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Identification of Comment Authorship in Anonymous Group Support Systems

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ABSTRACT: This study examines whether technically "anonymous" comments entered by participants during group support system (GSS) brainstorming sessions are, in fact, unidentifiable. Hypotheses are developed and tested about the influences of comment length, comment evaluative tone, duration of group membership, and prior communication among group members on the accuracy of attributions they made about the identity of the authors of these technically anonymous comments. Data on prior communication and group history about each of the 32 small groups was collected before participants began using a GSS for brainstorming. Immediately after the session, each member was asked to attribute authorship to a sample of the session's anonymous comments (comment authorship was known to the researchers). The study's participants made attributions that were significantly more accurate than chance guessing. Factors that had a positive influence on attribution accuracy include evaluative tone of comments (especially humorous comments) and amount of prior communication received from other group members. Vividness of comment tone and comment length was not significantly correlated with attribution accuracy. Although the attributions of anonymous comments were more accurate than expected by chance, most of the attributions were incorrect. Implications and consequences of both accurate and inaccurate attribution are discussed along with suggestions for future research.

KEY WORDS AND PHRASES: anonymity, computer-mediated communication, group support systems, social networks.

ANONYMOUS CONTRIBUTIONS HAVE STIRRED considerable debate in areas as diverse as literature, journalism, history, academic reviewing, organizational whistle-blowing, grapevines, religious confessions, radio talk-shows, online newsgroups and chat groups, support groups, and voting [4, 7, 48, 51, 71]. In the field of group support systems (GSS), one feature of the software is the technically "anonymous" condition, whereby individuals can create messages and express preferences or vote without identifying themselves or being identified by others [59]. GSS often embed this feature into a range of different activities such as brainstorming, categorization, and voting [18, 21, 38, 95]. Recently, several theoretical models have been developed to study the phenomenon of anonymity, particularly within the GSS context [25, 49, 55, 61, 71, 84].

This study examines some issues related to use and implications of the anonymity feature of GSS. The impetus for this study arose from our experiences with conduct-

ing over 200 meetings using GSS of various types with the anonymity feature engaged. During breaks, we observed participants attempting to decipher "who said what"—attributing authorship to the in-session anonymous comments. It appeared that these attributions were sometimes based on cues in the textual comments or perhaps prior knowledge about the individual. However, the accuracy of these attributions was unknown, and posed the following empirical question: *Does the technical anonymity feature of a GSS preserve social anonymity of the entered comments?*

This question is important because attributions can influence interaction during, and outcomes from, decision-making in general [5, 8, 27, 29, 41, 58, 83], and anonymous GSS contributions in particular. Attributions of any kind have the potential to influence the evaluations of supposedly anonymous comment content. Correct attributions would mitigate the potential benefits of anonymity, such as removing biases due to organizational role, status, gender, power, or past decisions. Incorrect attributions, at the very least, add noise to the process, but at the worst, erroneously associate consequential comments with a highly (dis)respected author and therefore may generate unfounded (as opposed to founded!) biases. Mennecke et al. [57] suggest that these "extra-meeting" influences can then become inputs into subsequent GSS interactions and degrade those aspects of GSS decision-making that are theoretically improved by anonymity. From a research perspective, if participants' attempts at attribution are noticeably (in)accurate, results from prior research and models of anonymous GSS may have to be reexamined. Furthermore, if subsequent research shows that this negatively impacts interaction and outcomes, both GSS software and facilitation processes will need to be modified.

Existing theoretical models and prior research suggest that attribution accuracy during an "anonymous" GSS session may be influenced by components of at least six dimensions: the mechanism by which anonymity is induced—technical or social; participant awareness—possible sources of messages or of participants in the group; the perspective taken—the extent to which one feels others are anonymous, or oneself is anonymous to others; the group task—simple or complex; the time span and density of the group's communication; and group demographics—specifically group duration and prior interaction. This study focuses specifically on the issue of whether attributions of anonymous comments in a computer-mediated communication (CMC) system (here, a GSS) are accurate or not, and what factors influence this level of accuracy.

The next section reviews prior relevant research on attribution and anonymity in the GSS environment. This provides the basis for hypotheses concerning attribution, social and content cues in mediated communication, the individual's perspective on anonymity, and group history and prior communication. The methods section describes the study's procedures, sample, and measures. Results for each of the hypotheses are then presented, and a discussion section assesses the implications and limitations of the study. The phenomena reported here and the factors proposed to account for them are distinctly relevant to understanding the role of anonymity, not only in GSS, but in other domains of CMC.

Research Foundations, Questions, and Hypotheses

Attributions

A FUNDAMENTAL AND TYPICALLY UNEXPLORED assumption of research on and use of the anonymity feature of GSS is that participants do not attempt to attribute authorship of technically anonymous comments. However, attribution theory says attempts to identify authorship are quite likely [43, 45]. Attribution theory examines the conclusions people reach about their own and other people's characteristics and the effects that these conclusions have on future judgments and choices [41]. It argues that people make attributions about others and use these attributions to predict and evaluate actions [8, 14, 27]. Humans search for the causes of all events, since an accurate understanding of such causes will permit the person to function more adaptively [31, 44, 89]. For example, causal attribution for group performance is an important determinant of group decision-making [70]. Blount [5] even demonstrated that differences in causal attribution regarding prior events directly influence social decision-making. Hayes and Hesketh [29] suggest that attribution theory should also consider the role of cognitive biases and errors [58, 83] in not only generating inaccurate attributions, but also in leading to inappropriate evaluations based on those attributions.

Attribution theory, then, implies that it is at least plausible, and probably likely, that some GSS participants make attributions of authorship of technically anonymous GSS comments. Technical GSS anonymity has been implemented in many ways: by not introducing participants who have not previously met, not requiring or posting author or account identity, using encryption or anonymizers, or allowing participants to use "pen names" or aliases [3, 11, 25, 32, 33, 37, 39, 47, 73, 90]. Technical anonymity presumes that these features completely prevent participants from being able to identify the authorship of comments from other participants. Thus, our preliminary research question is:

> *RQ1: To what extent are attributions of technically anonymous GSS comments accurate?*

Social and Content Cues

A related fundamental and typically unexplored assumption is that if GSS users did attempt to attribute authorship to technically anonymous comment, they would be inaccurate because there are supposedly no social or nonverbal cues available in the computer-mediated text about the comments' authors. People (such as members of groups making decisions) attend and respond to the content of what others have said, written, or done, as well as cues such as attractiveness, dress, or communication style, to different degrees. Such cues provide the basis for forming impressions and evaluating others [4, 80]. The more cues that participants successfully decode, the more accurate their attributions, and this influences participants' evaluations of other participants and their contributions, as well as general decision outcomes.

But does mediated communication, as in a GSS, allow the exchange of such cues? Both social presence [66, 74] and media richness [13, 69] theories propose that text-based CMC generally transmits fewer social and nonverbal cues than face-to-face interaction. This cue reduction is associated with negative effects such as increased group polarization, disinhibition (flaming), misunderstandings, lack of consensus, and feelings of impersonality [46, 65, 75, 79]. However, the reduction of such cues may also lessen status differences and domination based on gender, role identity, appearance, or oral skills that are common in face-to-face group discussions. In CMC, this reduction of cues is often reflected in more equal participation, more reciprocal communication, greater evaluation based on content instead of personality and status, and less sequential or linear comments. Technically anonymous CMC, such as in GSS, occurs when the software is set to remove the identity of authors from the comments, and is intended to increase such benefits [15, 32, 65, 78].

This is not always the case. Joinson [40] has found that significantly higher levels of spontaneous self-disclosure were found in CMC compared to face-to-face discussions. Furthermore, Flanagin et al. [22] found that males were more likely than females to reveal social cues to afford them greater potential influence during the interaction.

Social anonymity refers to the degree to which participants *perceive* they are anonymous, or perceive others as anonymous (in this study, they feel their, or others', comments are not identifiable). For example, several studies have found that GSS group members thought they could not accurately identify the authorship of messages from others, but that other users may be able to accurately identify their (the surveyed member's) messages [11, 39, 42, 77, 80, 92]. Social anonymity can change throughout a group decision process, and may not necessarily correspond to technical anonymity. This process can include intentional stylistic and substantive alterations in the content of the message in an attempt to disguise the author [76], or, as we analyze here, evaluations of comment style and content of technically anonymous comments in an attempt to identify the author. Accurate attributions would seem to be more difficult under conditions of decreased cues (such as in technically anonymous GSS) and increased diversity of participation (such as in large groups or groups with little prior history).

Postmes and Lea [63] conducted a meta-analysis of 1,101 participants in 264 groups in nine GSS experiments, assessing 32 hypotheses about the impact of anonymity. Across these analyses, anonymity had a significant effect on increased number of remarks, especially critical ones, but not on number of ideas, decision quality, satisfaction with decisions and decision process, or rated effectiveness. They suggest that the variability of individual results, and the overall nonsignificance of the combined results, may be due to the fact that technical GSS anonymity may increase or decrease social influence, depending on the social context, such as the salience of group identity and membership. Weisband et al. [91] found that pseudonymous group members could accurately identify the social status of others. Postmes et al. [64] found that ad hoc groups were able to guess others' gender correctly 57 percent of the time (greater than chance), although members of Bhappu et al.'s [3] pseudonymous groups felt they could

not identify the gender of their groups' other participants. So, conceptually and empirically, social anonymity is not necessarily guaranteed by technical anonymity.

Further, in spite of theories (such as social presence or media richness) that presume CMC systems and GSS filter out most social cues, some researchers argue that text-based media may still convey substantial emotional and personal content [12, 46, 68]. Further, CMC users may develop richer relations and ways of increasing inclusion and decoding of social cues in their electronic mail messages over time [10, 82, 86]. Walther argued [86], and found [87], that impression formation through CMC may increase over time to approach the initially higher levels of face-to-face impression formation. This will be more likely for smaller groups (fewer alternative identities to choose from), for groups of people who expect to interact in the future (generating a group social identity and consequence of current interactions), and for groups with prior history (so that members are more familiar with each other's styles and arguments), all of which will foster a greater ability to decode text-based cues and associate them with specific authors. For example, some authors may always use a certain abbreviation or jargon (particularly if it highlights a salient group identity); their grammatical style may be unique and reveal their identity through stylistic, vivid, detailed, or individualized cues; they may repeatedly state a position that a reader knows the author holds; or they may regularly write longer comments.

One interesting cue shown to influence human judgment is "information vividness." Nisbett and Ross state that vividly presented information has more impact on judgments (i.e., is weighted more heavily) than do "pallid and abstract propositions" [58, p. 44]. Taylor and Thompson wrote that "vividly presented information is impactful and persuasive" [81, p. 155], either during information input or later processing [28]. Wilson et al. [93] demonstrated that when there is too much information for a decision-maker to process, vivid information will more likely be included in the limited amount of information that *is* processed. Another type of cue may be the "evaluative tone" of group discussion comments, which presumably provides varying social and linguistic cues. Connolly et al. [11], for example, found that anonymous groups were significantly more critical than identified groups, and that the critical groups generated more output (due perhaps to a cueing effect or incipient flaming).

What this brief review of CMC cues and content means is that readers of technically anonymous textual comments in a GSS—especially those comments with particularly vivid, long or more evaluative social cues—may in fact perceive enough cues to make attributions of varying accuracy. Therefore it is hypothesized that

H1a: Attributions of the source of technically anonymous GSS comments are more accurate for vivid comments.

H1b: Attributions of the source of technically anonymous GSS comments are more accurate for longer comments.

H1c: Attributions of the source of technically anonymous GSS comments are more accurate for evaluative comments.

Group History and Prior Communication

Members of small groups may find it easier to accurately identify authorship of otherwise technically anonymous comment because there are fewer participants to choose among, and fewer messages to evaluate. Members of groups with significant history and extensive prior communication may have memory of both social and content cues which allows participants to more accurately attribute authorship. Members of groups that have a dense communication network may be able to identify authorship more accurately because they have had easier access to particular members' positions and terminology. Members of groups with social norms of honesty and integrity may have higher levels of accuracy. Group members with high influence may wish to indicate their authorship, and a group with a great amount of shared knowledge may affect perceptions of anonymity and attributions of anonymous comments [30]. This study assesses the role of three of these group factors: prior history, prior communication, and group size.

Individuals with more or stronger prior communication with other members of the group should be better able to identify the authors of technically anonymous comments. This is due to prior knowledge of relevant cues such as others' status, expertise, authority, role, conflict, positions on various issues, and language styles (as noted above in the subsection on social and content cues). For example, Carlson and Zmud's [10] concept of "channel expansion" posits that prior familiarity and experience with partners and a medium increases the ability to use a new medium for a wider range of communication purposes, and Walther [86, 87, 88] showed that users of mediated communication systems can develop personal impressions of other participants over time. Thus,

> *H2a: Longer prior membership in a group is positively associated with one's accuracy of attribution of authorship of technically anonymous GSS comments.*

Prior communication may be conceptualized in at least two more rigorous ways, based on network analysis theory [67]. The first is simply the *total amount of communication* with other group members. The second is the location within one's social network, in particular one's *betweenness centrality.* This construct measures the frequency with which a member is part of and thus can engage in, or control, interactions along the shortest paths between each dyad in the group. The more central a person is, the greater an individual's control of the flow of information from and about all other group members [27]. Both forms of prior communication—amount and centrality—potentially increase a group member's familiarity with all others' opinions and communication cues, and possibly increase the member's accuracy of attributions. Scott [71] found that individuals with the greatest influence (both self-reported, and the average of all others' ratings)—one consequence of network centrality—may perceive messages from anonymous sources as threatening and therefore put more effort into authorship attributions, and thus be more accurate.

H2b: Greater total amount of one's prior communication within a group is positively associated with accuracy of attribution of authorship of technically anonymous comments.

H2c: Greater centrality in the group's prior communication network is positively associated with accuracy of attribution of authorship of technically anonymous comments.

Method

Participants

IN ORDER TO AVOID SOME OF THE POTENTIAL validity threats in GSS studies [35, 53], this study used natural groups and "real-time" questionnaires in a controlled laboratory setting. Participants were MBA students engaged in an 18-month, intensive, full-time program, where students were encouraged to form groups for the duration. A total of 32 groups were formed from 124 participants: nine groups of three, 18 groups of four, and five groups of five persons. The experiment was conducted six months after the beginning of the students' program. The groups were small, motivated real teams with significant prior interaction histories and could all be characterized as leaderless groups.

Group Support System

The groups engaged in a typical GSS session consisting of brainstorming/discussion and rating/ranking using GroupSystems™ [59]. The GroupSystems tool used to gather technically anonymous comments for this study was Topic Commenter, which supports idea sharing through textual comment entry about user-selectable topics.

Task/Setting

Several authors have asserted that the *group task* exerts powerful effects on group behavior and outcomes [62, 94]. Simple tasks primarily requiring communication may innately have less anonymity than both complex and fuzzy decision tasks [94]. This may interact with participants' or others' influence, as tasks that are more threatening to those with high influence may be less anonymous [71]. This study uses a simple communicative task in order to detect possible departures from technical anonymity. Under McGrath [52] and Gray et al.'s [26] classifications, the task used was a low complexity judgment task. According to Zigurs and Buckland's [94] criteria, the fit between the technology (Topic Commenter) and the task (simple communicative) was good.

With respect to *time period* of the group's anonymous communication, the more real time the GSS interaction, the more difficult it may be to accurately attribute authorship of any particular comment [9]. If the interaction is asynchronous, the participants have more time to assess the nature and possible authorship of comments,

but they may also use more time to wordsmith their comments in order to *hide* their identities [32]. Scott's [72] study showed that over time, users' perceptions of others' anonymity declined, and their confidence in their source attributions increased, even though they were generally inaccurate. This study assesses attributions and thus social anonymity immediately after the task.

The full set of 32 sessions was completed over several days, with four or five groups meeting simultaneously in an electronic meeting laboratory that accommodated a total of 30 participants. The same researcher, trained in GSS facilitation, conducted all of the sessions. Before each GroupSystems session began, a simple group communication survey was completed by each person (discussed below). A separate electronic meeting was created in GroupSystems for each group prior to each session. Each person was seated so that it was impossible to see another group member's screen. They were allowed access only to their own group's discussion.

When all participants were settled, the facilitator discussed the pros and cons of traditional and electronic meetings. The various tools in GroupSystems were then demonstrated and the entire class was asked to log into their group's electronic meeting. They were then specifically instructed to "discuss four issues relating to your feelings about privacy and the ethical use of information in the work environment" (each in its own Topic Commenter window). These issues were: keeping a secret record on your employees; monitoring e-mail of your employees without them knowing it; copying commercial software from a friend who has bought it; and automating some employees out of their jobs to save money.

Each Topic Commenter session lasted 45 minutes. The session consisted of group members entering comments under each issue and reading other members' comments, in whatever order they chose. Within the issue areas, one member's comment would often respond to or expand upon another member's comment. There was no indication via the GSS features as to who entered which comment; that is, all comments were technically anonymous. Thus these sessions had message source anonymity but not participant anonymity.

We believe the participants were motivated to take the exercise seriously. They had all attended a lecture and discussion on privacy and ethics in the previous class and were told that one or more essay questions on their final exam would focus on these issues. The participants appeared to be interested and committed to the exercise due to their animated comment generation and electronic discussion.

After completing the survey, the groups went on to create, rate, and rank the issues generated from the Topic Commenter session. Participants were asked not to reveal the purpose of the research to other students until the complete debriefing the following week. Our discussions with the participants afterward indicated they did not discuss the experiment.

Data

Using this process, three forms of participant data were collected. The first form was the pre-session *communication network roster.* This roster listed the names of that

group's members, and asked each person to indicate the extent to which they had previously communicated on any topic, using any communication channel, with each group member on the roster.

The second form of data was the *actual comments* generated on all four issue areas for each group. These items were downloaded from GroupSystems ten minutes before the end of each group session. Comments were *not* restricted to any particular length, and could have been as short as "*Me, too!"* An example comment included in the questionnaire is:

> Employees should be able to see their personal files. I worked for an organization that did defense contracting and had detailed security files that were done upon hire and accessible only to Human Resources. Luckily I was in H.R. Would you consider keeping these security files private from the employee ethical?

Note that we have no basis to assert (or question) that any *particular* comment was actually read during the online discussion session by any *particular* member.

The third form of data was the *post-session survey.* This survey asked *individual-level questions* about demographics and group membership. The post-session survey also provided participants with a *list* of each of their group members, each identified by a sequential letter to facilitate the process of assigning authorship to the comments. It also listed a random selection of the *comments* entered into their electronic group session (explained below). Since Topic Commenter was designed to maintain technical anonymity by not maintaining a log of who entered each comment, participants were first asked to indicate which comments were their own (if any), by entering their own letter alongside the comment(s). This process also served to remove one's own comments from any subsequent authorship attributions. Note that we have no a priori basis to assert that each self-identification would be correct. However, no comment was claimed by more than one participant, and only 6.8 percent of the comments were left unclaimed (75 out of 1,107). Also, as explained below, we did not rely on this self-identification as the basis of correct comment authorship.

Then, the participants were asked to make their best guess as to which other participant contributed each of the listed comments by entering the particular other participant's letter alongside each comment that they chose to identify. In the event a participant was not completely sure who had made the comment, they were instructed to "please leave the entry blank." We know of no research that has been successful in determining attributions without asking participants about their attributions (see [19])—nor are we sure how this could be accomplished. However, how the question is framed is important—by not giving participants a binary question, *and* by allowing participants to not answer if they were unsure, we have conformed to recommended practice [19]. Participants were advised that their accuracy in identifying comments would be reported during the debriefing the following week, and the first, second, and third place individual and group winners would be recognized in class. This was considered an effective incentive in keeping with the "friendly rivalry" that was evident between the participant groups during their interactions in the MBA program. Our intention was to motivate participants to be as accurate as they could be in their attri-

butions. Note that we did not intend, or attempt, to motivate them to lie or disguise their identity during the GSS discussion. The post-session questionnaire was completed and returned by the participants before they engaged in any other activities and before they left the meeting room.

To avoid the validity threat of inaccurate self-attributions, after the groups had left the laboratory but before the Topic Commenter software was shut down, we were able to code which workstation (and thus which participant) had actually entered each comment. Therefore, all analyses used the *actual* authorship of each comment for determining the accuracy of attributions by the participants.

Measures

Eleven specific measures were developed within four conceptual categories, presented in the order in which they were they might be involved in the process of social anonymity: (1) prior communication, (2) characteristics of the comments, (3) demographics and perceptions, and (4) accuracy of attribution. Because few other GSS studies involving anonymity have developed any related measures, other than the experimental condition of technical anonymity, most of our measures of attribution accuracy and attitudes about anonymity were developed for this study. The communication network measures, however, are typical operationalizations of interaction [67].

Prior Communication (from Pre-Session Communication Roster)

The communication roster on the pre-session survey asked each group member *i* to indicate their level of prior interaction with each other group member *j* (from 0 = never, 1 = once every few months, 2 = once a month, 3 = several times a month, 4 = once a week, 5 = several times a week, 6 = once a day to 7 = several times a day). These data represent a *matrix* of interactions from *i* to *j* within each separate group. As *j* may report a different level of interaction with *i* than *i* with *j*, such matrices are inherently asymmetric.

1. *Total communication* for each member was measured by the total of each person's column in the matrix of that member's group. This is a more reliable measure than the row total, because it does not rely on the respondent's possibly systematically biased reporting (i.e., *i* to each *j*); rather, it averages all others' biases (i.e., all *j*s to *i*). The *mean total communication* divides the column total by group size (less one) to control for different numbers of potential communicators across the groups (i.e., controls for different group size); so this is the measure we use. See Appendix A for an example.

2. *Betweenness centrality* measures the extent to which each group member lies on the paths of the shortest number of links required to connect each other pair of members in the group [24]. First the communication matrix was symmetrized by putting the average of the $cell_{i,j}$ and $cell_{j,i}$ into both cells, then dichotomizing all cell values at three (with communicating at least several times a month = 1; less than that = 0). Betweenness centrality for each individual in the group was calculated using this (now) symmetric binary matrix, and then standardized to control for group size differences

(by dividing the value for each person in a group by the maximum possible betweenness for that group), using UCINETIV [6].

Characteristics of the Comments (from the Comment Transcripts)

3. The *number of comments* collected from each group session ranged from 17 to 72 (M = 36.1, s.d. = 13.9). The number of comments was not correlated with *group size* ($r = 0.03$), so there is no bias in number of comments (and thus possibly accuracy) due to group size.

4. *The number of words* in each comment, not counting common "stop" words (we also computed total characters, but that was correlated $r = 0.98$ with number of words so was not used).

5. *Vividness* of each comment was coded by an independent rater, blind to the experimental conditions, who assigned a number from 1 to 5 depending on how "vivid" the comment was. Nisbett and Ross state that information is vivid to the extent that it attracts or holds attention and excites the imagination by being "(a) emotionally interesting, (b) concrete and imagery-provoking, and (c) proximate in a sensory, temporal or spatial way" [56, p. 45]. Examples of comments coded at the lowest (1), middle (3), and highest (5) levels of vividness include:

1 = This is ethical when done for business reasons.

3 = Since I'm not a huge Tetrus fan, I would probably pass on copying it. There are lots of things that would tempt me . . . but I would rather pay a moderate (student) price for software that I needed and have a clear conscience.

5 = Probably, you see, when I confronted her, she told me she took the money to pay her fuel bill, she had run out of oil to heat the house, and her kids were cold, this was in Yellowknife. Do you think I'll rot in H__?

A random sample of 122 comments, stratified by sequential number of the comments (first half and second half) coded by the independent rater to take into account possible coding fatigue, was coded by the senior author and compared to the coding of those same comments by the independent rater. This comparison produced a Scott's inter-coder reliability *pi* of 0.74.

6. *Evaluative tone* of each comment was coded by an independent rater using Connolly et al.'s [11] group discussion coding scheme. Responses to our open-ended question (see below) revealed that several participants mentioned "joking" as a way they may identify an author of a comment, so we added a category to the evaluation tone coding sheet for Humorous Remark. Thus, Evaluative tone included these categories: proposes solution, supportive remark, supportive argument, solution clarification, problem clarification, critical remark, critical argument, query solution, query proposal, humorous remark, remark about the system, remark about interpersonal processes, off-topic, and uncodable text. The coding by the senior author of the same stratified random sample of 122 comments was compared to the coding by the independent rater, resulting in a Scott's inter-coder reliability *pi* of 0.72.

7. *Presence of cues* was indicated by responses to an open-ended question on the post-session questionnaire asking whether there were any events during the meeting that made it easy for the respondent to identify others' comments.

Individual-Level Variables (from Post-Session Questionnaire)

8. *Demographic information* included gender, age, and years since undergraduate degree.

9. *Duration of group membership* was measured by asking members how many months they had been a member of this particular group (used in many studies mentioned in Jessup and Valacich [38]).

Attributions (from Post-Session Comment Questionnaire)

10. *Number of attributions* is simply the total of all the attributions made by any particular participant.

11. The *accuracy score* for each member is the row mean, ignoring the diagonal, of the *asymmetric matrix of normalized attribution accuracy* of each other member's comments by each member. Each cell in each group's accuracy matrix is filled with the result from this equation (see Appendix B for an illustration):

$$cell_{i,j} = \frac{\sum_{1}^{k}\left(a_{ij} - k_j\right)}{n},$$

where: i,j = participants; $i \neq j$ (unless misattributed to themselves; discussed below); a_{ij} = attribution by i that comment k was made by j (1 if made, 0 otherwise); k_j = comment k was made by j (0 if true, 1 otherwise); and n = number of attributions made by i about j.

For each comment listed on the comment questionnaire, *if* person i makes an attribution of authorship to person j, *then* for that $cell(i,j)$, $a_{ij} - k_j = 1$ if correct, 0 if incorrect. If a participant claimed they had written a comment ($i = j$) when in fact they did not (ex post), we code that as an inaccurate attribution. Remarkably, this only occurred one time in the entire data set. These data are summed, and then divided by the number of attributions i made. There was no correction for random (as opposed to well-intentioned) guessing (though we do test mean group accuracy scores against chance accuracy in the result section). Thus the attribution accuracy score for each i,j relation theoretically ranges from 0 to 1 (0 percent to 100 percent).

We considered two kinds of accuracy. The first, called Accuracy G (guesses only), does not presume that i *should* make attributions to every comment; it only considers when i *does* make attributions. In this case, if i did not make an attribution for a particular comment k, the value is set to missing, so that non-attributions do not count either as accurate or not accurate. However, some may feel that not making an attribution indicates that the group member does not feel they can identify the comment's

author, and this should be counted as an error, or an inaccurate attribution. Therefore, we also computed and analyzed Accuracy NG (no guessing) by setting the value to zero, if *i* did not make an attribution. Mean accuracy for NG, counting non-guesses, was 43 percent, s.d. = 0.34. As would be expected, both mean Accuracy G and NG are negatively related to group size, but slightly more so for Accuracy NG ($r = -0.35$ compared to –0.29, both $p < 0.005$), because as group size increases, there are proportionally more comments to not make attributions for. Because we believe only actual attribution attempts should be assessed (not making an attribution is not the same as an incorrect attribution), there was only one slight difference in the results between these measures, and these two measures are highly correlated with each other ($r = 0.82$, $p < 0.005$), we report results only for Accuracy G (see Appendix B).

Results

TABLE 1 PROVIDES SUMMARY DESCRIPTIVE STATISTICS on the 11 measures, some of which are noted as appropriate in the following sections.

RQ1: Extent and Accuracy of Attributions

Although we made no hypothesis about the extent of attribution, it may be helpful to describe how much attribution of technically anonymous comments occurred in this study. The percent of group comments to which individuals attributed authorship ranged from 9.3 percent to 100 percent. The percent of group comments that received authorship attributions by all members of their respective group ranged from a low of 25 percent to a high of 64 percent.

Individual accuracy ranged from 0 percent to 100 percent (M = 0.60, s.d. = 0.24). Group mean accuracy ranged from 39 percent to 83 percent (M = 0.59, s.d. = 0.39). Overall and for groups of each of the three different sizes (M = 3.9, s.d. = 0.62), individuals were significantly more accurate (overall mean chance = 0.35, s.d. = 0.08; $t = 11.8$, d.f. = 123, $p < 0.000$) than expected by chance guessing (defined as $1/n - 1$, where n = group size, and we assume each respondent knows their own comments). Thus the *technically* anonymous condition is not completely *socially* anonymous. Not only did a substantial percent of users make attributions, and a substantial number of comments received attributions, but 60 percent of all those attributions were correct.

In a field study [30] that analyzed attributions from seven *large* groups (from 13 to 26 members) with considerable prior history (on average, five years), mean group accuracy was also higher than expected by chance guessing (accuracy from 0.01 to 0.29; average accuracy across the groups = 0.12; average chance accuracy across the groups taking into account group size = 0.06). So although average accuracy increases as group size decreases, both small (3–5 members) and large (13–26 members) groups exhibit greater-than-chance accuracy of attribution of authorship of technically anonymous comments.

Table 1. Summary Descriptive Statistics of the 11 Measures

Measure	Mean	Standard deviation
A. Prior communication		
1. Group communication		
Total communication	14.5	3.5
Mean total communication	4.98	1.2
2. Betweenness centrality	0.57	0.32
B. Comment characteristics		
3. Number of comments per group	36.1	13.9
4. Number of words per comment	19.5	15.2
5. Vividness of comments	2.3	0.76
6. Evaluative tone	See Table 2	
7. Comment cues	See text	
C. Individual-level variables		
8. Demographics		
Female	51%	
Age	31.5	5.9
Years since college	8.0	5.8
9. Months of group membership	4.0	1.2
D. Attributions		
10. Number of attributions per group	17.0	6.1
11. Accuracy of attributions		
Individual	0.60	0.24
Group	0.59	0.39

Notes: Participants $N = 124$; comments $N = 1{,}107$.

H1a,b,c: Comment Characteristics and Attribution Accuracy

For each evaluative tone category, Table 2 provides frequency, means tests analysis of variance (ANOVA) for accuracy across the evaluative tone categories, and correlations of accuracy with vividness and word count for each category of comment. At the level of the 1,107 comments, there was no significant correlation between vividness of the comment and accuracy (H1a) ($r = 0.02$) or between number of words in the comment and accuracy (H1b) ($r = 0.00$). Thus, these two hypotheses are rejected. However, humorous comments were more accurate than any other evaluative tone category, supporting H1c.

H2a,b,c: Prior Communication and Attribution Accuracy

Participants had been a member of their group for, on average, four months (s.d. = 1.2) (Table 1). There is no significant correlation between group duration and accuracy of attributions ($r = 0.09$, n.s.) rejecting H2a. Mean total prior group communication was significantly correlated with higher accuracy ($r = 0.21$, $p < 0.01$), supporting H2b. (These analyses control for the range of group sizes here—3, 4, and 5—because

Table 2. Comment-Level Analysis: Accuracy of Attributions for Different Categories of Comment Evaluative Tone, and Correlations of Vividness and Comment Length with Accuracy

			Mean	Correlation	
Category	Operationalizations of evaluative tone of comment	Frequency	Accuracy	Vividness and accuracy	Comment length and accuracy
PS	Proposes solution.	271	0.55	–0.08	0.02
SR	Supportive remark, such as “good idea”; “I like that proposal.” Expresses support for a proposal without adding evidence or argument.	31	0.64	–0.31	–0.18
SA	Supportive argument, such as “I like that because it will stop cheating.” Supports a proposal and gives evidence or argument.	74	0.53	0.01	–0.02
SCL	Solution clarification, such as “Hire a private detective and obtain your own record on your boss.” Adds detail or new features to a solution.	39	0.62	0.19	0.29
PCL	Problem clarification, such as “Do the ends justify the means?” Adds detail or new features to the problem statement.	72	0.65	–0.21	0.06
CR	Critical remark, such as “I don’t like that”; “That’s a terrible idea.” Expresses opposition to a proposal without adding evidence or argument.	10	0.53	0.09	0.40
CA	Critical argument, such as “If it makes good business sense, then do it, however, be careful in managing the process of laying off employees.” Opposes a proposal and gives evidence or argument.	56	0.55	0.21	0.13

QS	Query solution, such as, "What about personal financial records?" Requests clarification of a proposed solution. Responses will be coded as one of the other categories.	84	0.48	0.07	0.13
QP	Query proposal, such as, "Clearly an infringement on privacy; however, employees are being paid to be productive on company time, so should employees expect that privacy?" Requests clarification of problem specification or solution criteria. Responses will be coded as one of the other categories.	34	0.49	0.27	0.17
HUM	Neutral, positive, or negative humorous remark.	259	0.68[a]	0.10	0.04
COM	Neutral, positive, or negative remark about the system or its operation.	21	0.53	–0.36	0.41
GRP	Neutral, positive, or negative remark about the interpersonal processes of the group.	59	0.63	–0.14	0.16
OTT	Remarks that are "off the topic" and do not fit into the existing categories.	88	0.63	0.06	0.09
UC	Uncodable text.	9	0.71	–0.51	–0.05
Mean		79.1	0.59	0.02	0.00
Standard deviation		82.9	0.39		
F-ratio			2.5**		

Notes: [a] = highest (equivalent) group(s), according to Duncan paired comparisons; only this one comparison shown, for parsimony.
* = $p < 0.05$; ** = $p < 0.01$; *** = $p < 0.005$; $N = 1{,}107$ comments.

group size is a denominator of the mean total communication, and because each person's accuracy score controls for the number of attributions they make.) Although not hypothesized, longer group duration was associated with greater mean total prior group communication ($r = 0.45, p < 0.001$), indicating the increased interaction among groups with more extensive history, and thus a possible source of knowledge and cues to use in making authorship attributions. Betweenness centrality (also controlling for group size) was not significantly correlated with attribution accuracy ($r = 0.16$, n.s.), rejecting H2c. We also tested whether level of communication between each pair of respondents was correlated with level of accuracy of each attribution between each pair, by applying the Quadratic Assignment Procedure [36] between the communication matrix and the accuracy matrix. In only two of the 32 groups were the accuracy and communication matrices significantly correlated. The mean correlation across the 32 groups was $r = -0.02$, s.d. = 0.32, n.s.

In answer to the open-ended question, many people expressed observations about available social cues such as "how people express themselves," "the way they write," "grammar," and "just the type of comments led me to assume I knew the person." Each of these perceptions presumes prior knowledge of the other person from communication cues or associated issue positions.

Multiple Regression of Influences on Accuracy

Because there were some significant correlations among the independent variables, a final summary stepwise multiple regression on accuracy was run, using only the individual-level measures, not the comment characteristic measures. Only mean total prior communication was a significant but weak predictor ($\beta = 0.22, p < 0.01$), explaining 4 percent of the variance ($F = 6.1, p < 0.01$), supporting only H2b.

Discussion

THIS STUDY EXAMINED THEORETICALLY DERIVED FACTORS that may influence the level of accuracy of attributions of authorship of comments in GSS sessions to explore whether using the technical anonymity feature in fact preserves social anonymity. The results (summarized in Table 3) provide empirical support for the notion that there is both a technical and social dimension to anonymity in CMC [84], in that GSS participants who attempted attributions of authorship of technically anonymous GSS comments were significantly more accurate than would be expected from chance guessing. We extend previous findings on social anonymity in GSS contexts (e.g., [30, 64, 76, 91]), which found that GSS participants were able, in many cases, to identify the gender or social status of technically anonymous contributors and challenges the proposition that "while some participants believe they can identify contributors, they cannot really know for sure, and experience has shown that such guesses are most often incorrect" [59].

With respect to the factors that influence the level of accuracy of authorship attributions of specific comments, the present findings showed mixed support for results

Table 3. Summary of Results

No.	Research question/hypothesis	Support
RQ1	Do people in technically anonymous conditions make accurate attributions of identity?	Yes
H1a	Attribution accuracy is positively related to vividness of comments.	No
H1b	Attribution accuracy is positively related to comment length.	No
H1c	Attribution accuracy is positively related to evaluative tone.	Yes
H2a	Attribution accuracy is positively related to length of prior group membership.	No
H2b	Attribution accuracy is positively related to the amount of prior communication.	Yes
H2c	Attribution accuracy is positively related to prior communication centrality.	No

from previous studies. For example, it affirmed studies that have shown that attribution accuracy can be positively influenced by social and content cues, in that comments with a more humorous evaluative tone were positively related to attribution accuracy. However, neither comment length nor vividness of the comments was significantly related to the accuracy of authorship attribution.

These results somewhat refute social presence and media richness theories that propose that text-based CMC carries insufficient social and nonverbal cues to develop accurate impressions about anonymous participants. Rather, the present results imply that text-based media may still carry substantial emotional and personal content [12, 46, 68, 88].

Based on results from this study, which used groups of size 3, 4, and 5, and from Hayne and Rice [30], which used groups ranging from 13 to 26 members, and using a variety of measures that controlled for group size, attribution accuracy is not primarily a result of having fewer, rather than more, other participants to choose among, though group size does play a role. Interestingly, no support was found for Carlson and Zmud's [10] concept of "channel expansion" with respect to anonymity, in that longer prior membership in a group, and thus supposedly greater familiarity with the social context of the communication, was not positively associated with authorship attribution accuracy. However, length of, and variance in, group duration was small.

Mixed results were also found in connection with prior communication within a group. Centrality in the group was not related to accuracy, though greater average total prior communication with other group members was positively related to authorship attribution accuracy. This may support Lea et al.'s [49] conclusion that a significant mediating influence on the effect of CMC on individual communication behavior is the development of a general group social identity, rather than changes in social cues through individual interactions.

Finally, the present study helps to clarify prior results in that it demonstrates that the accuracy of attributing authorship to technically anonymous GSS comments is

positively influenced by comments' humorous evaluative tone, and greater average prior communication with other group members (even controlling for the size of the group).

Limitations

A natural question is how frequent or intense would GSS participants' attributions of authorship of technically anonymous comments be without the stimulus of being asked to share their attributions through a survey? This study cannot address this question. There may be situations where the search for attributions would be more intense; that is, during high stakes (or high conflict) decisions and discussions, when rewards or consequences of participant contributions were high, in homogenous groups, in groups with strong norms toward consensus, or when participant status is a useful indicator of the implementability of a decision [85]. However, groups in such situations are not likely to invoke the technical anonymity feature of GSS because their discussions should be relatively free of conflict and biased comments. It is similarly possible that members of groups engaged in more consequential tasks, and with greater status inequality, than the ones studied here, engage in *more* frequent attributions.

At this point, our study can only suggest aspects of an overall GSS anonymity model that need to be more deeply understood. While our results are not definitive, they do raise and clarify some previous propositions about GSS anonymity [15, 59 82], shed light on the perplexing mixed results of anonymity in previous studies, and raise concerns about subtle consequences of the use of GSS anonymity features.

Implications for Practice

The results of this study suggest a number of implications for users, facilitators, and researchers of GSS.

Of primary consequence is that comments in technically anonymous GSS sessions—in both small (in this study) and large groups (in [30])—are not necessarily *socially* anonymous. Technical anonymity is not the same as social anonymity, because users may still be making attributions, and those attributions may be substantially accurate. It is thus conceptually plausible that for other groups (including possibly many in prior studies of GSS anonymity) with a salient task and prior history, GSS participants may well be quietly attempting to identify authors of technically anonymous comments. They would be using cues from the text of the comments (especially humorous ones) that may be identifiable on the basis of prior communication with group members. Of particular consequence is that attributions (whether accurate or inaccurate) may reduce or even thwart the presumed benefits of using the anonymity feature of a GSS. These benefits include reducing evaluations of comments based on the identity of the author, so that message content is the primary basis for decision-making (at least in the comment generation phase). The persistence or emergence of social anonymity means that one cannot always guarantee that these benefits will be achieved in technically anonymous GSS sessions.

Facilitators may recommend to their participants that they actively engage in changing their writing style, such as reducing humorous comments, as a first attempt at enhancing anonymity, if the task and group context would benefit from socially anonymous comments. But, perhaps more importantly, we suggest that groups be wary of *any* attributions they may make. Our results demonstrate that participants may be more accurate than technical anonymity presumes, and more accurate than chance guessing, but that many attributions are still wrong (and more so for larger groups). *Inaccurate* attributions seem a worse possibility than accurate attributions of anonymous comments, because the cues and bases for evaluation and decision-making would then be misinformed and misleading. These preliminary indications of (more or less accurate) attributions to authorship of anonymous comments are important because individual-level attributions affect future choices and judgments [14, 43, 44, 45, 89], which in turn affect an individual's contribution to the group process [60, 90]. Research has identified a variety of decision faults that can result from these biases and errors [5, 58, 70, 83]. For example, if participants inaccurately attributed a "bad" idea to one of the group's experts or "trusted" persons, this "bad" idea may find its way into the final decision process; conversely, a "good" idea misattributed to a newcomer may well be rejected. Such activities may explain some of the ambiguous findings on GSS decision quality [2, 54].

Future Research

The conceptualization and use of GSS anonymity in general, and attributions about technically anonymous comments in particular, appear to be complex enough to warrant further study. Returning to the six dimensions of anonymity noted at the beginning, these results have shown that the *mechanism* of anonymity (technical anonymity is not the same as social anonymity), the *domain* (message characteristics make a small difference), and *group demographics* (prior average communication with other group members) are all relevant.

Do our results generalize across other categories of *task?* In combination with the prior study [28], we have found similar results in both laboratory and field studies, MBA students and veteran administrators, simulated and salient tasks, and small and large groups. Still, users and groups may vary on a wide range of cultural and contextual factors (i.e., system literacy, voluntariness of use, desirability of visibility of individuals' participation, group protocols, group structure, composition, salient group processes, role models, nature and importance of tasks, goals, behavioral tactics, and time frame), often opposing the assumptions and features of specific GSS systems [1, 50, 56]. Although this study did test for the influence of *time* in terms of duration of group membership (though the variation in duration was small), it did not test for the differential influence of asynchronous or synchronous commenting on making attributions, or for decay in attribution accuracy over time.

This study did not address deception. Research on lying suggests that the detection of deception is dependent upon a variety of cues, both verbal and nonverbal (e.g., [17, 20]). The relative importance of these cues for accurate detection is dependent upon

the stakes (patterns of rewards and punishments) involved in the deception [23]. Verbal cues are most likely to betray deception in low stake situations, whereas nonverbal cues are more likely to betray deception in high stake situations [16]. The one study that we know about concerning deception in computer-mediated context is by Hollingshead [34]. Comparing pairs of students randomly assigned to dyads (where one had to present a position contrary to their own held position on four controversial issues), she found no difference in face-to-face versus CMC in a participant's detecting deception in the other's presentation of position, or in perceptions of how convincing the other was, regardless of the truthfulness of their position. What would happen to attribution accuracy if intentional deception were involved?

We did not explore participant's perceptions about anonymity. Perhaps self-reported measures can lead to deeper insight into the individual's perspective. Reliable scales need to be developed.

These issues raise four important theoretical and practical topics for future research. First, are participants quietly making attributions in the GSS context as prior research in many other contexts suggests? Second, what is the influence of attributions in general, and inaccurate attributions in particular, on *individual* evaluations of comments and decision-making choices in technically anonymous GSS settings? Third, what are the implications for *group* decision-making processes and outcomes? It may well be that due to varying levels of accuracy, individual variations in attribution frequency, mediation of the group process by the GSS, and low general influence of individual attributions on group decisions, the practical implications are in fact quite minimal. However, this study raises the empirical question. Fourth, to what extent have variations in social anonymity in prior technically anonymous GSS studies contributed to the overall *contradictory results* of such studies?

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Appendix A. Who-to-Whom Communication Matrix

THREE GROUP MEMBERS. S1 indicates communication with S2 "several times a week" and with S3 "once a day," and so on. 0 = never, 1 = once every few months, 2 = once a month, 3 = several times a month, 4 = once a week, 5 = several times a week, 6 = once a day, 7 = several times a day.

	S1	S2	S3
S1	*	5	6
S2	4	*	7
S3	6	6	*
Column total	10	11	13
Mean total communication	5.0	5.5	6.5

Appendix B

Simple Example Showing Accuracy Computations

TWO COMMENTS, THREE GROUP MEMBERS. According to M (master list of "who entered which comment"), A makes comment 1 and C makes comment 2. Suppose A attributes 1 to B and does not attribute 2 to anyone (A = B, 0). Suppose B attributes 1 to himself or herself and 2 to A (B = B, A). Suppose C attributes 1 to B and 2 to himself or herself (C = B, C).

	Attributed author			
Attributor	A	B	C	Accuracy
A	*	(1 – 0)/1 = 1	*	1.0
B	(1 – 1)/2 = 0	—	*	0.0
C	*	(1 – 0)/1 = 1	*	1.0

We could also compute a form of accuracy (NG, no guessing) that considers an unattributed comment as an inaccurate attribution; that is, if they could not attribute an author to a comment, which would be the same thing as being inaccurate. Under that formula, the accuracy figures would be as follows. However, we rejected this approach, as we did not request that respondents guess each and every comment, so accuracy should be assessed only using those comments that received attributions.

	Attributed author			
Attributor	A	B	C	Accuracy NG
A	*	(1 – 0)/1 = 1	(0 – 0)/1 = 0	0.5
B	(1 – 1)/1 = 0	*	(0 – 0)/1 = 0	0.0
C	*	(1 – 0)/1 = 1	*	1.0

Real Group Example: Data for Group 1, Session 6

M's record of authorship of 32 comments, and attributions made by A, B, C, or D as to authorship of those comments (see Table A1).

Accuracy Matrix

	A	B	C	D	Number correct	Number attributions	Accuracy
A	*	0.50	0.83	0.75	9	12	0.75
B	0.50	*	0.80	0.86	14	20	0.70
C	0.00	*	*	0.00	0	4	0.00
D	*	*	1.00	*	3	4	0.75

Note that participant D "misattributed" a comment to himself or herself that was actually written by participant C. This was the only comment that was misattributed this way in the entire data set.

* No value.

Table A1. Sample Authorship Matrix

M	B	C	A	D	B	C	D	B	C	D	A	D	C	B	D	B	C	D	C	B	C	D	A	C	C	B	D	B	C	C	A	D
A	0	C	B	0	B	0	D	0	C	0	A	0	0	0	0	0	0	0	0	0	C	D	0	C	C	D	C	0	0	0	A	D
B	B	D	A	C	B	0	A	B	A	D	A	D	A	B	D	B	C	0	0	B	C	D	A	C	0	B	D	B	A	C	A	D
C	0	C	0	0	0	C	0	0	0	0	0	0	0	0	0	0	C	0	D	0	C	A	0	C	C	0	A	0	C	C	0	A
D	0	C	0	D	0	C	D	0	0	D	0	D	0	0	D	0	0	0	0	0	0	0	0	C	D	0	D	0	0	0	0	D

Notes: M = master list of "who wrote what" by defeating technical anonymity feature after the session; A, B, C, D = group members.