, the explanation offered below emphasizes specific, known relationships, roles, and obligations, rather than generalized social worlds (Becker 1982; Hall 1997) or large, unknowable, objective structures (Dodds et al. 2003).

Below we demonstrate that the two most significant conflicts during Skylab 4 were both caused by the crew withholding information about the mission due to concerns about future transmission to and between third parties. Importantly, we show that the astronauts' concerns were not about sharing the information within NASA, but about NASA's existing obligations and agreements to share with external parties, specifically Congress and the press. This embeddedness within a broader network of relations fundamentally altered the ways the astronauts viewed their interaction with ground control.

NETWORKS OF RELATIONSHIPS AND EMBEDDED INTERACTIONS

Theorizations of these external structural influences on interactions often treat them as abstractions: impersonal groups (Fine 2012; Mead 1934; Shibutani 1955), generalized social worlds (Hall 1997), or positions in macrosocial structure (Maines 1997; Stryker 2008). In contrast, our focus here is on a concrete structure composed of specific relationships between known individuals, which we will refer to as simply a network (McLean 2016; Fine and Kleinman 1983; c.f. Becker 1982; Hall 1997).

For relationships outside of a specific interaction to plausibly affect how an actor behaves within the limits of that interaction, those relationships must be reflected in the mind of the actor (Krackhardt 1987; Mische and White 1998). Interactions are dependent upon the actors' knowledge of previous interactions and expectations of future interactions for all parties involved (Goffman 1969; Tavory 2010). We label these interactions as "embedded" based on Marsden's (1981) definition of embeddedness, which refers to a history of interaction structures that affects behavior by "constraining the set of actions available to individual actors and by changing the dispositions of those actors toward the actions they may take" (Marsden 1981:1210). More simply, an embedded interaction is one where the interactants anticipate others' behavior beyond this interaction. A speaker does not merely consider events

in their own future or their alters' futures, but also projects events in the futures of others (Tavory 2010).

It follows that the relevant networks are actors' *subjective* understandings of networks (Krackhardt 1987; Sun, Brashears, and Smith 2021). It is only the actors' understandings of the others' future interactions that affect their behavior in that situation. Whether an anticipated interaction actually occurs in the future is irrelevant. Actors can only respond to their own and their interlocutor's perceived network, together with their misperceptions, errors, and biases (Krackhardt 1987). The salience of a network need not be restricted to an actor's own set of relations, as actors tend to have some level of knowledge of others' social relations and expected future interactions, however flawed they may be. Every interaction is embedded within anticipated subsequent interactions, rather than the objective structural configuration (c.f. Uzzi 1996).

Interactional embeddedness exists when we must interpret the current interaction in terms of participants' future interactions, obligations, and contexts. Put differently, embeddedness is not necessarily a feature of a relationship, but of the situation. The embeddedness of an interaction may shift depending on which sets of external relations (Mische and White 1998; White 2008), roles (McLean 2007), or identities (White, Godart, and Corona 2007; Walker and Lynn 2013; Stryker 2008; McFarland and Pals 2005) are salient at a given moment. Speaking "off the record" or "as a friend" does not change the existent relationships between the speakers but does entail distinct differences in expectations about and obligations for future behaviors. Similarly, when individuals shift the venue or medium in which the interaction occurs (e.g., office to home or from email to face-to-face), they implicitly change the expectations about how to invoke the content of the interaction in future encounters (Menchik 2019).

Selective Disclosure

One possible response to embedded interactions is for speakers to withhold information they would have shared in an unembedded interaction, a phenomenon that others have called *selective disclosure* (Cowan 2014; Cowan and Baldassarri 2018). To illustrate this phenomenon, consider Simmel's discussion of "the stranger," an interlocutor who has no ties to one's immediate community. Interactions with strangers are ideal *un*embedded interactions. The stranger comes from outside the community and has no predictable or shared relationships with others. Thus, their interactions have no extended future and no anticipated consequences. Fittingly, Simmel observes that strangers are often spoken to with unusual frankness and taken into confidence with surprising readiness (Simmel 1950:404). As disconnected individuals, we do not expect them to pass on information to others we know and feel comfortable discussing topics "which would be carefully withheld from a more closely related person" (Simmel 1950:404).

Embedded interactions present the inverse condition. When a person is connected to the rest of our community, they have relationships with others we know; people with whom we should expect them to interact in the future. This knowledge of conditions outside the current interaction changes our view of that interaction, constraining and enabling possibilities of expression (Goodwin 2000; McLean 2016). Though interactions occur with a specific individual and in a specific situation, the interactions are still connected both socially and structurally to the general community within which they occur. We discuss information with a specific person, but we remain cognizant that this may be a discussion with others by proxy. In contrast, because the stranger is already outside the community, they can be seen as an isolated or less entangled interaction partner with fewer expectations.

An embedded view of interactions suggests that external patterns of relations will affect the content of a single interaction. An actor's decision to share certain information results from the combination of the character of interaction, content of the information, and the nature of external relationships. In this way, embedded interaction provides a broad framework for integrating findings on the relationship between interactions and content of information (Brashears 2014; Cowan 2014), the interactions and relationship structure (Aral and Van Alstyne 2011; Brashears and Quintane 2018), and the content and that structure (Brashears and Gladstone 2016; Centola and Macy 2007; Hansen 1999).

Embeddedness proposes a reverse, causal relationship between network structure and interaction than what researchers generally assume in social networks research. Existing studies of information transmission have tended to focus on how transmission across a sequence of relations is contingent on the ways individual relationships combine to produce emergent and objective network features, including bridges between groups (Centola and Macy 2007; Granovetter 1973), structural holes (Burt 2004), overall relational clustering (Reagans and McEvily 2003), distances between actors (Dodds et al. 2003; Reagans and McEvily 2003), or the relative timing and frequency of interactions (Gibson 2005; Moody 2002). In contrast, embeddedness suggests that it is subjective understandings of these structural features, coupled with the character of the relations as understood by the interactants, that affect behavior within a specific interaction.

Embedded interactions may lead to selective disclosure in two ways. First, the possibility of future transmission will limit sharing information that is sensitive or stigmatizing (Burt and Knez 1995). People are less likely to trust others who are seen as opportunistic information brokers (Gladstone and O'Connor 2013). Second, embeddedness will also discourage content that requires the proper context or audience. Outside of direct interaction, speakers cannot control the way their statements are construed. They are unable to save face (Goffman 1963) or monitor the understanding of recipients. For this reason, they avoid topics that may be easily misunderstood or dependent upon the proper framing. In both cases, these types of information will only be communicated in highly trusted interactions or when the population of possible recipients shares the same interpretive frame.

Viewed more broadly, embedded interactions highlight the extent and limitations of social efficacy. Though we maintain a measure of control over a situation we participate directly in, that control declines as encounters become further removed. As Hall (2003) argued, clever use of interactions may provide a degree of power (or meta-power) over distant situations; future interactions will have their own determinants as well. Information we share may be retransmitted under conditions not of our choosing. As a consequence, single encounters may involve strategic efforts aimed at exerting power or mitigating powerlessness over some future encounter between third parties.

The Skylab Program

Before analyzing the interactions in our two cases, we must provide historical context to the Skylab missions. Skylab was the first US space station, in operation from 1973 to 1974. Following on the heels of the successful Apollo program, NASA intended Skylab to demonstrate that humans could live and work in space (Miller 1971). All previous space missions had sent astronauts to space and back in a short time frame, ranging from a few hours to almost 2 weeks. NASA's new goal was to establish a sustained presence in space that could serve as a platform for extended space-based astronomical observation, scientific experimentation, and investigation of the health effects of long-term space flight.

To this end, NASA retrofitted the third stage of a Saturn V rocket to serve as an "Orbital Workshop," complete with long-term life support, living quarters, and workshop and capable of supporting a crew of three for months at a time (Belew and Stuhlinger 1973). The station was also equipped with solar panels, a sophisticated space telescope known as the Apollo Telescope Mount (ATM), an airlock for extravehicular activities (EVAs) or "spacewalks," and a docking adapter. Altogether, Skylab had about the same size and space as a small house. Skylab was launched in 1973 in an unmanned mission known as Skylab 1. Once in orbit, Skylab orbited the earth at an altitude of 432 km once every 93 min and covered 75% of the earth's surface (Belew and Stuhlinger 1973).

Without the benefit of modern satellites, astronauts communicated via radio signals transmitted directly from the space station to ground stations and then relayed over the surface to ground control in Houston. Although relay stations were situated around the planet, this arrangement still left many areas with no radio coverage. As Skylab proceeded in its orbit around the earth, it would connect with the nearest ground station, maintain contact for 5–10 min, and then lose signal as it moved out of range. As a result, direct voice communication was limited to brief exchanges separated by long interruptions. Ground control could also send messages and schedules to the astronauts via teleprinter, similar to an early fax machine. Such schedules detailed the tasks, breaks, sleep, meals, and exercise for each crew member down to the minute. On all missions, the schedule was the subject of negotiations and modifications. Occasionally, schedules would be shifted to accommodate an astronomical

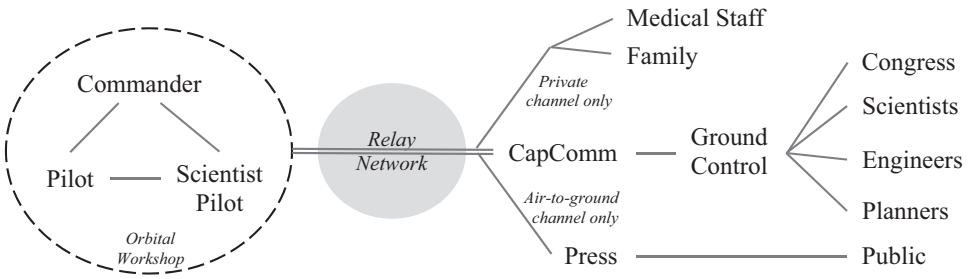

FIGURE 1. Communications Network. Ties on the diagram show the lines of direct communication. For simplicity, NASA's bureaucratic linkages between ground control and congress have been omitted.

observation or experimental procedure that would normally conflict with sleep or meal times.

Crews and Mission Control

Three crews of astronauts lived and worked in Skylab. Each crew consisted of a commander, a pilot, and a science pilot. Of the nine Skylab astronauts, only Pete Conrad and Alan Bean, commanders of Skylab 2 and 3, had previous spaceflight experience. As a result, while Skylab 4 was the only all-rookie crew, it only had one fewer experienced astronaut than the other two missions. Still, all nine astronauts and their respective backup crews were highly trained and accomplished. Each astronaut had years of experience in spaceflight simulators and training exercises, including months of training on all instrumentation and equipment aboard Skylab. A significant portion of astronaut training consisted of simulations designed to practice communicating with mission control under different scenarios.

Communications between the ground and the crew were almost entirely channeled through a single point of contact on the ground, a position known as Capsule Communicator or CapComm (see Figure 1). NASA largely selected CapComms from the astronaut corps, being former or future astronauts themselves. Of everyone at ground control, CapComms were best positioned to understand the experiences of the crew and tended to have friendly relations with current astronauts.

Political and Institutional Environment

NASA pitched Skylab to the public and Congress as the next step in space flight — a step toward a permanent manned presence in space. As the first major manned spaceflight program since Apollo, public interest in Skylab was high. Regular communications between Skylab and ground control were conducted on an open channel, giving the press an unusual level of unfiltered access. As a result, accounts of activities aboard Skylab regularly ran in major newspapers. The

New York Times even included Skylab observation times with their daily weather forecast.

Despite this general enthusiasm, NASA conducted the Skylab program under considerable scrutiny and budget pressure. In the early 1970s, the question of whether NASA should be involved in manned spaceflight at all was being actively debated in Congress and among scientists, with implications for both Skylab and the proposed space shuttle. Proponents, led by Senator Goldwater, emphasized the practical, economic, and technological benefits of sending people into space, while detractors led by Senator Mondale argued that manned spaceflight was dangerous and wasteful, serving no purpose other than keeping the public interested in space (Mondale 1970; Skubitz 1973).

Though NASA had not suffered space-related casualties since Apollo 1, the biomedical consequences of longer-term space exploration on the human body, including the phenomenon of space sickness, were still uncertain (Mondale 1970). By contrast, unmanned exploration, like that of the soon-to-be-launched Voyager missions, was safer, faster, and more efficient. Determining that humans could survive and function in space for long periods of time was critical to the development of the shuttle program, and it was fittingly one of the chief goals of the Skylab program (Miller 1971).

By the time Skylab launched, the development of the space shuttle program consumed a large portion of NASA's budget (Hitt, Garriott, and Kerwin 2008). Skylab, by comparison, was a low-budget operation, constructed from Apollo-era technology and launched using surplus rockets from canceled Apollo missions. Unfortunately, the station sustained significant damage during its launch in May 1973, threatening to render the whole project a costly disaster. Such failure would ensure dramatic reductions in NASA's operating budget and doom the space shuttle (Abzug 1973; Skubitz 1973). Though the station was successfully repaired and salvaged by the Skylab 2 mission, further failures for Skylab were certain to be made public, potentially jeopardizing NASA's funding in Congress and its future.

DATA AND METHODS

As a research context, Skylab presents a nearly ideal case for examining processes of selective disclosure. Methodologists have long lamented the logistical or ethical problems of creating well-contained social settings where we can study human interactions of considerable duration and realism (Zelditch 1969). In contrast, space stations are about as close as possible to approximating an ideal controlled environment. The three manned Skylab missions (Skylab 2, 3, and 4) lasted between 28 and 84 days and offer public access to recordings of a substantial portion of communications. As such, it presents an authentic social setting with a reduced possibility of unobserved interactions.

We analyze the disclosure and filtering of sensitive information on Skylab using the transcripts of communications among astronauts from the onboard voice

recorder and between astronauts and ground crew as recorded at mission control (NASA 1973a, 1973b, 1973c). The onboard voice recorder captures all essential and mission-critical communications between astronauts, as well as much of their day-to-day communications. They could not record all of their voice communications due to the rarified air on the space station. In contrast, the air-to-ground transcripts captured every interaction between astronauts and the CapComm. These transcripts contain all communications that were publicly released.[1] Altogether, this totals 19,120 pages of transcribed communications, including 9069 pages from Skylab 4.

We identified instances of selective disclosure based on two criteria. First, we compared conversations among the crew (from the onboard voice recorder) to conversations with ground control (from the air-to-ground channel) to identify when information among the crew was not shared with ground control. Second, to understand whether these omissions were meaningful, we looked for confirmation from within the actors' own retrospective statements about the mission. The two cases identified in this way share two other important features. They are arguably the two defining events of the mission from the perspective of interaction and social relations, serving as critical junctures (Mahoney 2000). At the same time, there is nothing fundamentally extraordinary about either, allowing us to identify similar events that occurred under almost identical conditions.

We approach each event below with a mixed-methods approach. Our primary analysis is based on close reading and interpretation of the transcripts and other available sources, such as diaries and post-hoc interviews. Our secondary analysis employs structural topic models (STMs) to quantitatively summarize the content of the transcript over time and across missions (Roberts et al. 2014). While qualitative analysis enables us to understand the meanings, reasonings, and justifications for each event, quantitative analysis can provide reliable summaries and frequencies of events, which are particularly useful given the large quantity of source material (Mohr and Bogdanov 2013; Spillman 2014).

Our discussion of each event includes a brief description of the incident and then demonstrates the effects of interactional embeddedness in three steps. We first show that Skylab 4 could have discussed similar non-sensitive information with CapComm by comparing the focal event to other periods throughout the mission. The topic models provide a useful map of the content focus of communications and how it evolved over the course of the mission by identifying similarities across conversations (Lee and Martin 2015). Figures 2 and 3 below provide visualizations of the relative proportion of each tape dedicated to the highlighted topics. For clarity, a detailed discussion of STMs is reserved for Appendix A.

Second, we use specific details of the incident to establish that the information would have been shared in an unembedded interaction. The justifications for this counterfactual condition rest on the crews' articulated reasoning in the first case and on their actions in the second. Third, we show that the selective disclosure in Skylab 4 was a strategic action intended to control the interpretation of the information. To do this, we draw on similar events in previous Skylab missions, but attend to where

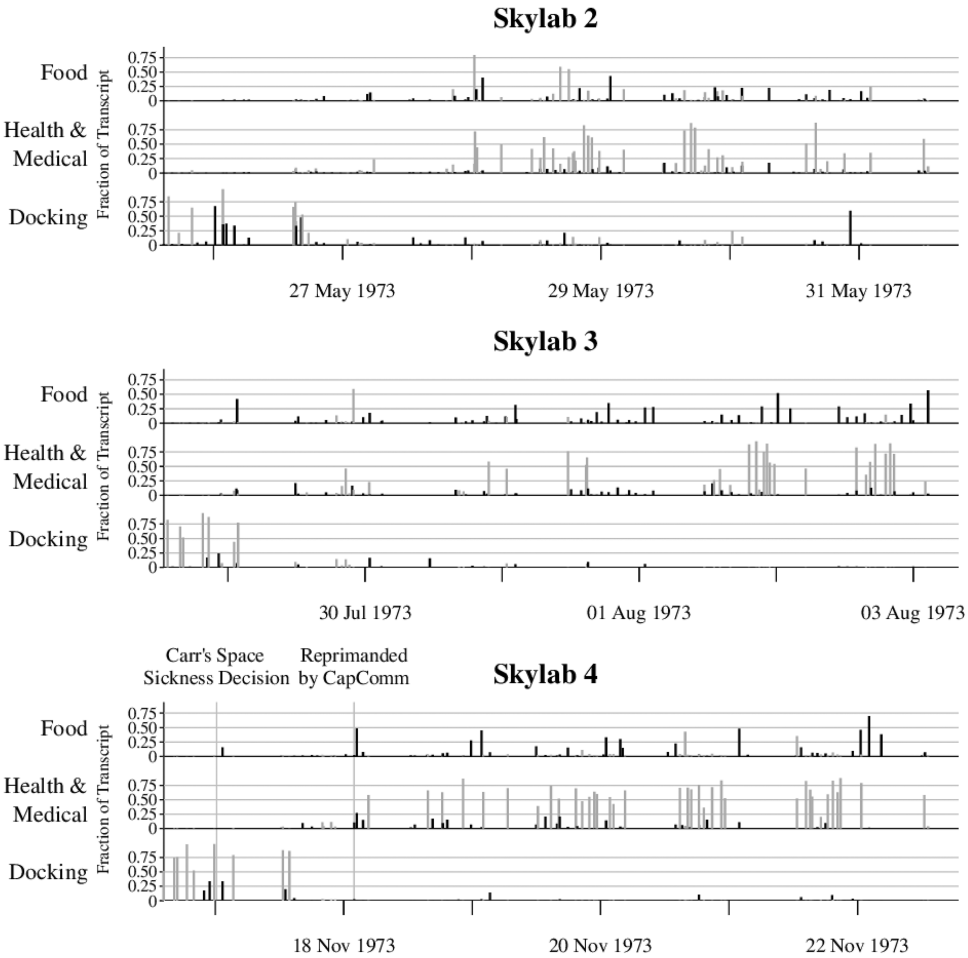

FIGURE 2. Health and Medical Activity during the First Six Days of Each Mission. Bars indicate the proportion of a tape devoted to each topic. Tapes from the onboard voice recorder are shown as gray bars. Tapes from the air-to-ground channel are shown as black bars.

the content of the discussion would be interpreted differently by external parties. Based on these parallels, we argue that it would have been possible to discuss sensitive information with CapComm had future interactions and external relationships not been an important consideration.

CASE 1: EARLY DIFFICULTIES AND MISTAKES

We now turn to an instance of selective disclosure at the beginning of the Skylab 4 mission. An hour after docking with the station, Skylab 4's pilot, Bill Pogue developed a severe and incapacitating case of space sickness. Space sickness is

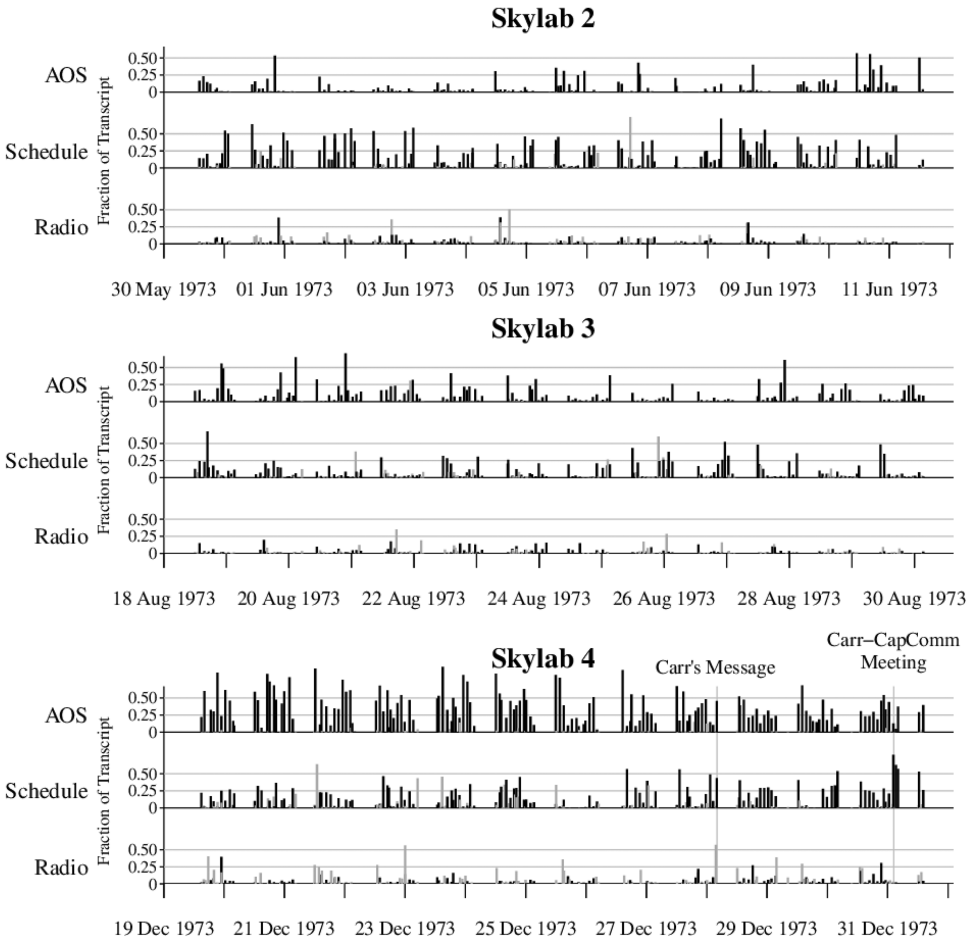

FIGURE 3. Acquisition of Signal (AOS), Schedule, and Radio Topics during the Middle of Each Mission. Bars indicate the proportion of a tape devoted to each topic. Tapes from the onboard voice recorder are shown as gray bars. Tapes from the air-to-ground channel are shown as black bars.

much like earth-based motion sickness, with dizziness, disorientation, nausea, and frequent vomiting. NASA was aware of the possibility of space sickness from cases during the US Apollo and Soviet Soyuz missions, but they considered it largely unavoidable and unpredictable. Most Skylab astronauts experienced some degree of space sickness, though none had been as incapacitated as Pogue was. While sick, Pogue was unable to eat, perform any job tasks, or operate the radio. During the first few days, he rarely spoke more than a few words at a time (e.g., NASA 1973b:321:01:52:17). This space sickness was somewhat ironic as Pogue had been the least susceptible to nausea in any of the training exercises (Hitt et al. 2008:246).

NASA protocols called for astronauts to record everything that went in or came out of their bodies (Shayler 2008). In the first hours after docking, Commander Gerald Carr was expected to report any medical conditions and dietary deviations and to save all vomitus bags for further study upon return to earth. Instead, Carr decided to delay including it in the report to ground control, hoping that it would improve over time:

> Carr: I don't think I'll — I'll mention anything, Bill, tonight about it. If you still feel bad in the morning, we'll say something about it. Bill, what about the menu deviations that you made? I haven't gotten around to you yet. That's all. Just say he's not hungry. I'm not going to eat all mine, either (NASA 1973b:321:00:28:09).

A few minutes later, Carr reconsidered his approach, deciding to decenter Pogue from his excuse and postpone the entire status report. On the next pass over a ground station, Carr took over the radio from Ed Gibson and claimed that they have not yet had time to eat.

> Carr: Hey, Bill, this is Jerry.
> CapComm: Go ahead, Jerry.
> Carr: Okay, what do you say we have our evening status report at some later pass. We haven't even got started eating yet. And it's going to take a while while we fiddle around in here, so why don't we have our status report at some later time?
> CapComm: Okay. Stand by just a minute, Jerry, and we'll see what we can do.
> Carr: Quite frankly, we haven't had much time to eat during the rendezvous and we're trying to catch up now. And it's going to take more time than we got, I think (NASA 1973a:321:01:05:21).

CapComm agreed to push back the status report to the next contact with a ground station around 3 am. As the appointed time approached and Pogue was still largely incapacitated, Carr suggested to Gibson and Pogue that it was time to provide an honest status report, only for Gibson to encourage further deception.

> Carr: Well, Bill, I think we better tell the truth tonight … Because we're going to have a fecal/vomitus bag to turn in, although I guess we could throw that down the trash airlock and forget the whole thing — and just say, "Bill doesn't feel well, and he's not eating. We got him immobilized with pro/eph."
> Gibson: Could do that. I think all the managers would be hap — would be happy.
> Carr: Well, let's do that then. We won't mention the barf; we'll just throw that down the trash air-lock. I doubt if you threw up any more than what you've taken in — in what you took in. Just a few seconds — a few minutes earlier.
> Gibson: They're not going to be able to keep track of that. Let's do that, because they seem to make a big distinction between the — whether you throw up or not.
> Carr: Yes.

> Gibson: It's small, as the distinction in reality really is. So, it's just between you, me, and the couch. You know darn well that every manager at NASA would probably, under his breath, want us to do that (NASA 1973b:321:02:24:40).

These exchanges show a deliberate effort to conceal Pogue's condition, progressing from simple delay tactics to outright deception. Simple explanations based on perceived unimportance or constraints on time and communications bandwidth can be dismissed (Aral and Van Alstyne 2011; Fine 1987). The Skylab 4 astronauts were acquainted with the inevitability of space sickness and had simulation training reporting such cases (Hitt et al. 2008). As shown in Figure 2, reports to mission control on both the Medical and Health topics were routine and frequent during the first few days of each mission. Skylab 2's reports were delayed while they focused on docking and the habitability of the damaged station. Neither Skylab 3 nor 4 had that initial problem. Carr was aware that this requested status report was intended for exactly this situation, which is why it was necessary to go further and remove any physical trace.

The intended deception was detected later that day when the conversations on the onboard voice recorder were downloaded by ground control. In response, ground control called on Alan Shepard, then Chief of the Astronaut Office, to chastise Carr for this decision.

> Shepherd: And I Just wanted to tell you that on the matter of your status reports, we think you made a fairly serious error in judgment here in letting us know — the report of your condition. We're on the ground to try to help you along and we hope that — that you'll let us know if you're having any problems up there again, as soon as they happen.
> Carr: Okay, Al. I agree with you; it was a dumb decision (NASA 1973b:322:01:55:02).

This incident can also not be attributed to a limited spread of information due to organizational functioning, such as the "structural secrecy" Vaughan (2016) observed in NASA around the Challenger disaster. Carr's deception was explicitly contrary to mission regulations and was an ineffective attempt at secrecy (Gibson 2014). Even without the recording, it is likely the deceptions would have eventually been revealed by the numerous vomitus bags they brought back or in the extensive post-mission debrief (NASA 1973b). Carr's attempted secrecy was thus never intended to hide the space sickness from ground control or NASA in general. As Gibson stated, the crew felt they were working *with, rather than against*, ground control, i.e. the managers would "want us to do that."

The explanation of their actions must then lie beyond their concern for their own appearance to NASA or its administrators. The crew's actions were still about strategic self-presentation, just a self-presentation of NASA to Congress and the scientific community. The previous Skylab missions had been successful in allaying fears about the negative health consequences of long-term manned spaceflight (Allen 1973), but severe space sickness could upend that and would bolster political opposition

to the planned space shuttle. Walter Mondale had stated this unequivocally in a speech to Congress: "If the Skylab [sic] missions demonstrate that man cannot operate effectively in space for long periods of time, then the enormous funds allocated for the space shuttle … will have been wasted" (Mondale 1970). Congress was further uneasy about the practicality of a potentially space-sick pilot landing a shuttle that had such poor aerodynamics (Hitt et al. 2008:191). Carr explicitly made this connection in his diary the evening after Shepherd's rebuke:

> Shepard called and slapped our wrists. It was a dumb stunt for us to pull. I wish I'd had more sense than to try it. All we did was discredit ourselves. Didn't do the shuttle program any good at all (excerpt from Carr's diary as quoted in Shayler 2008:133).

In a later interview, Carr confirmed that he felt pressure from within NASA to not get sick and this was the main influence on his decision (Hitt et al. 2008:346). The obligation to include such cases in reports to Congress made space sickness somewhat unwelcome at mission control and presented a large disincentive for the astronauts to report it to ground control.

A comparison to Commander Conrad on Skylab 2 shows how Carr's decision hinges on Congress as an outside observer. On the fourth day of his mission, Conrad made a mistake in following the specified procedure for the Apollo Telescope Mount (ATM), one of the first space-based telescopes, which was designed to be manually operated by the crew. Conrad preemptively reported this mistake:

> Conrad: I may have goofed there, if you see something funny on your ATM [Apollo Telescope Mount]. I didn't think we were supposed—I didn't hear that one thing that you passed, and I didn't think we were supposed to be experiments pointing, so I went to SI … I hope I didn't goof anything up (NASA 1973a:148:00:47:30).

Conrad accepted full responsibility for an error that resulted from a miscommunication even though it may not have ever been discovered. The differences in the reactions were due to how the content of the message would appear to outside observers. The Apollo Telescope Mount was a new but uncontroversial piece of equipment intended for capturing solar flares. While Congress and the scientific community had been briefed on the new telescope and were excited about its astronomical and military applications, compared to the space sickness issue there was little public scrutiny and fewer budgetary or other repercussions if something went wrong.

CASE 2: MISSION PROGRESS AND DISSATISFACTION

After the space sickness was resolved, the mission got off to a grueling pace. Ground control began scheduling tasks at the same rate as the end of the Skylab 3 mission (Hitt et al. 2008), leaving the Skylab 4 crew without the necessary time to acclimate to working in a zero-gravity environment. Consequently, they frequently fell behind

schedule. As mission control pushed them to keep up, Carr expressed dissatisfaction with interrupted breaks, work scheduled immediately after meals, and postponed days off (Balbaky and McCaskey 1980). Carr also stressed the need for the crew to have more exercise time than previous crews to counteract the longer duration in space.

Subsequent events reveal that Carr had been concealing the extent of their dissatisfaction. After several weeks of contesting schedules, on December 27th Carr informed CapComm that he was working on a special message that would be included in the voice recorder dumps later that night. Far from sending a "manifesto" or "declaration of independence" as others have suggested (Balbaky and McCaskey 1980), Carr adopted a concerned and helpful tone, expressing his interest in discussing the scheduling problems and long-term mission objectives.

> Carr: This message is for Flight Director Phil Shaffer and CapComm Dick Truly. Phil and Dick, what we would like, since we have about reached the halfway point of this mission … [is] a recap of the … mission objectives we've accomplished so far … I think we'd very much like to see where we stand right now as far as accomplishment versus what's planned.
> Are we behind, and if so how far? … I'd like to know what kind of problems are plaguing you, and I'd like to know what kind of monkey wrenches that we're casting into your machinery. I would like to know if it appeared to you that we appear to be overly concerned about free time … I really, frankly would not object to a private comm, … And I'd like to know just exactly what everybody's motives are when they're asking these questions, because we're trying to get a straight answer up here … That's essentially the big question, you guys, and that is, where do we stand? What can we do if we're running behind and we need to get caught up? What can we do that's reasonable and we'd like to be in on the loop … CDR out (NASA 1973c:362:04:04:11).

This message was unusual for both its content and the channel it was sent on. All previous communications on the Skylab missions had focused on short-term planning and tasks. The onboard voice recorder was regularly used for messages delivered asynchronously and was typically reserved for medical readings and the results of scientific experiments. It was a private channel not released to the press, which is highlighted by the fact that it is the only channel where the transcriptions still have redacted segments. This is the only instance where it was used for coordination purposes.

The day after Carr's message, CapComm Dick Truly responded that he would enjoy the opportunity to discuss the issue, but it would take a few days to arrange the meeting and organize the data on mission objectives. The meeting occurred 3 days later, on December 31, spread out over multiple contacts. Carr later described this meeting: "We told them all the things on the first pass they were doing to make our lives miserable … and then on the net pass they dumped on us and told us how difficult we were making life for them down there" (Shayler 2008:162). Truly pointed

out that mission planners had started the schedule too fast, not allowing time for the astronauts to get acclimated, but that they had relaxed the schedule 10 days earlier. Carr acknowledged they had felt the pressure come off, and consequently he felt their efficiency was improving. The meeting ended with a compromise on the scheduling issues and Carr expressing his appreciation for the CapComms (NASA 1973b:365:03:10:19).

The immediate cause of this conflict was clearly the workload and scheduling problems. On the surface, all missions show frequent discussions of scheduling, which were necessary to balance the shifting constraints imposed by experiments, orbit position, meals, and sleeping (see Figure 3). However, a closer inspection of the content of these communications reveals that a short time frame dominated these discussions. The Scheduling topic, which comes closest to this idea, heavily emphasizes words concerning the near future (*tomorrow*, *tonight*, and *afternoon*). This is consistent with ground control's short-term orientation. The interrelationships in timings between tasks caused most schedule changes. A delay in one task meant that other tasks had to be rescheduled or postponed. The main points of Carr's message, mission progress, and accomplishments, were not typically discussed at all.

This evidence suggests two possible explanations. First, the complete absence of long-term conversations in any of the transcripts (apart from Carr's message) seems like the crew and ground control had conflicting cognitive frames (Eliasoph and Lichterman 2003). Truly admitted in the conference Carr's concerns took him by surprise: "I'll be very honest with you, [the accomplishments] have not been completely discovered until the last couple of days when we took the trouble to get a bunch of numbers out." Mission control simply had not foreseen how performance on a longer scale was relevant to the day-to-day execution of the mission. Still, conflicting cognitive frames do not explain the manner of the message and Carr's request for a private channel.

We can find a second explanation in the fact that Carr addressed his message specifically to Shaffer and Truly. Concern about reaching the right people and needing the proper audience for the message would seemingly indicate simple impression management (Goffman 1967) or selective disclosure (Cowan 2014). Although Truly and Carr had an especially good relationship, this explanation also does not hold up. Not only do CapComms not make scheduling decisions, but Carr could have spoken directly to Truly during his regular shift as CapComm without requesting a private channel.

As before, we can find a better explanation of Carr's actions by attending to third parties outside the interaction. Considering the broader flow of information, Carr's actions fit well with a face-saving and impression-management explanation if his actions were oriented toward the press and the public (Tian and Menchik 2016). Since the main air-to-ground channel was open to reporters, they could have published anything said over it turn into public knowledge. The crew and ground control were continually conscious of this possibility. For example, ground control did not

share any developments in the Watergate scandal, though the crew learned about them from their private family conversations. Carr later remarked "I think they were afraid we might say something derisive on an open channel" (Shayler 2008:151).

The request for a private channel would have allowed the team to handle the discussion with discretion, away from the press and public. Ed Gibson later reflected:

> [T]he situation was further compounded by the lack of open communication after liftoff. You couldn't just call down and say "Hey, guys, let's talk this out," because everything had to be open for the whole world to hear including the sensationalism-seeking press. So, we thought "Okay, we'll just work through it." (Gibson as quoted in Hitt et al. 2008:335)

The crew had become increasingly dissatisfied with their treatment in the press, who tended to overemphasize the negative aspects of the mission. The press billed their dissatisfaction with the fast pace as "Experiments criticized" (*New York Times* 1973a), "POGUE ANGRY" (*Los Angeles Times* 1973a), and "Too busy, astronaut complains" (*Chicago Tribune* 1973). They even tended to exaggerate more mundane occurrences. The crew's normal adjustment to working zero gravity was reported as "Skylab Crew Fatigue" (*Boston Globe* 1973) or the crew not being "enthusiastic" (*New York Times* 1973b). A conversation about being the first people to spend Christmas in space was printed with the headline "SKYLAB COMPLAINT: Mistletoe's Scarce 270 Miles in Space" (*Los Angeles Times* 1973b).

This concern about bad press led directly to Carr's desire for discretion. Just after sending his message to CapComm, Carr wrote in his diary about his worries about an upcoming press conference on January 2:

> I asked the guys on the ground to send us up a status report on how we stand, relative to mission objectives that were planned … We also heard today that we are scheduled for a TV conference with Dr. Kohoutek. I suspect it's more of a PR play than anything else, but it'll be different … Anyway, it's too easy to make an ass of yourself [up here], and most of the press find that to be more newsworthy than anything else we're doing. (excerpt from Carr's diary as quoted in Shayler 2008:161)

The press conference later confirmed these fears by focusing on his message and the resulting meeting (NASA 1973b:002:19:28:06). The evening after the press conference, he wrote:

> We had our TV press conference today and that was rough! They asked some mean questions, mainly concerning Bill's sickness, our mistakes, our demands for time off etc. … We fielded them but felt bad because the critical questions indicated to us that we have been labeled as screw ups and slackers. We were also feeling like the managers weren't behind us either, otherwise the press wouldn't be asking so many critical questions. Talked to JoAnn tonight and she said we went over great. (Carr's diary as quoted in Shayler 2008:163)

Frustrated by the press' framing of their mission, Carr turned to his one reliable source for unfiltered information — talking to his wife JoAnn over the private channel. JoAnn later recounter that conversation:

> It was our turn to have a telephone conversation that night of the press conference. The guys were very upset by this press conference and the first thing Jerry said to me was "What's going on down there?" They just got the feeling that they were being portrayed as a bunch of screw ups that were not doing their job. Of course, I lied through my teeth and said "No that's not true, it's just the press trying to find something interesting … " (JoAnn Carr as quoted in Shayler 2008:164)

Unfortunately, for the Skylab 4 astronauts, the press did not find all events equally "interesting." Two days later, spurred on by a private meeting with JoAnn Carr, the head of Flight Crew Operations, Deke Slayton, took over from CapComm to offer his congratulations on surpassing Conrad's record time in space and their "outstanding job all the way" as the first rookie crew since Gemini (NASA 1973b:004:17:42:12). Though this was broadcast on the publicly available air-to-ground channel, there was no coverage celebrating the crew's historic milestone (Hitt et al. 2008:388).

The public conference with Truly and ground control had not addressed all of Jerry Carr's concerns. Therefore, Carr again utilized unembedded private channels to convey sensitive information — his unmonitored private calls to his family and his wife's informal friendship with Deke Slayton. Carr's diary indicates that this resolved his worries about ground control (Shayler 2008:164), but concerns about press coverage remained an ongoing issue for the crew. NASA held another press conference 4 weeks later. Carr seemed slightly relieved afterwards:

> All three of us dreaded today's press conference. We took a good long time answering questions so there would not be too many. They were good questions and we felt pretty good when they finished with us. None seemed antagonistic or argumentative or accusing. I'm sure the press will treat us okay when we get back, but Ed and Bill are still skeptical. Actually, Ed's really worried. (Carr's diary as quoted in Shayler 2008:178)

Carr's relief was caused less by fair treatment from the press and more by their growing disinterest. Despite the crew's increasing scientific productivity and significant spaceflight achievements, the lack of major drama in the second half of the mission failed to result in any news items of note. The decision of all the major television networks not to cover the Skylab 4 crew return via water landing due to a lack of "newsworthiness" exemplified this (Shayler 2008:188). JoAnn Carr later reflected: "We didn't tell Jerry that he wasn't being covered, because I thought that was just the final insult, the final slap in the face. He didn't need to know that" (Shayler 2008:187).

Regardless of whether this decision was due to apathy or antagonism, the media handled Skylab 4 differently from the previous Skylab missions. Most major networks covered the splashdowns of both previous crews live. Upon return, everyone lauded these astronauts on the floor of Congress as "resourceful," "fantastic," and "outstanding" (Rogers 1973; Teague 1973). This public perception persisted despite

other crews not hesitating to complain publicly. Pete Conrad aboard Skylab 2 frequently chided the mission planners over the open channel about their attention to detail:

> Conrad: I'm ready to do your CBRM [charger battery relay module] thing. Be advised to support scheduling, though. You realize that I'm holding 10 EREP [earth resource experiment package] tape cleaning swabs in my hand and a few other things, and I'd appreciate it if you guys would look at that and the scheduling a little bit closer. About two or three times now you got us doing things where we got 89 pieces of gear out, and you got us running all over the spacecraft. I think you got enough guys down there to think out the Flight Plan a little bit better than you're doing …
> CapComm: Copy, Pete. And we'll try to do better (NASA 1973a:151:14:59:17).

This kind of exchange was possible for Conrad not because the interaction was unembedded relative to the press, but because it was embedded in a different relationship to the press. Conrad's reputation with the press and the public were already well-established as the third man to walk on the moon (during Apollo 12). Additionally, he and his crew began the mission by successfully repairing Skylab, salvaging the Skylab program and the reputation of NASA, actions which eventually would earn him a Congressional Space Medal of Honor. Unlike the Skylab 4 crew, Conrad had little to worry about in terms of impression management.

DISCUSSION

The two incidents discussed above demonstrate different aspects of selective disclosure due to embedded interactions. In both cases, the crew sought out unembedded channels to communicate their problems with ground control. In the case of Pogue's space sickness, the power of Congressional oversight of NASA eliminated the possibility of directly sharing any information about his condition with ground control. Though they initially thought of communicating indirectly by returning the vomitus bags, Carr and Gibson concluded this option was still insufficient and that the only option was to dispose of the evidence out the airlock. They saw this not as an action against ground control, but as an action *with* ground control to protect NASA's interests.

The case of the progress report presented Carr with more options. Unlike Congress, the press did not have access to the private channels, so Carr used all available private channels to help resolve their conflict. Carr chose the private voice recorder over the more typical air-to-ground channel and requested the response also remain private. He expressed his continued unease privately to his wife, who passed this along to the head of the Astronaut Office through a private meeting at their house. Though the relationship between Carr and ground remained the same, these private interactions could do the work the embedded interactions could not.

The problems on Skylab 4 did not originate between Carr and ground control, nor were they caused simply by the presence of the press and Congress, or generalized concern about information being made public. Instead, the presence of specific actors external to the astronauts' interactions with ground control complicated and restricted the possibilities of communication. Carr believed there was little reason to think that Pogue's sickness or their scheduling complaints would remain undisclosed. Instead, he endeavored to conceal it solely from Congressional decision makers, seeking an excuse to derail the shuttle program, and the journalists, who he believed would cast them in a negative light. Consequently, we cannot characterize the situation that defined their interactions with ground control solely within the bounds of his relationship with the CapComms, NASA as an institution, or space travel as an activity.

While networks of interactions allow actors to exert power at distal locations and influence the future interactions of others (Hall 2003), Skylab 4 presents a complementary case that demonstrates the problem of distal powerlessness (Clegg 1989). The Skylab astronauts could not control the flow of information and how that information would be construed in future interactions and used in decisions. They were left with no other choice but to control the information by not releasing it or releasing it along private and more controllable channels (Tian and Menchik 2016).

Counterintuitively, the physically isolated conditions of Skylab demonstrate how difficult it is to impose social isolation, both subjectively and analytically. Physical separation does not remove actors' relationships, networks, or social context. Instead, the embeddedness of interactions underscores the importance of Emirbayer and Goodwin's proposition that "social structure, culture, and human agency presuppose one another" (Emirbayer and Goodwin 1994:1413). We cannot understand interactions in isolation, nor can network structures without attending to the systems of meaning and expectation within which relations are embedded. The concept of embedded interaction helps to unify considerations and analysis of individual strategic action, diffuse social norms and expectations, and broader network structures. In orienting themselves to their current interaction, actors in embedded interactions have to consider subsequent actors, their relative roles, obligations, and their motivations.

While our goal was to demonstrate that interactions are contingent upon these chains of future interactions, the analysis focused only on network connectedness and not on the role of specific structural features of the network. Still, there are indications that specific patterns of connections and network structures will influence how and why content is filtered. For example, consider the different positions of the press and Congress relative to mission control and CapComm. In order to avoid the press, who were connected through the same node as CapComm, Commander Carr could simply find a different path of communication. However, to avoid information reaching Congress, who lay downstream from mission control via NASA's reporting obligations, Carr had to conceal the space sickness altogether. Different network

structures enable or restrict the available modes of interaction and invoke different strategic responses.

Embedded interactions further challenge a dominant theme in networks research that more connectivity leads to more information transmission. Many studies have found that widely varying social connections and a central position within a network structure will lead to an accumulation of information and knowledge (Burt 2004; Granovetter 1973). If the sender considers further transmission, then the occupants of such central structural positions may only receive innocuous or largely public information, while the less connected individual, like Simmel's stranger, may hear the more privileged and private information (c.f. Gladstone and O'Connor 2013).

In evaluating the events of Skylab 4, it is fitting to draw parallels to another well-known case of institutional dysfunction at NASA: the Challenger disaster (Vaughan 1996). In both cases, the popular narrative in the press or the Challenger-era Presidential Commission tended to assign blame to specific actors, either the crew or the managers, respectively. However, as Vaughan reveals in her analysis of the Challenger and as we have argued here, both cases resulted from situations that required a form of communication not possible within the existing organizational culture.

NASA's culture during the space shuttle years, particularly with respect to external contractors, emphasized formal communications according to regulations and along rigid hierarchies. The massive bureaucracy in which the shuttle was produced, maintained, and operated required an orderly process. As Vaughan highlights, Thiokol engineers' warnings about O-ring failure were filtered through this formal communications structure, modifying their message and making them appear as normal deviations in operational conditions.

In contrast, the critical communications between the crew, CapComms, and direct supervisors of Skylab occurred within a working group who also had personal relationships with one another. In contrast to the accumulation of procedures and norms that characterized the Shuttle operations, Skylab operated in relatively unknown territory and, accordingly, was designed to enable frank communication about unanticipated occurrences. NASA elected CapComms from the astronaut pool and ensured that they trained together in their respective roles with the intention of making communications natural and friendly while maintaining necessary operational formalities. This intention, however, conflicted with increased Congressional interest and the Apollo-era policy of open access for the press. Open communication within personal relationships is not possible when there are conflicting third parties present.

In this respect, structural barriers to communication produced both the Challenger disaster and the Skylab difficulties. In the Challenger era, the presence of intermediaries altered and filtered communication. In the Skylab era, the presence of distal observers omitted and stymied communication. Both studies demonstrate the complexities of third parties in interaction. Observers, intermediaries, and future interactants can all alter, modify, and restrict communications. The barriers to interaction provided by the first two are obvious due to their physical presence,

but the anticipations of absent third parties also exist within the interaction and provide similarly effective barriers in much the same way as if they were actually present. Interactions then are not conditioned solely by the here and now of the current situation, but are intertwined with expected or imagined series of future interactions.

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NOTE

1. Any interactions containing secret or sensitive material and personal communications were not publicly released.

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