Modes of Communication[*]

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Abstract

The paper develops a theory of communication in which the sender's and receiver's motivations and abilities to communicate and process information endogenously determine the communication mode and the transfer of knowledge. In contrast with the economic literature, which focuses on the (mostly costless) transmission of soft and hard information, it models communication as a moral-hazard-in-team problem, in which the sender and receiver select persuasion and message elaboration efforts. The paper shows how strategies and outcomes depend on whether the receiver needs to absorb the content in order to act (executive decision-making) or uses the information only in order to assess the merits of alternative decisions (supervisory decision-making). The model is then shown to provide a rich set of insights concerning: (i) the impact of incentive alignment on communication strategies; (ii) the relative influence and the complementarity/substitutability between issue-relevant communication and cues (information that relates to the credibility of the sender rather than to the issue at stake); and (iii) the path-dependency of communication.

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1 Introduction

Communication, whether in organizations, personal relationships, politics or public information campaigns, is one of the most complex and strategic activities of human beings. It may have limited effectiveness for two interacting reasons. The first obstacle to effectiveness is the *lack of congruence* between the sender (source, persuader, speaker) and the receiver (recipient, addressee, listener). As many contributions have emphasized, the latter is unlikely to trust the former' s statement or recommendation if their interests diverge.

The second obstacle is also widely recognized, but has not yet been embodied into economic modeling. The acts of formulating and absorbing the content of a communication are privately costly, and so *communication is subject to moral hazard in team* (à la Holmström, 1982):

• As academics know too well, the sender must expand time, attention and other resources to communicate effectively her knowledge. Because the same message may convey different meanings to different receivers, the sender must address the receiver's knowledge (absorptive capacity, language, perspective). Similarly, the message should not be so concise as not to convey the relevant information, but should also not include information that is redundant, or irrelevant or else well-known to the specific audience, so as not to distract attention or discourage absorption.

• Conversely, the receiver must pay attention, decode, understand, and rehearse the acquired knowledge. He must decode the literal meaning, and, like the sender, take the properties of the other side into account in order to make a proper inference of what the intended meaning is.

In a nutshell, "it takes two to communicate". Senders complain that receivers fail to listen or pay attention, and receivers gripe about the senders' lack of preparation or clarity. Moral hazard in team occurs even when the sender and the receiver form a "team" in the sense of team theory,[1] that is when their preferences are perfectly aligned in terms of decision or outcome.

Economic theory has ignored the moral-hazard-in-team aspect of communication because it has focused on the two polar cases of soft and hard information. By definition, soft information cannot be substantiated, and so its validity can never be assessed by the receiver. It is just cheap talk.[2] By contrast, the literature on hard information looks at information that can be verified by the receiver, but it usually assumes that its disclosure and its absorption are both

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[1] See, e.g., Marshak-Radner (1972), Sah-Stiglitz (1986), Radner (1992), and Bolton-Dewatripont (1994).

[2] The fact that talk is cheap does not mean that it has no economic impact. Indeed, sizeable literatures in game theory and the economics of organization have identified the circumstances under which cheap talk differs from no talk. Some of these contributions allow for costly signalling. The corresponding costs, though, are not communication costs per se. For example, a lobby saying that it wants policy A may burn money or time in order to signal that it really wants policy A; but the mere act of indicating a preference for policy A is basically costless.

costless (and so the only possible form of gaming is the retention of information by the sender).

In practice, though, information is often neither soft nor hard. It's in between. And, importantly, its degree of softness is endogenous. Suppose that you are being presented with a new math theorem (the validity of which you have no particular reason to be confident in or doubt) and its thirty-page proof. If you have only one minute to look at it, or if you have little knowledge of mathematics, or if you are not interested, or else if the proof is "unreadable", the information contained in the paper is soft information. That is, to build an opinion as to whether the theorem is correct, you will assess the author's ability to prove such a theorem or her incentive to produce and circulate a sloppy or wrong proof, but the text won't be of much help to you. By contrast, the information contained in the paper becomes harder as your ability, time and motivation to understand the proof increase and as the author has put more effort in drafting it.

The theory of communication developed in this paper embodies both obstacles, imperfect congruence and moral hazard in team. A sender (S) is endowed with information that is relevant to the decision maker, the receiver (R). The communication's informativeness increases with the sender's communication effort and with the receiver's attention effort, as well as with exogenous factors such as the commonality of the two parties' background, language or references. For simplicity, we assume that the two efforts jointly determine the probability p that the sender's information is properly assimilated by the receiver (is hard); with probability $1 - p$ the information remains soft.[3] (More generally, the coarseness of the receiver's post-communication partition could be a stochastic and monotonic function of the two efforts).

The effectiveness of communication then hinges on *the alignment of the parties' objectives*. As one would expect, R exerts less effort to understand S's message when he has less of a "stake" in their joint project. First, R is then less likely to make use of or to benefit from the information when he understands it. For example, a politician is less likely to try to understand the rationale behind some economic advice if he knows that the corresponding policy would be unpopular anyway, and so that he would be unlikely to adopt the policy even if he were convinced by the argumentation. Similarly, individuals are unlikely to listen to advice or communication campaigns that create dissonance and will rather look for distractions or even refuse to listen. Second, when the two communication efforts are strategic complements, R knows that S, anticipating this, will herself put less effort to clarify the argument and to take R's perspective. This

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[3]The soft information model thus corresponds to the case in which p is always equal to 0. The hard information model is one in which, say, $p = 1$ if the sender exerts any arbitrarily small but positive effort (discloses the information), and $p = 0$ if she exerts no effort (withholds the information).

further discourages R from trying to absorb the content, and so forth.

The strategies and outcome of communication also depend on what use R is to make of the information. Under *supervisory decision-making* (or approval decision-making), R uses the information received solely to assess the appropriate course of action. Communication does not affect payoffs associated to policies and only serves to help R assess the merits of alternative choices. By contrast, *executive decision-making* (or implementative decision-making) refers to a situation in which R must effectively understand S's knowledge in order to implement the policy.[4]

Returning to our math theorem illustration, a journal editor and the referees engage in supervisory decision-making when deciding whether to accept the paper or ask for a revision.[5] By contrast, colleagues wanting to generalize the theorem probably need to fully understand its proof . The distinction between the two forms of decision-making applies more generally to most realms of economic life. Many decisions are of a supervisory nature: The politician chooses a policy, the retail investor decides whether to follow the analyst' s buy/sell recommendation, the consumer reacts positively or remains unconvinced by the advertising/public information campaign, by the art critic or the salesperson. However, when the "policy choice" is only a broad orientation and a thorough understanding is needed for a proper implementation of the policy, decision-making acquires an executive nature. The computer programmer or chess player must assimilate his mentor's lesson. The subordinate whom the boss delegates a task to must understand the boss' objective and the question at hand. Decision-making may also acquire an executive nature when a manager must put together different pieces of information as different components may not fit together even if they pass muster individually; and when R does not implement the policy himself but must stand ready to provide proper arguments to a board of directors, colleagues or other third parties whose support he needs to secure.

The nature of decision-making matters because effective communication is more likely under executive decision-making. In fact, under supervisory decision-making, R may suffer from an increase in congruence between him and S, as S then takes R for granted and no longer bothers to carefully document her recommendation.

This paper builds on literatures on communication in economics and psychology. As we will see, it is most closely related to the latter.

Relevant economic literature: We already discussed the relationship of this paper with the liter-

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[4]This terminology is inspired by the distinction between supervisory boards, which rubberstamp or oppose managerial decisions, and executive boards, that are composed of managers actively running the firm.

[5]In the extreme, a journal editor who would fully trust the author's ability, diligence and honesty, could accept the paper without reading it and sending it to referees.

atures on soft and hard information. Another relevant strand of the economic literature is team theory. This literature analyzes the impact of communication failures (see Marschak-Radner (1972) or Sah-Stiglitz (1986)) or delays (see Radner (1992, 1993), Bolton-Dewatripont (1994) or Van Zandt (1999)) for the design of organization. We differ from this literature in three respects: First, team theory posits perfectly aligned preferences, while we allow for dissonant objectives. Second, team theory implicitly focuses on executive decision-making, while we also allow for supervisory decision-making, for which, given perfect congruence, members of an organization would otherwise eagerly follow whatever recommendation made by other team members, resulting in costless perfect communication. Third, in contrast with most of team theory, we endogenize communication failures and their determinants.[6]

Relevant psychological literature: Psychologists (see e.g. the books by Petty and Cacioppo (1981, 1986) and the paper by Chaiken et al. (1996)) also emphasize communication costs. Many theories of persuasion take a "dual mode" perspective: *issue-relevant messages* convey information that is directly relevant for the issue at stake; *cue messages* relate to the trustworthiness of the sender, but not to the issue. For example, Petty and Cacioppo distinguish between (i) the (often) more costly "central route" of persuasion, which requires "thoughtful consideration of issue-relevant argumentation" by the receiver and presupposes his "motivation and ability to process the message and think about the issue";[7] and (ii) the (often) less costly "peripheral route emphasizing issue-irrelevant cues" (expertise or attractiveness of the sender, credibility of her position given her personal stakes).[8] Because the central route is more effective and durable in terms of changing the receiver's attitude to the issue, the sender may face a tradeoff between these two routes. Petty and Cacioppo, as well as Chaiken (1980) stress that the two modes of communication, issue-relevant messages and cues, may coexist and may be complements or substitutes. For example, the attractiveness or general expertise of the sender can lead the receiver either to simply take for granted her argument (heuristic route) or instead to think very hard

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[6] Note the recent work of Meagher et al (1999) and Dessein-Santos (2002), that allows the quality of communication to be a choice variable. In our setup however, this quality results from individual choices.

[7] The view that communication requires effort on both sides and that in particular the sender needs to reduce the receiver's cost of absorbing the information is widely accepted in sociolinguistics too. For example, Grice (1975), on the premise that communication is intrinsically costly for both parties, states four maxims cooperative speakers must follow for maximum usability for their recipients: "(i) Be as informative as required, but not more so; (ii) say only what you believe is true and for which you believe you have adequate evidence; (iii) be relevant; (iv) avoid ambiguous or obscure expressions or unordered presentation." Such maxims however entirely focus on the recipient's benefit and ignore the communicator's two incentive problems, associated with the cost she incurs in maximizing usability and, in some circumstances, the desire *not* to maximize usability.

[8] The general idea of a dual mode of communication is shared by many authors. For example, Petty and Cacioppo (1981, pages 268 and 269) stress the similarity between their distinction and the distinctions between "deep" and "shallow" processing (Craik–Lockhart (1972)), "controlled" and "automatic" processing (Schneider–Shiffrin (1977)), or "thoughtful" and "scripted" or "mindless" processing (Abelson (1976), and Langer et al. (1978)).

about it, in which case the effectiveness of the systematic route is reinforced by issue-irrelevant factors. The latter reaction is however to be expected only when the receiver has a sufficient potential stake in the issue under scrutiny (the "high-involvement" condition).[9]

The paper's first objective is to develop a tractable model of communication, which we set up in Section 2. A number of interesting results emerge from the analysis. In particular, due to the moral-hazard-in-team nature of communication, a decrease in *any one* party's stake in the project or in the ease of communication leads to a decrease in *total* communication effort. In the presence of communication set-up costs, this can lead to a sudden and discontinuous breakdown of communication. Moreover, costly communication can give way to soft information transmission when the receiver's interest in the project becomes more closely aligned with the sender's. Consequently, an increase in congruence can hurt the receiver (while it always favors the sender).

Section 3 introduces "cues" that alter the receiver's assessment of the sender's credibility. It shows that "issue-relevant" communication can be either a substitute or a complement to the communication of cues. Cues that are "bad news" about the sender's credibility lower the intensity of issue-relevant communication. Issue-relevant communication intensifies when cues enhance sender credibility, except if this credibility rises so much as to allow her to exert "real authority", as in Aghion-Tirole (1997).

Section 4 considers various relevant extensions. It shows in particular how communication evolves over time as the parties learn about their respective stakes: first impressions matter, leading either to breakdowns of communication, or to virtuous circles of more intense communication. Moreover, communication efforts can be enhanced by one's desire to signal high personal stakes and thereby induce higher future effort from the other party.

Finally, Section 5 concludes.

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[9]Recently, Erb et al. (2002a,b) have argued that assimilating cues may in certain contexts require substantial cogitation, and that any element of information considered as potentially relevant by the receiver (be it issue-relevant or linked to the personality or expertise of the sender) will be treated with more or less intensity depending on the receiver's motivation and ability to process information, the intrinsic difficulty of processing this information and the order in which it reaches the receiver.

For example, assessing the quality of an anthropologist's CV may be rather straightforward for an anthropologist, but would require substantial work for an economist (figuring out the quality of journals, departments and co-authors, and the originality of the scholar's contributions).

To illustrate the latter point, note that when considering a tenure decision, one can spend more or less time thinking about the content of letters of reference that detail the (issue-relevant) research of the candidate or thinking about the (issue-irrelevant) credibility of the referees by going through their possibly very detailed personal webpages.

2 Collaborative communication

Let us begin with the simplest model.

(a) *Actions and payoffs.* There are two parties, the sender (S, she) and the receiver (R, he). The receiver, the decision-maker, chooses between a known status-quo option that yields payoff 0 to both, and an action A that, if implemented, yields payoff $s > 0$ to S. The receiver's payoff r from action A is either r_H or r_L, with $r_H > 0 > r_L$. Let α denote the ex ante probability of r_H. The parameter α, among other things, measures the alignment of the two parties' interests. The ex ante expected receiver payoff is positive if and only if

$$\alpha \geq \alpha^* \equiv \frac{-r_L}{r_H - r_L}.$$

The sender has technical information that, if assimilated by the receiver, tells the latter whether his payoff to A is low or high. We shall discuss in turn the case where the sender does not know the receiver's payoff (that is, she does not know whether her technical information makes A a good match for the receiver's interests) and the case where the sender does know the receiver's payoff.

As discussed in the introduction, two forms of decision-making are of interest:

Supervisory decision-making. Under supervisory decision-making, R does not need to understand the message in order to generate the payoffs attached to decision A. Rather, scrutiny helps R figuring out whether A is better for him than the status-quo.

Executive decision-making. Under executive decision-making, the receiver can implement action A only if he understands the sender's message (if he assimilates S's knowledge, if the information is made hard). Formally, the case of executive decision-making can be viewed as a special case of supervisory decision-making in which $r_L = -\infty$ (the receiver would never pick A without understanding it).

(b) *Communication technology*: The probability p that R assimilates S's knowledge is $p(x, y)$, where x and y are S and R's communication efforts. To illustrate our results in the simplest manner, we will assume that:

$$p(x, y) = xy.$$

Communication involves increasing and convex private costs $S(x)$ and $R(y)$ for the sender and the receiver, respectively, where $S'(1) = R'(1) = \infty$. We assume that S and R are continuous and differentiable on $(0, 1)$, but allow for potential set-up costs ($R_0 \equiv R(0^+) \geq 0$, $S_0 \equiv S(0^+) \geq 0$).

For now, we assume that S and R choose their efforts simultaneously and non-cooperatively. In particular, the sender's effort x is not observed by the receiver when choosing y. We will later allow part of the sender's effort to be observed by the receiver before the latter chooses y.

Due to the technology we posited, the communication game exhibits strategic complementarities: Each party is willing to try harder if the other also tries harder. The return from expending effort increases when the other party explains better or listens better.[10]

Strategic complementarities may give rise to multiple equilibria. In particular, there always exists a babbling equilibrium with zero effort levels: $x = y = 0$. In case of multiple equilibria, we will select the Pareto–dominant, highest-efforts one, and denote it by (x^*, y^*).

2.1 Sender does not know receiver's project payoff

(a) *Low congruence* $(\alpha < \alpha^*)$.

For $\alpha < \alpha^*$, even under supervisory decision-making, R does not select action A unless he becomes convinced that this action has payoff r_H to him. Put differently, S's recommendation of action A must be substantiated in order to have an impact. The sender's and the receiver's payoffs are: $U_S(x, y) = xy\alpha s - S(x)$ and $U_R(x, y) = xy\alpha r_H - R(y)$.

Either the equilibrium values (x^*, y^*) are given by

$$S'(x^*) = y^* \alpha s \tag{1}$$

and

$$R'(y^*) = x^* \alpha r_H; \tag{2}$$

or there is breakdown of communication $(x^* = y^* = 0)$. In the former case, let $\{x^*(\alpha), y^*(\alpha)\}$ denote the (highest) solution of $\{(1),(2)\}$. Then:

$$\frac{dU_R}{d\alpha} = [\frac{dx^*}{d\alpha}\alpha + x^*]y^* r_H.$$

An increase in congruence benefits the receiver in two ways: directly through the impact on his own payoff and indirectly through the increase in the sender's effort. This indirect effect would still be operative even if the direct effect were controled by lowering r_H as α increases so as to keep αr_H constant. Similarly, U_S increases with α through a direct and an indirect effect. Let α^{**} denote the lowest level of congruence α such that $U_R(x^*(\alpha), y^*(\alpha)) \geq 0$ and $U_S(x^*(\alpha), y^*(\alpha)) \geq 0$. We assume that $\alpha^{**} < \alpha^*$, and so the region in which communication occurs is non-empty even under supervisory decision-making.

(b) *High congruence* $(\alpha > \alpha^*)$.

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[10]Note that this assumption is not inconsistent with the idea that, *for a given success probability p*, one party can expend *less* effort the more effort the other party has expended. Strategic complementarity arises because p is endogenous and because higher effort by one party raises the marginal productivity of the other party's effort. Just like in a production function with capital and labor inputs, where a higher capital stock means lower employment for a fixed output but a higher profit-maximizing employment when more capital raises the marginal product of labor.

For $\alpha > \alpha^*$, the outcome depends crucially on whether decision-making is of the executive or supervisory type. In the former case, the equilibrium is still described by $\{(1),(2)\}$. In contrast, when the receiver does not need to assimilate the knowledge for A to be implemented, the sender has "real authority". It is a dominant strategy for her to pick

$$x^* = 0,$$

since (i) the sender's lack of information about the receiver's payoff implies that the receiver infers nothing when failing to assimilate knowledge,[11] and (ii) information can only lead the receiver to opt for the status-quo. And so

$$y^* = 0$$

as well.[12] The fact that the sender takes the receiver for granted when their interests are aligned and no longer bothers to "explain" action A's characteristics implies that the receiver's payoff decreases discontinuously with α at $\alpha = \alpha^*$. Figure 1 depicts the receiver's and the sender's payoffs under supervisory (solid curve) and executive (dashed curve) decision-making.
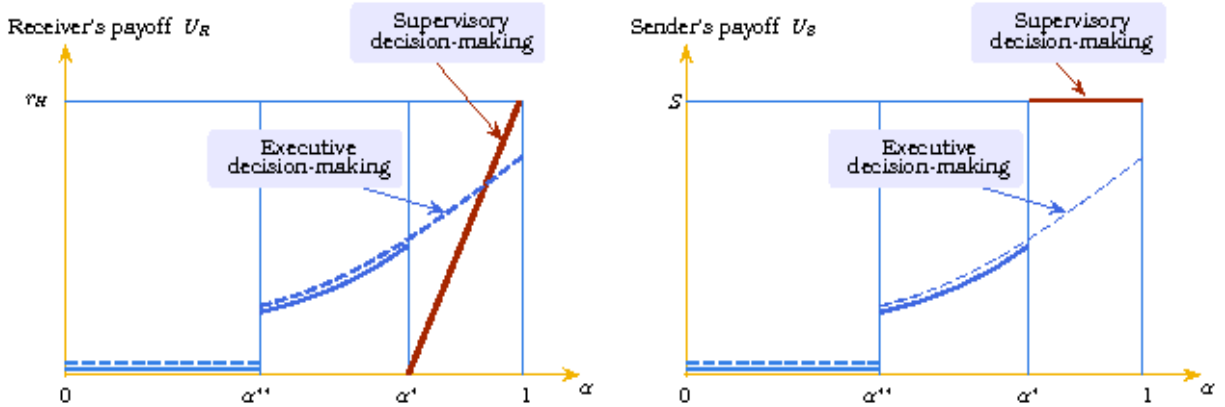

Figure 1

Proposition 1 summarizes the above discussion, and also performs comparative statics with respect to s,r as well as a "communication-enabling" parameter θ such that $S = S(x, \theta)$ and $R = R(y, \theta)$, with $S_{x\theta} \leq 0$ and $R_{y\theta} \leq 0$ and at least one strict inequality. For example $S_{x\theta} < 0$ if θ refers to pedagogical talent, $R_{y\theta} < 0$ if it refers to the receiver's absorptive capacity; and

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[11]This is the "no-signaling-what-you-don't–know" property of perfect Bayesian Equilibrium (see e.g., Fudenberg-Tirole 1991).

[12]A receiver whose affect impacts decision-making (e.g. who is reciprocity-driven) might want to retaliate to the absence of communication by not rubberstamping. This would result in more communication.

both $S_{x\theta} < 0$ and $R_{y\theta} < 0$ if it refers to the commonality of the two parties' cultures.[13] With these interpretations, a decrease in θ makes communication harder and reduces both x^* *and* y^*, possibly prompting a complete breakdown of communication.

Proposition 1 *When S does not know R's payoff, there exists a unique Pareto-dominant equilibrium, with payoffs summarized in Figure 1.*

(i) Under supervisory decision-making, an increase in congruence between S and R can lead to a breakdown of issue-relevant communication, because S can, for high enough congruence, count on R to "rubberstamp" her (costless) recommendation. An increase in congruence therefore raises the payoff of S monotonically but not that of R.

(ii) Under executive decision-making, the two payoffs increase monotonically with congruence.

(iii) When the equilibrium involves communication ($x^* > 0$, $y^* > 0$), then x^* and y^* jointly decrease as any of the three parameters r, s and θ decreases, and do so, if at least one party incurs a set-up cost ($R_0 > 0$ and/or $S_0 > 0$), until a threshold under which communication breaks down ($x^* = y^* = 0$).

Experiments in social psychology provide strong empirical support for Proposition 1. The literature on persuasion has in particular stressed factors that affect the receiver's ability or incentives to elaborate: (i) "As the personal relevance of a message increases, people become more likely to undertake the cognitive work of evaluating the issue-relevant arguments presented."[14] In the context of the model, y^* increases with r. (ii) Response involvement, the requirement that the person be later interviewed on the issue or explain the message to a friend, enhances message processing.[15] Response involvement can be viewed as raising the stake from r to $r + b$ where b is an extra "bonus" or reward for being able to perform properly in the subsequent presentation. (iii) Counterattitudinal messages have to be "stronger" to generate the same degree of acceptance.[16] (iv) On the cost side, distraction engages cognitive ability and reduces persuasion (for strong arguments; this is of course not the case for weak arguments, that contain

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[13]One important aspect of the commonality of cultures, investigated in Crémer et al. (2003), refers to the overlap of language and common references across cultures. This overlap may be endogeneous as in Lazear (1999)'s model in which multiple cultures co-exist and members of each culture decide whether to invest in the other culture's language in order to improve interaction.

[14]Petty and Cacioppo (1986, p. 87).

[15]Chaiken (1980). An exception arises when response involvement is so high that the subject is anxious about the later presentation and thereby distracted from information processing.

[16]Intuitively, the option value of assimilating the information is often higher when the receiver is predisposed toward the attitude supported by the message. Understanding a message that, among other things, transforms a negatively valued action A into a mildly positively valued one, carries little benefit for the receiver.

Another possible reason why people may pay little attention to counterattitudinal messages is that such messages may threaten the ego, and so "rational ignorance" (e.g. Carrillo-Mariotti (2000), Bénabou-Tirole (2002)) may prevail. Similarly, resistance may occur if the message is intimately linked to the receiver's central values. See e.g. Petty-Cacioppo (1986, pp. 61-63) for a review of experiments on counterattitudinal messages.

flaws).[17] (v) Last, in the realm of supervisory decision-making, a similar observation is that personal responsibility enhances the receiver's cognitive work. By contrast, group responsibility ("you'll be one of n evaluators, where $n > 1$") creates free riding or "social loafing".[18] Group responsibility can be viewed as reducing the stake r to λr where $\lambda < 1$.

2.2 Sender knows receiver's project payoff

Assume now that the sender knows whether the project is good or bad for the receiver, that is, whether $r = r_H$ or $r = r_L$. Clearly, the sender never exerts effort in the latter case, since there is no hope of convincing the receiver that the project is good.[19] Let x^* denote the effort exerted by the sender when $r = r_H$. Once again, we can distinguish two cases:

(a) *Low congruence* $(\alpha < \alpha^*)$

Because the sender exerts effort only when $r = r_H$, communication failure makes the receiver even more dubious about the value of the project, and so, for low congruence, the latter does not select action A. Equilibrium values of x^* and y^*, if an interior solution exists, are given by:

$$R'(y^*) = x^* \alpha r_H \tag{3}$$

$$S'(x^*) = y^* s. \tag{4}$$

There is thus a higher probability than earlier that projects that benefit the receiver go through since both x^* and y^* are higher, conditional on $r = r_H$, and a zero probability that bad projects go through.

(b) *High congruence* $(\alpha > \alpha^*)$

Under high congruence, equilibrium conditions are still (3) and (4) under executive decision-making. Under supervisory decision-making, the no-communication equilibrium where A is selected still exists: When $x = 0$, no information about project quality reaches the receiver. Another equilibrium may exist, though, in which the sender is obliged to exert effort because the receiver interprets a communication failure as a signal of low project quality. Put differently, an expectation by the receiver that the sender exerts effort when $r = r_H$ can be self-fulfilling.

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[17] E.g. Petty-Cacioppo (1986, p. 79).

[18] See, e.g. Petty-Cacioppo (1986, p. 90). Again, there are exceptions. When the task is interesting, group evaluation may stimulate effort; but this does not affect the basic insight, that lower personal interest leads to reduced cogitation.

[19] Note that R wastefully exerts effort in this case. When $r = r_L$, S is indifferent, since she knows she cannot induce decision A. She might therefore reveal that $r = r_L$ in order to save R the cost of y^*. This would not be the case however if there were a small probability that R misperceived r_L to be r_H. Then S would have a strictly negative incentive to tell R that $r = r_L < 0$.

Note also that a different form of inefficiency would arise if r_L were positive and x were observed by R before choosing y. Then S might overcommunicate (to raise attention) when $r = r_L$. And so, it might be in the interest of R to increase S's communication cost in order to better screen her (as in Avery-Meyer (2003)).

Denoting by x^* the sender's effort when $r = r_H$, and by y^* the receiver's effort, this equilibrium requires the receiver to prefer *not* to select action A when communication fails, that is,[20]

$$\frac{\alpha\left(1 - x^*y^*\right)}{1 - \alpha x^*y^*}r_H + \frac{1 - \alpha}{1 - \alpha x^*y^*}r_L \leq 0. \tag{5}$$

Optimal effort levels are characterized as when $\alpha < \alpha^*$ by conditions (3) and (4). For this equilibrium to exist, we need condition (5) to be satisfied, but this does not suffice: the receiver must get more by exerting effort y^* than by not exerting effort at all. (Global) optimality thus requires:

$$\alpha x^*y^*r_H - R(y^*) \geq \alpha r_H + (1 - \alpha)r_L, \tag{6}$$

or:

$$\alpha \leq \frac{-r_L - R(y^*)}{-r_L + r_H\left(1 - x^*y^*\right)} \equiv \alpha^{***} < 1,$$

which implies condition (5) since $R(y^*) > 0$.

This discussion can be summarized in the following Proposition:

Proposition 2 *When S knows R's payoff, the equilibrium is unique, except under supervisory decision-making, when $\alpha^{***} \geq \alpha^*$, on the interval $[\alpha^*, \alpha^{***}]$ over which the real authority equilibrium exists, as well as an equilibrium involving issue-relevant communication.*

3 Cues versus issue-relevant messages: The dual mode of communication

Building upon the work in social psychology discussed in the introduction, we now introduce a second type of communicable information, cues, that are not directly relevant to the decision problem but impact the sender's credibility in the eyes of the receiver. We are in particular interested in the possible substitutability/complementarity between such cues and the issue-relevant messages that we have considered until now, and more generally in the use of cues in communication processes.

Cues: We build on the set-up of section 2.1 by adding information that can help the receiver assess the sender's trustworthiness, that is, information (facts, endorsements) about the sender's expertise or integrity track record. Recall that the receiver expects his payoff from action A to be r_H with probability α and r_L with probability $1 - \alpha$ (and the sender does not know which obtains) The congruence parameter α is now a weighted average of a high probability $\overline{\alpha}$ (with associated probability γ) and a low probability $\underline{\alpha}$ (with associated probability $1 - \gamma$):

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[20]Indeed, communication is successful with ex ante probability αx^*y^*. Therefore, the posterior probability of r_H in the absence of successful communication is $[\alpha - \alpha x^*y^*]/[1 - \alpha x^*y^*]$.

$\alpha = \gamma\overline{\alpha} + (1 - \gamma)\underline{\alpha}$. The sender knows the realization $\widetilde{\alpha} = \overline{\alpha}$ or $\widetilde{\alpha} = \underline{\alpha}$ but not the receiver's payoff and all this is common knowledge. We assume that $\underline{\alpha} < \alpha^*$.

Information that the sender communicates about α is a cue (since it concerns the sender's credibility) while information conveyed about A, on which we have focused until now, is an issue-relevant message.

Costs: In general, we need to consider efforts (x_c, y_c) and (x_i, y_i) on cues and issue-relevant messages, respectively. To keep things simple, though, we assume that cue communication is a zero-one choice for both S and R, with associated effort costs S_c and R_c. The sender can reveal hard information about the value of α (of course only type $\overline{\alpha}$ will have an incentive to do so), but this information is understood by the receiver only if both exert effort. We further specialize the model by assuming that cue communication is relatively cheap (S_c and R_c are small), to reflect the fact that communicating about cues is often simpler than communicating about substance.[21] To avoid unnecessary indices, we let (x, y) $(= (x_i, y_i))$ denote, as earlier, the efforts on the issue-relevant dimension, and $S(x)$ and $R(y)$ their costs.

Note that our assumption of additivity of effort costs rules out effort substitution and can be viewed as an approximation of the psychologists' "no-load" experiment (experiments often compare outcomes in the "no-load condition" with those in the "load condition", in which effort substitution is likely to be substantial.)

Payoffs and timing: We focus on supervisory decision-making. First, S chooses x and decides on whether to send the cue. Second, R chooses (in whatever order he wants) y and whether to spend R_c to assimilate the cue. As in section 2.1, we assume that the receiver does not observe the sender's effort x, and we disregard Pareto-inferior equilibria.

Let us make some preliminary observations:

- First, if cues are communicated in equilibrium, we are back in the symmetric information situation of section 2.1, with $\widetilde{\alpha}$ equal to $\overline{\alpha}$ or $\underline{\alpha}$,[22] and with respective issue-relevant efforts relabeled as $\overline{x}$, $\overline{y}$, $\underline{x}$, and $\underline{y}$.

- Second, in an equilibrium with cue communication, it is optimal for the receiver to look at the cue first and then make a decision about how much effort to exert on the issue-relevant message (since this allows him to fine-tune his effort to the sender's credibility).[23]

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[21] Although this is not always true, as emphasized by Erb et al. (2002a).

[22] If the receiver gets nothing from the cue, he rationally infers that $\alpha = \underline{\alpha}$.

[23] Indeed, there is much evidence that: (i) cues have more impact on persuasion if provided before the issue-relevant message, and (ii) conversely, a forewarning of persuasive intent affects message processing and reduces persuasion (Kiesler-Kiesler (1964)).

- Third, if cues could not be communicated in equilibrium, we would be in a signalling situation similar to that of section 2.2, but with different thresholds since S does not have full information about R's payoff from choosing action A. S's issue-relevant effort would depend on the realization $\widetilde{\alpha} = \overline{\alpha}$ or $\widetilde{\alpha} = \underline{\alpha}$ (with respective effort intensities $\overline{x}$ and $\underline{x}$). On the other hand, R's effort intensity y would still be non-contingent.

Using these observations, we obtain the following result:[24]

Proposition 3 *Assume that the communication is cheap and so the cue is indeed communicated in equilibrium. The possibility to communicate a (relatively cheap) cue: (i) crowds out issue-relevant communication when the cue conveys "bad news" about the credibility of the sender;[25] (ii) enhances issue-relevant communication when the cue conveys "good news" about the credibility of the sender, but not sufficiently so that the receiver rubberstamps her recommendation ($\overline{\alpha} < \alpha^*$); (iii) eliminates issue-relevant communication when the cue is sufficiently "good news" about the sender's credibility that the receiver rubberstamps her recommendation ($\overline{\alpha} > \alpha^*$).*

In cases (i) and (iii), the cue crowds out issue-relevant communication, while it crowds it in in case (ii). Cues can thus be substitutes or complements to issue-relevant communication.

Social psychology evidence is broadly consistent with Proposition 3. The literature on persuasion[26] stresses that argument quality is the more important determinant of persuasion under high personal relevance, while source expertise is the more important one under low relevance (provided that assimilating cues is relatively cheap); and that, under "intermediate" personal relevance, favorable cues heighten the associated issue-relevant thinking while unfavorable cues reduce it. While the second point derives immediately from our analysis, the first one obtains if the set-up costs for issue-relevant effort are high relative to S_c and R_c (this ensures the sole reliance on cues under low personal relevance) and if the costs of achieving perfect issue-relevant communication are bounded.[27]

4 Extensions

While the model of section 2.1 captures the basic features of collaborative communication, it makes a number of strong assumptions. Relaxing these, besides enabling us to ascertain the robustness of the results, delivers a number of further insights.

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[24] The proof of Propositions 3 through 5 can be found at http://idei.fr/vitae.php?i=3.

[25] We implicitly start here from an equilibrium with positive issue-relevant communication when communicating about cues is impossible.

[26] See for example Chaiken et al. (1996, p. 711) and Petty and Cacioppo (1986, p. 172 and pp. 204-211).

[27] This ensures the sole reliance on issue-relevant communication under high personal relevance.

4.1 Strategic substitutability

The multiplicative formulation, $p = xy$, embodies two features. First, communication is more likely to be successful when parties select costlier strategies. Second, each party's *marginal* product of effort is *increasing* in the other party's effort (efforts are strategic complements);

The first feature is relatively uncontroversial (see section 4.3, though): R should indeed benefit from higher clarity in S's explanations, while the probability that R understands the content of S's message increases with y.

To investigate the impact of a lack of strategic complementarity, assume:

$$p = p(x + y),$$

where $p' > 0 > p''$. The key property of this formulation is that the cross-partial derivative satisfies $p_{xy} < 0$, while in the previous sections we had $p_{xy} > 0$.[28] Communication may then break down since if one party exerts no effort, the other may not find it worthwhile to exert positive effort either. By contrast, interior equilibria exhibit strategic substitutability. Assuming that the probability of success depends on $x + y$ allows us to obtain results concerning the total communication effort. In particular, one can show that the monotonicity results with respect to *individual* efforts x and y obtained in Propositions 1 through 3 carry over to *total* effort $x + y$ (or, equivalently, to the probability of successful communication):

Proposition 4 *With a probability of successful communication $p(x + y)$:*
(i) When the equilibrium involves communication ($x + y > 0$), total effort $x + y$ rises with congruence and with any one party's stake in the project.
(ii) Under supervisory decision-making, higher congruence raises total effort until the sender enjoys real authority, prompting the breakdown of issue-relevant communication.
(iii) Unfavorable cues reduce total issue-relevant effort, while favorable cues raise it unless they allow the sender to enjoy real authority.

4.2 Sequential communication: first impressions matter

The basic model considered the simplest case in which the receiver chooses y without observing x. This may be a fine assumption if $R(y)$, say, represents the opportunity cost of the time set aside to listen to the sender. In general, though, the receiver learns the quality of exposition "along the way" and can therefore partly adjust his effort in reaction to the sender's choice of x. This section first studies the other (and often unrealistic) polar case in which the receiver perfectly observes x before choosing y. It later considers the more interesting intermediate case

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[28] Note that there remains an element of strategic complementarity in the presence of set-up costs S_0 and R_0.

in which the receiver must incur some effort cost before adjusting y to the quality of exposition.

(a) *Pure sequentiality*

Under pure sequentiality, the receiver's reaction curve $y = Y(x)$ is still given by:

$$R'(Y(x)) = x\alpha r_H$$

The sender is now a Stackleberg leader and solves:

$$\max_x \left\{ xY(x)\alpha s - S(x) \right\},$$

yielding

$$S'(\widehat{x}) = \left[Y(\widehat{x}) + Y'(\widehat{x})\widehat{x} \right]\alpha s.$$

As is familiar in games with strategic complementarities, the sender has an extra incentive to invest in expositional quality. The "Stackelberg" equilibrium $(\widehat{x}, \widehat{y} = Y(\widehat{x}))$ thus corresponds to higher levels of effort than the "Nash equilibrium" (x^*, y^*) of section 2.

(b) *Multi-stage communication*

More realistically, communication occurs in multiple stages. To simplify, let there be two stages, $t = 1$ and 2, with efforts (x_t, y_t). Let us also focus on executive decision-making and assume a single payoff $r > 0$ for the receiver when action A is chosen.

Within each stage, effort choices are assumed to be simultaneous. At the end of the first stage, though, the receiver learns whether he understood it (in a slightly different version, he would even learn the sender's stage-1 effort.[29]) The receiver may then adjust his second-stage effort y_2 on the basis of what happened in stage 1 for two reasons. First, a failure to understand in stage 1 may lower the benefit from listening in stage 2 (*payoff channel*). Second, the receiver may have learnt something about the sender's expository skills or else (in the case in which the sender has private information about payoffs) about the congruence or the sender's interest in the project (*learning channel*).

Assume that the probability of successful first-stage communication $p_1(x_1, y_1) = x_1 y_1$. Both parties then observe whether the first-stage material was assimilated by the receiver. The probability that the receiver understands is then given by $p_2(x_2, y_2) = p_S(x_2, y_2)$ if the first-stage material was assimilated, and $p_2(x_2, y_2) = p_F(x_2, y_2)$ otherwise, with $p_S \geq p_F$ for all (x_2, y_2). To separate the payoff and learning channels, we choose an *additive* specification, with $p_S(x_2, y_2) = M + x_2 y_2$ and $p_F(x_2, y_2) = m + x_2 y_2$, with $M \geq m$.[30] The cost of communications

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[29]Either assumption may be reasonable. While the receiver never observes the sender's effort directly, he may find the exposition "sloppy". On the other hand, there are also cases in which it is difficult to understand why communication failed and the receiver's attributions in the matter may not be reliable.

[30]We can alternatively take a *multiplicative* specification, with $p_S(x_2, y_2) = Mx_2 y_2$ and $p_F(x_2, y_2) = mx_2 y_2$ (with $m = 0$ if first-stage communication success is indispensable for overall success). In this case, the analysis is quantitatively but not qualitatively different.

is $S_t(x_t)$ and $R_t(y_t)$ in period t, where the functions S_t and R_t satisfy the same properties as in section 2.

To investigate the learning channel, let us assume an uncertain payoff s for the sender when action A is chosen: $s = s_H$ with probability ρ and $s = s_L$ with probability $1 - \rho$, where $s_H > s_L > 0$. The value of s is private information of the sender.

Without loss of insights, let us assume that there is effective communication at date 1:

$$x_L^1, x_H^1, y^1 > 0.$$

At the beginning of stage 2, the receiver updates his beliefs about the sender's type to ρ' on the basis of whether the first-stage communication was successful or not. Let

$$x_L^2(z), x_H^2(z), y^2(z)$$

denote the stage-2 efforts contingent on $z = S$, F. We will say that *cognitive closure* occurs when $y^2(z) = 0$, that is when updating about the sender's motivation leads to a communication breakdown.

Under these assumptions, we obtain the following result:

Proposition 5 *There exists an equilibrium of the multi-stage communication game such that:*
(i) A successful date-1 communication signals a motivated sender:

$$\rho'(S) > \rho > \rho'(F).$$

(ii) Consequently, communication is more effective at stage 2 if it was successful at stage 1: x_L^2, x_H^2 and y^2 are (weakly) greater after a success than after a failure. In particular, a failure is more likely to trigger a cognitive closure.
(iii) First-stage efforts $\left(x_L^1 , x_H^1 , y^1\right)$ are (weakly) higher than they would be in the absence of date-2 communication (i.e., for $p_S = M$ and $p_F = m$).

Intuitively, a more motivated sender puts more effort into communicating $\left(x_H^1 > x_L^1\right)$. Hence, as long as $y^1 > 0$, a successful first-stage communication suggests a high motivation (part (i)); this in turn facilitates stage-2 communication (part (ii)) and encourages the sender (and indirectly the receiver) to invest more in communication at stage 1 (part (iii)).

4.3   Strategic information overload

This paper has by and large maintained the hypothesis that "more information is better": Each party benefits from a higher communication effort by the other party. In the executive

decision-making case, this externality implies that equilibrium communication efforts are always excessively low relative to first-best outcomes. This "undercommunication" property may not hold in the supervisory decision-making case, because of the option to take the decision while avoiding communication costs altogether. The receiver may "overmonitor". By contrast, the sender never "overcommunicates" in this framework.

In fact, an endogenous increase in the sender's communication cost need not benefit the receiver. As is well-known, informational overload may be as detrimental to a receiver as information underload. For example, management may spend effort supplying the Board of Directors with a huge amount of information, most of it of minor importance, so as to prevent the Board from zeroing in too fast on the sensitive issues. Patent application attorneys may cite tons of mildly relevant patents in an attempt to avoid that the (time-pressed) patent office examiners focus on the most closely related patents.[31]

How do such behaviors fit in our framework? Note that they take place only in the context of supervisory decision-making, and more precisely in situations in which the sender hopes that the receiver will rubberstamp without intense scrutiny. But then, why does the sender not content herself with a very low communication cost? The answer is that supplying little information raises suspicions. This is best understood through an extension of the model in which the number of pieces of information relevant to R's understanding is unknown to him (and perhaps also to S), and so S can make R's search process more difficult without necessarily appearing malicious (i.e. appearing to be a low-congruence type).[32] Of course, there is a limit to this strategy, but it can account for strategic information overload.

5   Conclusions and directions for future research

This paper developed a framework in which communication is modelled as a moral-hazard-in-team problem, and derived a number of insights concerning equilibrium modes of communica-

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[31] A related idea, studied by Legros and Newman (2002) is the attempt by a competing sender to "interfere", that is, "jam" the message the sender is trying to convey to the receiver.

[32] For example, take the set-up of section 2.1 but assume that it is common knowledge that R has zero (possibly even negative) effort cost but just enough time to read "one piece of information". Assume also that understanding whether $r = r_H$ or $r = r_L$ requires understanding either one piece of information (with probability q) or two (with probability $1 - q$), and this independently of the value of r. Assume that S privately knows whether one or two pieces are needed. When only one piece is needed and $r = r_H$, this piece is sent by S, R understands it and takes decision A. On the other hand, when $r = r_L$, it is in S's interest to send two pieces of information, whether one or two are needed: R is then unable to figure out whether $r = r_H$ or $r = r_L$, and rubberstamps S's recommendation provided:

$$(1 - \alpha)r_L + \alpha(1 - q)r_H \geq 0.$$

Instead, if R had time to read two pieces of information, there would be no incentive for S to send more pieces of information than what is needed for R to understand the value of r, and R would take decision A if and only if $r = r_H$.

tion. We feel that this framework has significant potential for the analysis of communication in organizations and markets. Of course, we have made a number of simplifying assumptions in order to keep the analysis tractable. Investigating their importance is also a natural avenue for further research. In particular, the model of multi-stage communication of section 4.2 focused on a sequence of one-shot communication exchanges, thereby ruling out repeated communication rounds concerning a *given* piece of information. While students reading lecture notes or sitting in a large amphitheater cannot alter the teacher's expository plan, small classroom lecturing or face-to-face communication allow students to ask the teacher to come back to poorly understood material or skip well-known one. Second, even if communication is not interactive, it may involve a multi-stage process. For example, the student may come back to the notes taken in the amphitheater and try to grasp what he had not understood then. Or he may ask someone else to explain the material to him without reference to the notes he took (in the same way managers may ask for a second opinion).

Allowing for interactive communication is a very interesting avenue for research, with natural applications for the design of educational/training programs for example. Interactive communication has several benefits: (i) it can allow S to monitor R's effort through periodic checks of his understanding; (ii) rehearsal by R of specific fragments of the message can happen immediately while they await the completion of the overall lecture in an ex cathedra course, say; and (iii) therefore, communication can be adaptive: S can spend more time on questions that R does not understand well and less time on others (in particular, S can more easily detect how much of the context R is familiar with). On the other hand, interactive communication may exacerbate moral hazard: Each party gets a "second chance", and therefore may exert insufficient effort even relative to the one-shot case. Investigating this in detail is a natural topic for further research.

Our framework can also generate interesting implications for communication strategies in markets. Think of advertising strategies pursued by an incumbent, who enjoys a brand name advantage, and an entrant. Natural questions include: (i) Should the entrant and/or the incumbent engage in comparative advertising? (ii) Who would want to rely on cues or on issue-relevant communication? (iii) How do the answers to (i) and (ii) depend on the degree of product differentiation (which influences the "stake" consumers have in understanding the advertising content)? These important questions are left for future research.

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