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Abstract

Among the most researched solutions to social dilemmas is communication. Since the late 1950s, it has been well known that communication enhances cooperation in social dilemmas. This article reports a meta-analysis of this literature (forty-five effect sizes) and finds a large positive effect of communication on cooperation in social dilemmas (d = 1.01). This effect is moderated by the type of communication, with a stronger effect of face-to-face discussion (d = 1.21) compared to written messages (d = 0.46). The communication-cooperation relationship is also stronger in larger, compared to smaller, group social dilemmas. Whether communication occurred before or during iterated dilemmas did not statistically affect the communication-cooperation effect size. Results are discussed according to theory and research on communication in social dilemmas.

Keywords

social dilemmas, communication, cooperation, conflict, meta-analysis

> There is more than a verbal tie between the words common, community, and communication.
>
> John Dewey

Individuals often find their interests in conflict with what is best for their relationships, family, work organization, community, nation, and, perhaps most abstractly, their own

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species. These conflicts between individual and collective interest are referred to as social dilemmas and provide the foundation of many diverse societal problems, such as divorce, low wages, pollution, tax evasion, and overpopulation (Van Lange and Joireman 2008). Social scientists have long been working on solutions to social dilemmas. After roughly sixty years of research, no magic bullet has arrived in the arsenal for attacking such problems and resolving these conflicts. However, if there is any single solution that has harnessed the most support and reduced the most conflict, it must be communication between participants in the social dilemma.

In one of the earliest recorded studies of this effect, Deutsch (1958) found that a brief period of discussion prior to the social dilemma greatly improved cooperation. Since this seminal work, several studies have replicated the positive effect of communication on cooperation in social dilemmas (Bouas and Komorita 1996; Braver and Wilson 1986; Dawes, McTavish, and Shaklee 1977; Isaac and Walker 1988; Kerr et al. 1997; Orbell, van de Kragt, and Dawes 1988; Ostrom and Walker 1989; Scodel et al. 1959). There have been several explanations for this well-established effect, including expectations of others' cooperation, group identity, and norms. Interestingly, however, there have been relatively few reviews of this literature (for reviews, see Bicchieri 2002; Bicchieri and Lev-On 2007; Crawford 1998), especially quantitative meta-analytic reviews (for an exception, see Sally 1995).

Sally (1995) published the first meta-analysis of this literature and concluded that communication increases cooperation by 40 percent. Sally also discovered that communication exerted the strongest effect on cooperation, relative to other variables known to influence cooperation, such as group size, the magnitude of reward for defection, and group identity. Although Sally's quantitative review is commendable, there were several limitations to this review. Among the most prominent of these limitations is that Sally didn't conduct any moderator analyses on the communication-cooperation relationship. I address this gap in the literature and report what I believe to be the first meta-analysis of the communication-cooperation relationship that considers how specific study characteristics may moderate this relationship. Moderators can identify when communication is most important and may help address some of the underlying explanations for this well-established relationship. In the following, I briefly review social dilemmas and the communication-cooperation relationship and then discuss three potential moderators of that relationship.

Behavior in Social Dilemmas

Imagine being called and asked to donate money to public television. This caller has placed you in a social dilemma. This social dilemma has two defining properties (Dawes 1980; Kollock 1998; Komorita and Parks 1994). First, it is in each individual's best interest to defect or free-ride in the dilemma, for example, not donate to public television but still watch its programs. Second, if everyone acts according to their own best interests, then the entire group gets a worse outcome, for example, no public television to watch. The public television illustration is a classic step-level

public goods dilemma. In the step-level public goods dilemma, a group of individuals makes a decision to contribute money to the public good. The amount of money allocated to the public good must reach a specified level for the public good to be attained. Importantly, there is an impossibility of exclusion, such that anyone who does not contribute to public television can still watch its programs. Therefore, it is in each individual's interest to keep their money and still watch public television. However, there will be no public television if everyone acts this way. Another related dilemma is the resource dilemma, which models the use of many natural resources. In this dilemma, several individuals have an unlimited access to a common pool of resources and decide how much to harvest. The resource pool may be replenishable at a fixed rate over time. It is in each individual's interest to take as much as possible from the resource, but if everyone does this, then the resource becomes depleted and everyone is worse off, relative to a self-restrained and sustainable harvesting approach. These dilemmas, in combination with the prisoner's dilemma, are the most studied social dilemmas.

Of the three types of dilemmas, the prisoner's dilemma (PD) is the most studied dilemma, especially when considering the effects of communication on behavior in social dilemmas. In PD studies, two or more individuals are often simultaneously presented with a binary choice matrix. Most often, participants are set in separate rooms and not allowed to communicate when making their decision. The possible outcomes for an *n*-person prisoner's dilemma including six persons are shown in Table 1. In this example, the best individual outcome is attained by choosing to defect when the other five persons choose to cooperate. However, if everyone chooses to defect, then this results in a worse outcome, relative to when each individual chooses to cooperate. The prediction delivered by rational choice theory for behavior in a single trial PD game, both with and without communication, is that all players should choose to defect (Hargreaves Heap and Varoufakis 2004). However, research has consistently shown that this prediction is not supported by the data because a considerable percentage of individuals choose to cooperate (Sally 1995). This is especially true when individuals are allowed to communicate with one another prior to making their choices.

Communication and Cooperation

Early research on the prisoner's dilemma discovered that a brief discussion prior to an interaction increased subsequent cooperation in the dilemma (Deutsch 1958, 1960; Loomis 1959). Since this seminal work, much research has examined the role of communication in social dilemmas, extending the communication-cooperation relationship to other well-studied dilemmas, such as public goods dilemmas (Chen 1996; Chen and Komorita 1994; Wilson and Sell 1997) and resource dilemmas (Brechner 1977; Dawes, McTavish, and Shaklee 1977; Hackett, Schlager, and Walker 1994). This research has manipulated communication in several ways, including pregame discussion (Bouas and Komorita 1996; Dawes, McTavish, and Shaklee 1977), pretrial discussion during iterated dilemmas (Kerr et al. 1997), sending either standardized or

Table 1. A Six-Person Prisoner's Dilemma

	Number of people choosing to cooperate						
	0	1	2	3	4	5	6
Defect	4	8	12	16	20	24	—
Cooperate	—	0	4	8	12	16	20

open-ended messages (Chen and Komorita 1994; Betz 1991), continuous communication during the dilemma (Isaac and Walker 1988), discussion among subgroup members (Braver and Wilson 1986), e-mails (Frohlich and Oppenheimer 1998), and Internet chat groups (Zheng et al. 2009). One resounding conclusion emerges from this literature: opportunities to communicate with other participants in the dilemma increase cooperative behavior. Several explanations for the effect of communication include a better understanding of the game, increasing expectations of cooperation, enhancing group identity, and generating norms of cooperation (Kerr et al. 1997). However, research has identified group identity and norms as the most likely explanations (Orbell, van de Kragt, and Dawes 1988). More recently, however, Kerr et al. (1997) has cast doubt on the group identity explanation and forwarded norms as the mostly likely alternative. Given the amount of research generated on this topic over the past sixty years, it is interesting that only one systematic quantitative review has been conducted.

Sally's (1995) meta-analysis (1958-1992), however, included a few notable limitations. First, this article primarily considered research on the prisoner's dilemma. Second, Sally didn't consider a moderator analysis of the effect size distribution. Of course, it is important to understand the magnitude of the communication-cooperation effect, but it is equally, if not more, important to also understand the conditions when communication is more strongly or weakly related to cooperation. While Sally's work is respectable, the present study addresses the limitations of that article and extends the findings to the current state of the literature. Indeed, there have been many published works on the effect of communication since Sally's original article. However, the most novel contribution of this meta-analysis is to test for several moderators of the communication-cooperation effect size.

Moderators of the Communication-Cooperation Relationship

There are several potential moderators of the communication-cooperation effect size. Examining these moderators will provide insight regarding when communication is most effective in enhancing cooperation. Specifically, this study considers the moderating influence of three study characteristics: (1) the type of communication medium, (2) if the communication occurs prior to the dilemma compared to during the dilemma, and (3) the size of the group facing the dilemma.

Type of communication. Most generally, communication has been manipulated in social dilemmas as face-to-face discussion or sending written messages, either in the form of notes or via computer. Interestingly, there has been little work that systematically compares these two types of communication. The few studies conducted on this topic have resulted in inconsistent findings. Some research finds that face-to-face discussion increases cooperation, relative to email or written messages (Bos et al. 2009; Frohlich and Oppenheimer 1998; Lev-On, Chavez, and Bicchieri 2009; Rocco 1998; Rocco and Warglien 1996). However, other work finds that there is little to no difference between these two types of communication (Bochet, Page, and Putterman 2002; Bochet and Putterman 2009; Zheng et al. 2008, 2009). A meta-analysis is useful in resolving these inconsistent findings.

Precommunication versus continued communication. Not only do research methods vary in communication medium, but also at what time the communication occurs. In the standard dilemma without communication, participants are separated by rooms or cubicles and asked to make simultaneous decisions in the dilemma without communication. The social dilemma might occur only once or the dilemma can be repeated several times. This is typically the baseline condition when examining the effect of communication. In the communication condition, participants are either allowed to communicate (1) prior to the first trial with no subsequent communication; (2) prior to each trial, but no communication while making the decision; or (3) allowed communication before the first trail and unrestricted communication during all trials.

Again, there are inconsistent findings on the effect of pregame communication and continuous communication. Some studies find that after communication is removed there remains a strong effect of communication (Brosig, Ockenfels, and Weimann 2001; Radlow and Weidner 1966). In these studies, communication is allowed either before the dilemma or during the first several trials of the dilemmas. The results suggest that communication tends to increase and sustain cooperation after it has been removed. However, other research finds that when communication is removed, there is a decrease in cooperation several trials after communication (Frolich and Oppenheimer 1998). To illustrate, Voissem and Sistrunk (1971) find that communication before each trial of playing a two-person prisoner's dilemma resulted in greater levels of cooperation compared to communication before every ten trials or just communication before the first trial. Moreover, Ostrom, Walker, and Gardner (1992) report a series of studies that suggest that one-shot communication initially increases cooperation, but then cooperation may reduce after several trials, while repeated communication keeps cooperation rates exceptionally high. Again, a meta-analysis is able to resolve these conflicting findings.

Group size. Research on the communication-cooperation relationship also varies the size of group in the dilemma. It may be possible that group size will moderate the effect of communication on cooperation. To date, no published research has directly examined this question in an experimental setting. However, at least one unpublished paper has found that communication increases cooperation in smaller groups, compared to larger groups, but only when communication is allowed before, and not during, the dilemma (Lubell et al. 2008). Observing any trends of the effect size across studies may provide a more powerful test exploring the moderating role of group size on the communication-cooperation effect size.

Method

Locating Studies

Most studies were found using various academic databases (e.g., PsycINFO, Econlit). The search words included *communication*, *discussion*, *cheap talk*, *cooperation*, *social dilemma*, *prisoner's dilemma*, *commons dilemma*, and *public goods dilemma*. Several studies were discovered by examining the citations in relevant review articles. Also, a few unpublished papers were found while searching the Internet. All attendees of the 12th International Conference for Social Dilemmas were contacted and solicited for any unpublished manuscripts or data. All studies were found using these methods.

Criteria for Selection

Several criteria were applied for selection of studies. First, all studies must manipulate some form of communication between participants in a social dilemma. Studies that did not manipulate communication but measured communication and related this to cooperation were excluded. Second, all studies that failed to have an adequate control group were excluded. Studies were required to compare a communication condition with a noncommunication condition. This excluded a few studies that considered a different form of communication as a comparison group. Third, studies had to measure cooperation in a social dilemma. Any study with an outcome variable that could not be strictly considered a social dilemma, such as the dictator's game, bargaining games, and trust games, were excluded. These criteria resulted in forty-five eligible effect sizes.

Coding Procedure

Type of communication: discussion versus writing. Most studies operationalize communication as either a discussion among players or sending written messages either via computer or paper. All studies that involved a written message were coded 1 (n = 12). Studies that allowed some form of discussion between participants were coded 2 (n = 32). There was one study that included both written and verbal communication. This study will be excluded from the analysis examining the effect of this moderator variable. In both conditions, communication could have occurred before or during the dilemma.

Communication before versus during the dilemma. Of course, all studies manipulated communication prior to cooperation. However, in studies that include several trials, there is variation in the extent to which communication is allowed during the several trials. Studies that only allowed individuals to communicate prior to the first trial of the social dilemma were coded 1 (n = 17). These experiments asked participants to communicate for a set period prior to the dilemma and then restricted communication while participants were actually making their choice. On the other hand, studies that allowed ongoing communication during the dilemma were coded 2 (n = 28). The continued

communication could include either a structured form of communication prior to each trial (e.g., a choice of sending one of several prewritten messages) or simply allowing participants to discuss with each other at any time their strategies or choices.

Group size. In this sample of studies, the groups facing the dilemma varied in size, from two to nine persons. The mode of group size is two persons ($n = 13$). Group size was coded as a continuous variable.

Effect Size: Computation and Analysis

The standardized mean difference (d) value is the measure of effect size used in the current meta-analysis. The d value is commonly used to examine the effect size of two-level independent variables on continuous dependent variables. In our analysis, the reported effect sizes are the mean differences in cooperation between a control group (no communication, coded 1) and experimental group (communication condition, coded 2). Positive d values indicate greater levels of cooperation in the communication condition, relative to a no communication condition.

The effect size distribution does not contain all studies in the population of studies examining the relationship between communication and cooperation in social dilemmas. In fact, several relevant studies lacked the statistical information necessary to be included in the analysis. Because a fixed effects model assumes the effect size distribution contains the entire population of studies, a mixed effects model is most appropriate for this analysis. A mixed effects model assumes that there is both systematic and random variation in the effect size distribution. Therefore, a random effects model is inappropriate, as this model assumes only random variation in the effect size distribution. However, one limitation of a mixed effects model, relative to fixed effects models, is that it may be too conservative and result in Type II errors (Lipsey and Wilson 2001). Therefore, any discrepancies between the results of a mixed effects model and fixed effects model will be reported.

All analyses adopt a Hedges and Olkin's (1985) approach to meta-analysis, as this approach allows for the consideration of moderators. Analyses were conducted using Comprehensive Meta-Analysis Software version 2.

Results

Analysis of Effect Size

The effect size and coding of each study is reported in Table 2. The results of the overall analysis demonstrate that the overall effect size distribution ($n = 45$) had greater variation than would be expected by chance alone, $Q(44) = 282.9$, $p < .001$. This suggests that a mixed effects analysis is appropriate. Overall, communication had a significant large positive effect on cooperation in social dilemmas, $d = 1.01$, 95% confidence interval (CI), lower limit (LL) = 0.82, upper limit (UL) = 1.20.[1] Because most all studies included in the analysis are published studies, it may be that there is a

publication bias in the effect size distribution. Orwin's (1983) fail-safe *N* is calculated, which estimates the total number of insignificant findings needed to reduce the estimated average effect size to nonsignificant (d = .1). Orwin's fail-safe *N* is 286. According to Hedges and Olkin (1985), to assure confidence in the results, Orwin's fail-safe *N* should be five times the number of studies (here, 5 × 44 = 220), plus ten (220 + 10 = 230). Therefore, the current analysis seems robust against finding a number of unpublished nonsignificant findings.

There are a few outliers in the overall analysis. Two studies had exceptionally large effect sizes. Therefore, the estimated effect size is considered while removing these two studies from the overall analysis. Again, the effect size distribution demonstrated greater variation than would be expected by chance, $Q(41) = 200.4$, $p < .001$, and communication had a significant large positive effect on cooperation, $d = .92$, 95% CI, LL = 0.76, UL = 1.07. For this analysis, Orwin's fail-safe *N* is 268. This analysis is also robust against finding several unpublished nonsignificant findings.

Moderator Analyses

Given that the distribution of effect size contained two outliers, the following moderator analyses will be reported both with and without these outliers.[2]

Type of communication. Two types of communication were coded: talking and written messages. Overall, the effect of communication is stronger in the talk category, d = 1.21, 95% CI, LL = 0.98, UL = 1.44, relative to the written message category, $d = .46$, 95% CI, LL = 0.25, UL = 0.67, $Q(1) = 22.35$, $p < .001$. Without the outliers, the effect of communication is still stronger in the talk category, $d = 1.07$, 95% CI, LL = 0.89, UL = 1.3, relative to the written message category, $d = .46$, 95% CI, LL = 0.25, UL = 0.67, $Q(1) = 18.56$, $p < .001$.

Discussion before versus during the dilemma. While considering the relationship between communication before or during the dilemma in only the iterated games, there is no statistical difference between the impact of communication during the dilemma, $d = 1.13$, 95% CI, LL = 0.83, UL = 1.43, relative to before the dilemma, $d = .87$, 95% CI, LL = 0.67, UL = 1.08, $Q(1) = 1.92$, $p = .17$. When excluding the outliers, communication during the dilemma, $d = .95$, 95% CI, LL = 0.72, UL = 1.19, is not statistically different than communication before the dilemma, $d = .87$, 95% CI, LL = 0.67, UL = 1.08, $Q(1) = .24$, $p = .63$.

Group size. Group size in the dilemma was coded as a continuous variable and used in a meta-regression as the predicting variable. Including the outliers, group size has a significant positive relationship with the effect size, slope = .033, $Z = 1.96$, $p = .05$. When excluding the two outlier studies, group size had a marginally significant positive effect on the overall communication-cooperation effect size, slope = .032, $Z = 1.87$, $p = .06$.

Discussion

In this meta-analysis, communication had a strong positive effect on cooperation in a broad range of social dilemmas. Two moderating variables of that effect were identified. First, face-to-face discussion enhanced cooperation more than written messages.

Table 2. Studies Used in the Meta-Analysis

Study	*N*	DV	MESS/ TALK	B/D	G#	OS/IT	*d*
Betz (1991)	40	PD	MESS	D	2	IT	0.87
Bixenstine, Levitt, and Wilson (1966)	96	PD	TALK	D	6	IT	0.59
Bohnet and Frey (1999)	85	PD	TALK	D	4	O	0.87
Borenstein (1992)	180	IPD/IPG	TALK	B	6	O	1.76
Bouas and Komorita (1996)	160	GS	TALK	B	4	O	1.85
Braver and Wilson (1986)	126	GS	TALK	B	9	O	0.32
Brechner (1977)	72	TS	TALK	D	3	IT	0.70
Brosig, Ockenfels, and Weimann (2001)	40	GS	TALK	B	4	IT	2.53
Caldwell (1976)	50	PD	TALK	D	5	IT	1.67
Chen (1996)	256	GS	TALK	B	5	IT	0.99
Chen and Komorita (1994)	120	GS	MESS	D	5	IT	0.34
Clark, Kay, and Sefton (2001)	80	PD	MESS	D	2	IT	0.51
Dawes, McTavish, and Shaklee (1977)	284	TS	TALK	B	8	O	1.13
Dawes, van de Kragt, and Orbell (1988)	36	GS	TALK	B	9	O	1.14
Study 2	112	GS	TALK	B	7	O	0.89
Deutsch (1958)	270	PD	MESS	B	2	O	0.31
Deutsch (1960)	270	PD	MESS	B	2	O	0.27
Duffy and Feltovich (2002)	60	PD	MESS	D	2	IT	0.47
Frohlich and Oppenheimer (1998)	85	PD	TALK	D	5	IT	8.37
Goren and Bornstein (2000)	120	IPD	TALK	D	6	IT	0.71
Isaac and Walker (1988)	40	GS	TALK	D	4	IT	1.61
Study 2	64	GS	TALK	D	8	IT	1.41
Jensen et al. (2008)	68	PD	TALK	D	2	IT	1.34
Jerdee and Rosen (1974)	100	PD	TALK	D	5	IT	0.73
Kerr et al. (1997)	173	GS	TALK	B	5	IT	0.70
Study 2	151	GS	TALK	B	5	IT	0.76
Kerr and Kaufman-Gilliland (1994)	441	GS	TALK	B	5	IT	0.85
Kinukawa, Saijo, and Une (2000)	60	GS	TALK	D	6	IT	12.09
Liebrand (1984)	152	TS	TALK	D	6	IT	0.35
Marwell, Schmitt, and Shotoloa (1971)	40	O	TALK	D	2	IT	1.90
Mermin (1976)	190	PD	TALK	D	3	IT	1.24
Orbell, van de Kragt, and Dawes (1988)	512	GS	TALK	B	7	O	0.94
Ostram and Walker (1989)	64	GS	TALK	D	8	IT	3.46
Study 2	48	GS	TALK	D	8	IT	1.59
Polzer, Milton, and Gruenfeld (2009)	94	GS	TALK	B	6	IT	0.53
Study 2	57	GS	TALK	B	3	IT	0.71
Radlow and Weidner (1966)	64	GS	MESS	B	2	IT	1.10
Swingle and Santi (1972)	54	O	MESS	D	2	IT	1.48
Tazelaar, Van Lange, and Ouwerkerk (2004)	134	GS	MESS	D	2	IT	0.31
Study 2	94	GS	MESS	D	2	IT	0.66
Voissem and Sistrunk (1971)	96	PD	MESS	D	2	IT	0.62
Wichman (1970)	88	PD	TALK	D	3	IT	1.26
Wilson and Sell (1997)	144	GS	MESS	D	6	IT	−0.14
Zheng et al. (2008)	67	GS	MESS + TALK	D	2	IT	1.07
Zheng et al. (2009)	38	GS	TALK	D	2	IT	1.06

N = number of participants in study, GS = give-some game, TS = take-some game, PD = prisoner's dilemma, IPD = intergroup prisoner's dilemma, O = other, TALK = allowed talking as form of communication, MESS = allowed written message as form of communication, B = allowed communication before the dilemma, D = allowed communication both before and during the dilemma, G# = group size in the dilemma, OS = one-shot dilemma, and IT = iterated dilemma.

Second, the communication-cooperation relationship is stronger in larger, compared to smaller, group social dilemmas. Finally, repeated communication during iterated dilemmas did not have a statistically larger communication-cooperation effect size, compared to only pregame communication. These findings have several practical and theoretical implications.

Communication Medium

Today, much communication is computer-mediated. We often find ourselves maintaining contact with colleagues, family, and friends via the Internet. Even communication that sustains international relations may occur online or via written messages. These ongoing relationships are certainly not immune to encountering social dilemmas. If a colleague of a current project is not responding to emails or is perceived to not be engaging effort into a specific project, these actions may be construed as free-riding on others' contribution to the project. In this case, should a frustrated collaborator send another message via email or should the collaborators meet and talk about the problem? The current findings suggest that talking about the problems will facilitate greater coordination of efforts and enhance cooperation. Indeed, face-to-face discussion in a social dilemma increased cooperation more than written messages. There are several reasons why this may occur.

First, face-to-face communication is more dynamic and fluid than electronic computer-mediated communication and allows individuals to more accurately address the important issues and concerns raised in social dilemmas. In face-to-face discussions there are more salient norms and rules of communication that allow issues to be addressed more accurately and effectively, for example, sequential discussion. An individual can raise a concern or idea and expect the other to address those thoughts. However, many forms of computer-mediated communication do not follow these norms of discussion. Therefore, some concerns of individuals may not be addressed by others in the group and this may inhibit the formation of cooperative relationships. Second, other social cues, such as eye gaze, sound, and touch, are often unavailable in written messages or communicating via the computer. These subtle cues might communicate the sincerity of others' commitments in the dilemma (Bicchieri and Lev-On 2007). Indeed, only being able to see the other in the dilemma tends to increase cooperative behavior (Boone, Declerck, and Suetens 2008; Kurzban 2001; Wichman 1970). However, Wichman (1970) found while only hearing the other can raise cooperation to levels observed in conditions when individuals are able to both see and hear the other, simply seeing the other only slightly increases cooperation relative to a control condition. These studies suggest that certain cues are being subtly sent when individuals are able to nonverbally communicate with each other that is not being captured in written message or some forms of computer-mediated communication.

A third possibility is that face-to-face discussion, compared to written communication, is more likely to activate the social norm of promise keeping, which would subsequently increase levels of cooperation (Bicchieri and Lev-On 2007). Bicchieri (2002) proposes that the effects of discussion on cooperation in social dilemmas can

be explained by the presence of the social norm of promise keeping. This social norm is a rule that individuals use to direct their behavior in specific situations. Bicchieri states that this norm directs behavior only when people expect others to cooperate in the dilemma. Bicchieri and Lev-On (2007) suggest that the social norm of promise keeping is more salient in face-to-face discussions, relative to computer-mediated communication, which lacks some of the situational features that make salient the norm of promise keeping. For example, computer-mediated interactions provide few social cues that can be used to evaluate the credibility of others' promises. They also indicate a lack of leadership in online communication as an important difference that can affect the norm of promise keeping. In line with this perspective, Orbell, van de Kragt, and Dawes (1988) noticed that groups with strong leaders resulted in a greater number of promises to cooperate and this actually resulted in greater levels of cooperation. Clearly there is a need for more research that systematically explores the different communication mediums and their effects on cooperation. This research will undoubtedly contribute to our understanding of why communication matters and will result in practical solutions to enhancing the effectiveness of communication.

One salient practical implication of these current findings addresses the complications of communication in long distance relationships. For example, when several individuals or groups are interacting via long distance, such as the UN or multinational organizations, it is important that communication occurs face to face, compared to emails or written messages, to discuss efforts and contributions toward superordinate goals. In the absence of face-to-face discussion there might be a collapse in effort by particular members and this may spread to reduce the effort by others. However, it might be of concern that face-to-face discussions are costly, time-consuming, and, if international, promote pollution of the environment through more extensive air travel. Ostrom, Walker, and Gardner (1994) find that the cost of communication can pose a second-order public goods dilemma. It's in each individual's self-interest not to pay for communication but to enjoy its benefits, but if everyone fails to pay for communication, then this doesn't occur and no one enjoys the rewards of communication. One effective way of resolving this second-order dilemma is identifying less costly forms of communication. Importantly, at least one study has demonstrated that a video conference is as effective as face-to-face discussion in facilitating cooperation (Brosig, Ockenfels, and Weimann 2001). Also, Jensen et al. (2008) find that communication over the phone increases cooperation more than both text chat and no communication, but this communication medium was not compared to face-to-face interactions. Therefore, two less costly communication mediums, video conference and the telephone, which are found to increase cooperation more than written messages, may be considered while sustaining discussion in ongoing dilemmas for multinational organizations.

Pregame Versus Continuous Communication

This meta-analysis did not find support for the hypothesis that when individuals are engaged in an iterated social dilemma, then continuous communication is more

effective at increasing cooperation relative to just preplay communication. Earlier research has resulted in mixed findings on this topic. While some studies show that communication before several iterated trials of a dilemma results in sustained cooperation after communication is removed (Brosig, Ockenfels, and Weimann 2001; Radlow and Weidner 1966), other studies find that after communication is removed, then there is a decrease in cooperation (Frolich and Oppenheimer 1998), especially compared to a continued communication condition (Ostrom, Walker, and Gardner 1992; Voissem and Sistrunk 1971). The current results bolster the findings that communication can have a sustained effect on cooperation after it has been removed. Indeed, while only considering the iterated dilemma studies, there was no statistical difference between when the discussion occurred, either before or during the dilemma, in the communication-cooperation effect size. It might be that communication prior to the social dilemma generates a personal norm of cooperation (Kerr et al. 1997) or a social norm of promise keeping (Bicchieri 2002), which may subsequently increase propensities to cooperate even in the absence of communication or oversight from others. Jerdee and Rosen (1974) observed higher levels of cooperation while communication was allowed during the dilemma and suggest that it was due to individuals sending "counter reinforcers," such as social approval or disapproval. Similarly, other researchers have noted that participants often communicate disapproval of others' defection in dilemmas and that this may potentially explain the effectiveness of communication (Frohlich and Oppenheimer 1998; Ostrom and Walker 1988). However, the current results suggest that it is not necessary for others in social dilemmas to send "counter reinforcers," such as praise or disapproval, in response to a partner's cooperation or defection, respectively. Alternatively, after communication, individuals might have greater anticipated positive and negative emotions in response to thoughts of cooperation and defection. It might be that the norms mentioned previously are in part sustained and influence behavior because of their effect on anticipated emotions. Indeed, Miettinen and Suetens (2008) recently found that individuals experienced more guilt in response to their defections when these defections were unilateral and occurred after a mutual agreement to cooperate. As these researchers mention, communication might establish a prosocial norm that subsequently affects anticipated guilt regarding a choice to defect. Future research exploring the communication-cooperation relationship will benefit by examining the effect of communication on both anticipated and experienced emotions (e.g., guilt, shame, anger, gratitude, and joy) in response to both own and other's cooperation and defection. Beyond simply provoking several theoretical questions, these findings have some exciting practical solutions to effectively dealing with iterated social dilemmas.

These results have several positive implications for individuals and groups in sustained relationships that repeatedly encounter social dilemmas. For example, communication is costly for many international organizations or groups that interact repeatedly while facing social dilemmas. These findings suggest that repeated communication may not be necessary while engaged in any one particular organizational project. Therefore, international organizations may be able to establish one face-to-face meeting prior to the beginning of any single project and then might consider

sustaining communication on project progress via email or other forms of less costly and time-consuming forms of communication.

While promoting this finding, it is important to note that there are some limitations in the current analysis to test this relationship. The effect might only occur for studies that include several iterations, perhaps more iterations than what were captured in most studies in this meta-analysis. The mode of iterations in the current sample of studies is 10 iterations (n = 15). However, there were several studies that observed behavior in more than 10 iterations (n = 18), and these studies ranged from 12 to 101 iterations. Conducting the same analysis on only the 10 plus iteration studies still fails to find a statistical moderation effect. However, this analysis suffers low power and might be at risk of resulting in a Type II error. Future meta-analyses that have a greater range of iterated studies will be in a better position to examine this relationship.

Group Size, Communication, and Cooperation

Group size has a positive effect on the communication-cooperation relationship. As group size increased, communication becomes more effective at enhancing cooperation, relative to a no communication condition. Why does group size moderate this relationship? I speculate on two explanations. First, it is well known that as group size increases, cooperation declines (Hamburger, Guyer, and Fox 1975; Olson 1965). It is possible that group size reduces cooperation in the no communication condition, but communication buffers the negative effect of group size and retains levels of cooperation in the communication condition similar to those observed in communication conditions with small groups. One explanation for reduced cooperation in larger groups is a lower perceived sense of individual and collective self-efficacy (Kerr 1989). Perhaps communication enhances an individual's perceived self-efficacy. Similarly, during communication if all or most participants promise to cooperate, then an individual may sense that their contribution is critical to attaining the public good (van de Kragt, Orbell, and Dawes 1983). While dilemmas research implicates self-efficacy and perceived criticalness as potential proximate mechanisms underlying this relationship, an alternative theory speculates on possible distal causes.

Evolution and costly signaling theory provide an alternative account of this relationship. From this perspective, individuals would be more inclined to express their willingness to cooperate in group discussion and to actually cooperate more as the group size increases (Smith and Bliege Bird 2000). In short, these authors argue that in the evolution of our species, there was likely selective pressure for an adaptation to discriminate among contexts that provide the opportunity to send "efficient" signals that a person is generous and a good relationship partner. One way to improve efficiency in signaling is for an individual to only signal to others their generosity when a large number of potential receivers are present. If this is correct, then individuals would be more inclined to make explicit commitment to cooperate during larger, compared to smaller, group discussions prior to the dilemma. When there are a greater number of commitments or promises from group members, then the individuals in that group are more likely to cooperate (Orbell, van de Kragt, and Dawes 1988). Future

research examining the costly signaling perspective might consider how group size interacts with communication to predict the likelihood of expressing commitments of contributing to the public good and how continued communication affects the promise-behavior relationship. The present findings certainly give credibility to further study of the interaction between group size and communication predicting cooperation.

There is, however, a limitation in the current meta-analysis examining the effect of group size. The mode of studies included in this analysis is a two-person interaction (30 percent of the studies). The largest group sizes were two studies including nine-person groups. Therefore, the studies included in this analysis may not have had enough larger groups to really provide a strong test of the overall interaction. Future research on the communication and group size interaction predicting cooperation in social dilemmas will benefit by observing behavior in larger group contexts.

Limitations and Future Directions

There are a few limitations to the current meta-analysis worth noting. First, there were a few outliers in the data set. In these studies there was almost unanimous defection in the noncommunication condition and unanimous cooperation in the communication condition. These studies certainly demonstrate the power of communication in social dilemmas. However, they may also strongly influence the moderator analyses and potentially bias the estimate of the overall effect size. All analyses were reported with and without these outliers to make clear any significant discrepancies in the interpretations of these analyses. Future meta-analyses, which will include more effect sizes, will be in a better position to handle the influence of these outliers. Second, as is usual in meta-analyses, there were several studies that were unable to be included due to a lack of required statistical information. Third, this study didn't include the few studies that measured, and so did not manipulate, communication. The analysis was limited to studies that only compared communication to a highly controlled noncommunication condition. Fourth, there were not enough studies to examine several other possible moderating variables, such as type of dilemma, the index of cooperation in the dilemma, and the percentage of prosocials in the dilemma. For example, I was interested in examining if communication would be more effective in prisoner's dilemmas with greater conflict between individual and collective outcomes (Boone, Declerck, and Suetens 2008). Rapoport's (1967) index of cooperation (k value) conveniently quantifies this level of conflict on a value ranging from 0 to 1. However, there were too few studies that permitted calculation of this value. Future meta-analyses may be in a better position to consider these other possible moderators.

Conclusion

One of the earliest findings in the social dilemma literature is that communication enhances cooperation. The current meta-analysis confirms these earlier findings and

John Dewey's idea that there is a meaningful relationship between communication and community. Indeed, communication has a strong positive effect on cooperation in social dilemmas. However, this effect is moderated by aspects of the study design, such as group size and communication medium. Future research exploring the several possible explanations for these findings will make notable contributions to understanding the communication-cooperation relationship and the development of solutions to the pervasive problems posed by social dilemmas.

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Notes

1. The overall effect size can also be reported as a correlation, $r = .49$, 95% confidence interval (CI) LL = .40, UL = .57.
2. Frohlich and Oppenheimer (1998) and Kinukawa, Saijo, and Une (2000) report effect sizes, $d = 8.37$ and $d = 12.09$, respectively, that are outliers in the current distribution of effect sizes. Each study has a communication condition where participants are allowed to discuss in groups of five or six people their strategy during a paid iterated dilemma. They each have relatively low sample sizes, eighty-five and sixty, respectively. In both studies, the communication condition resulted in almost unanimous cooperation with exceptionally small amounts of variation. Also, in both studies, the no-communication conditions resulted in very little cooperation.

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