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The Effect of Virtual Communication Channels on Human Behavior: A Literature Review*

Sven Walther

Abstract

As workplaces and social interactions continue shifting toward virtual environments, virtual communication channels like video conferencing and text chats have become fundamental for collaboration and information exchange. However, these channels differ in their capacity to convey information, potentially shaping the impact of communication on behavior through various mechanisms, such as anonymity. This review examines 21 studies to assess how face-to-face and different virtual communication channels affect human behavior. The results suggest that relying exclusively on virtual communication can impair behavior in some situations, such as group cooperation or creativity. This issue can be mitigated using richer communication channels such as video or audio. However, especially in one-way messages, using richer communication channels that convey non-verbal information is not always advantageous and poses some risks. This illustrates the complexity of using different communication channels and highlights the need for future research. The insights from this review have important implications for organizations and individuals, emphasizing the crucial role of using appropriate communication channels in virtual environments. Effective channel selection can enhance cooperation and innovation, thereby contributing to the broader discussion on the future of work in remote and hybrid settings.

Keywords: virtual communication; communication channel; behavior; future of work

JEL Classifications: C90, D83, M54

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1 Introduction

Remote work represents a fundamental transformation of the modern workplace, with an increasing number of individuals shifting from in-person toward virtual work environments (Barrero et al., 2023; Gallup, 2024), which impacts work in organizations (Bloom et al., 2022, 2024; Gibbs et al., 2024). One key consequence of this shift is the changing nature of communication (Yang et al., 2022), such as moving from spontaneous, in-person communication to increased reliance on technologies to interact, collaborate, or exchange information virtually.

In various workplace contexts, including contract negotiations, team collaboration, or product innovation, communication plays a crucial role, and a substantial body of literature underscores the significant influence of communication on human behavior and decision-making (see, e.g., Bohnet and Frey, 1999a; Charness and Dufwenberg, 2006; Cooper et al., 1992; Dawes et al., 1977; Isaac and Walker, 1988; Roth et al., 1995). The question is whether this positive effect of communication transfers from face-to-face to virtual environments as different virtual communication channels, such as text chats, audio calls, and video meetings, can differ in their characteristics. Non-verbal cues, which are available in face-to-face and video-based communication channels compared to text channels, influence anonymity and identification in interactions, thereby affecting subjects' behavior in strategic settings (see, e.g., Andreoni and Petrie, 2004; Bohnet and Frey, 1999a,b). Moreover, different communication channels vary in their ability to convey human presence, which is vital in fostering honesty (Cohn et al., 2022; Nieken and Walther, 2024). Such differences between communication channels are emphasized in the literature according to media richness (Daft and Lengel, 1986), social presence (Short et al., 1976), or media synchronicity (Dennis et al., 2008).

Thus, it is crucial to understand (i) how the shift from face-to-face to virtual communication impacts human behavior and decision-making and (ii) how different virtual communication channels shape these outcomes.

This paper serves as a first step towards a better understanding by summarizing and discussing the results of 21 experimental studies (see Table 1). I followed a structured methodology to address this interdisciplinary research topic (Kitchenham and Charters, 2007; Webster and Watson, 2002). To assure comparability across studies, the selection criteria prioritized depth over breadth. I focused on studies published in the field of economics that either relied on standard economic paradigms

or used financial incentives to influence subjects' behavior (see Appendix A for further details on the methodology of this literature review).

Overall, the findings of this review emphasize that the transition from face-to-face to virtual communication can reduce the positive effect of communication on behavior and decision-making in some situations. Furthermore, studies suggest that the impact of communication can depend on the specific virtual communication channel used. A generalized conclusion would be too simplistic, as communication can be one-way, for example, as a message, or two-way, such as live video meetings between subjects. Moreover, communication serves multiple functions, including facilitating problem comprehension, coordinating decisions, or strategically shaping expectations, which can vary based on the study design. Thus, to provide a more precise examination, the findings from experimental studies were structured according to the following four categories: i) two-way communication in interdependent strategic interactions, where individuals' payoffs directly depend on their own and others' decisions, ii) two-way communication in creativity tasks, iii) non-verbal information in one-way communication, and iv) honesty and promises in one-way communication.

Regarding two-way communication in interdependent strategic interaction, studies revealed that the transition from face-to-face to virtual communication can reduce the positive impact of communication, in particular when text communication is used, as this can minimize cooperation (Bochet et al., 2006; Frohlich and Oppenheimer, 1998; Rockmann and Northcraft, 2008) or impair reciprocity (Bicchieri et al., 2010; Lev-On et al., 2010). This negative impact was mitigated using richer video communication channels (Brosig et al., 2003; Rockmann and Northcraft, 2008), which underlines the importance of using appropriate channels. As for two-way communication in creativity tasks, rich video communication channels are important (Grözinger et al., 2020). Yet it seems that video channels could not fully compensate for the advantages of face-to-face interactions when innovative ideas are crucial (Brucks and Levav, 2022; Grund et al., 2025). To explore non-verbal information in one-way communication, studies have utilized standardized messages to isolate the role of non-verbal information by keeping the communication content constant across different communication channels. In contrast to the findings on two-way communication, where richer channels tended to increase the positive impact of communication, higher media richness was not always beneficial. For example, video messages used to motivate online employees or encourage donations were found to be equally or sometimes even less effective than text or audio messages

(Nieken, 2023; Zylbersztejn et al., 2024b), suggesting that an increase in non-verbal information may also introduce certain risks. In terms of honesty in one-way communication, studies have provided some evidence that anonymous text-based channels may encourage dishonest behavior compared to face-to-face communication (Abeler et al., 2014; Conrads and Lotz, 2015). However, this difference diminished when richer audio communication was used (Cohn et al., 2022; Conrads and Lotz, 2015).

Overall, this review is an essential first step to a better understanding how different communication channels affect human behavior and decision-making. It also points out that research is limited so far, and it has only been partially successful in identifying mechanisms to explain how different communication channels affect the outcomes in various experimental settings. This highlights the need for future research to gain more precise insights.

This paper makes a twofold contribution. First, I provide a comprehensive overview of experimental studies examining how different communication channels influence human behavior and decision-making. The insights from several studies were structured based on whether communication was one-way or two-way and according to the task or respective behavior investigated. Afterward, I summarized the insights into suggestions and implications for organizations and individuals. This review shows that communication effectiveness can vary depending on the channels used. This aspect should not be overlooked in research when designing experiments or conducting literature reviews in which communication is crucial. It points out that selecting appropriate communication channels is essential for individuals in companies, research, and daily life. Therefore, further research is necessary for a more detailed picture. Second, I relate empirical findings to the ongoing public debate on the future of work, particularly the shift from traditional office setups to more remote work. In the context of communication, I emphasize using hybrid work models that combine the benefits of remote and in-office work. While there are certain risks associated with exclusively utilizing virtual communication channels, these can be mitigated by using proper communication channels.

The remainder of this paper is structured as follows: Section 2 outlines the necessity and importance of this literature review based on existing findings. Section 3 examines experimental studies exploring how different communication channels influence human behavior and decision-making across various interactions. Section 4 discusses implications, limitations, and future research op-

portunities, and Section 5 concludes the paper.

2 Communication and Virtual Communication Channels

Communication is a fundamental aspect that allows individuals to exchange information in various settings effectively. Modern technologies enable people in organizations, companies, and their daily lives to rely on video conferencing, audio conferencing, or text chats to interact with others, and researchers are also increasingly shifting communication in studies from face-to-face to virtual communication. Thus, there is a growing need to understand better whether and how different communication channels affect human behavior and decision-making. Beyond the practical relevance, in this section, I highlight the importance of this question based findings in the literature.

2.1 The Effect of Communication

The role of communication in economics and various research disciplines has been extensively studied for decades (Charness and Dufwenberg, 2006; Cooper et al., 1992; Dawes et al., 1977; Isaac and Walker, 1988). Many studies point out the significant influence of communication on behavior and decision-making, which is reflected in a wide range of situations. Meta-analyses confirmed a positive significant effect of communication on cooperation (Balliet, 2010; Sally, 1995). Dawes et al. (1977), Isaac et al. (1985), and Isaac and Walker (1988) revealed that communication facilitated subjects to coordinate, which significantly increased cooperation in public goods games and social dilemmas. Other studies found effects of communication on trust and trustworthiness (see, e.g., Ben-Ner and Putterman, 2009; Charness and Dufwenberg, 2006), bargaining and fairness concerns (see, e.g., Bohnet and Frey, 1999a,b; Nieken and Schmitz, 2023; Roth et al., 1995) or coordination and efficiency (see, e.g., Charness, 2000; Cooper et al., 1992; Duffy and Feltovich, 2006; Van Huyck et al., 1993). These results suggest that the impact of communication on behavior and decision-making stems not only from its ability to facilitate coordination but also from its ability to shape expectations or influence behavior via promises. Thus, the impact of communication can vary depending on the type of interactions and the specific research context. While there are many possible causes for the positive effect of communication, and a comprehensive examination of these causes falls beyond the scope of this paper, many studies focused on face-to-face communication to investigate

communication. However, the transition from face-to-face to virtual environments necessitates the use of virtual channels, which fundamentally change the way of communication (Yang et al., 2022). Researchers adapted to these new possibilities by incorporating virtual communication channels, such as text chats, into experimental studies, demonstrating that virtual communication can also significantly influence behavior and decision-making (see, e.g., Ben-Ner and Putterman, 2009; Ben-Ner et al., 2011; Brosig et al., 2003; Cason et al., 2012; Nieken and Schmitz, 2023). Still, it is unclear whether and how the transition from face-to-face to virtual communication influences the effect of communication on behavior and decision-making.

2.2 Virtual Communication Channels

Virtual communication channels allow communication between individuals through various technologies without requiring physical presence. In this paper, three categories of virtual communication channels—text, audio, and video—alongside face-to-face (Brandts et al., 2019) are highlighted.[1] These channels differ in terms of multiple characteristics, but there can also be differences within one category of communication channel. For example, a text channel can be a live chat, enabling more real-time interaction than e-mails.

There are three widely recognized theories to highlight possible differences between communication channels: media richness theory (Daft and Lengel, 1986), social presence theory (Short et al., 1976), and media synchronicity theory (Dennis et al., 2008). The media richness theory states that different communication channels can vary in the degree to which they transmit different cues. Richer communication, such as face-to-face or video communication, enables the transmission of non-verbal cues and signals[2] like body language, facial expressions, gestures, or tone of voice, which are absent in text communication (Daft and Lengel, 1986). These cues influence factors such as the level of anonymity or the availability of information during communication. According to Short et al. (1976), the social presence theory describes the extent to which different communication channels enable individuals to perceive the presence of others and foster a sense of connection (as cited in Oh et al., 2018). In contrast, media synchronicity theory explains the degree to which the features of a communication channel support synchronous communication between individuals

[1] Brandts et al. (2019) also mention Paper and Pencil, which I do not examine in this study.

[2] In this paper, I consider cues to be unintentional, while I consider signals strategic and intentionally conveyed (Spence, 1973).

(Dennis et al., 2008). For example, while modern video communication channels enable high synchronicity via real-time interaction, e-mail communication is relatively asynchronous and, thus, potentially alters behavior in settings that require collaboration.

2.3 Understanding the Impact of Different Communication Channels

Based on the theories discussed, several studies provide implications on why different communication channels can impact behavior, such as cooperation, prosocial behavior, or trust. In the context of the media richness theory, video communication allows individuals to see one another, unlike audio or text communication channels, thereby affecting anonymity and identification. This, in turn, can influence human behavior and decision-making. Fairness concerns were impacted in dictator games. Dictators made significantly higher offers when they and recipients could visually identify each other (Bohnet and Frey, 1999b) when facial pictures were shared (Burnham, 2003), or when family names were revealed (Charness and Gneezy, 2008). Similarly, reducing anonymity through identification decreased free-riding in a public goods game (Andreoni and Petrie, 2004) and significantly enhanced cooperation in the prisoner's dilemma (Bohnet and Frey, 1999a). Moreover, in trust games, subjects valued pictures of their counterparts as they were willing to pay for these, and recipients were significantly more trustworthy when they saw a picture of senders' faces (Eckel and Petrie, 2011). Zylbersztejn et al. (2020) show that subjects in a hidden action game likewise valued being able to view photos and videos of their counterparts. However, only strategically relevant content significantly improved the subjects' ability to predict the trustworthiness of their counterparts (Zylbersztejn et al., 2020, 2021). Beyond possible effects of anonymity, non-verbal cues or signals, such as gestures, facial expressions, or eye movements, can impact interactions (Argyle, 2013). Face-to-face or video channels allow to convey smiles, winks, or handshakes, which could help to increase trust (Scharlemann et al., 2001) or could act as coordination device by establishing trust in groups (Manzini et al., 2009). Gaze information, such as where individuals look or for how long (Hessels, 2020), is a form of non-verbal communication either absent or only partially available in virtual communication channels (Bohannon et al., 2013). Kurzban (2001) showed that mutual eye gaze between group members can increase cooperation. Additionally, subjects' attractiveness can be important when communication channels with visual information are used. Expectations of others' cooperativeness increased with physical attractiveness (Andreoni and Petrie, 2008; Zyl-

bersztejn et al., 2024a), and the perceived trustworthiness was higher for more attractive trustees (Wilson and Eckel, 2006). A similar beauty premium has also been observed in hiring decisions, where physical attractiveness benefits men but not women (Ruffle and Shtudiner, 2015).

In the context of social presence theory, subjects were significantly less honest when reporting their results on their own, without interacting with the experimenter, compared to when they reported them verbally (Pascual-Ezama et al., 2015). Additionally, Cohn et al. (2022) found that human presence is crucial in reducing dishonesty, as individuals were significantly more dishonest when interacting with a machine rather than with a human being. Regarding media synchronicity, studies within the economic discipline that explicitly examined the influence of differences in communication synchronicity (e.g., Conrads and Reggiani (2017)) are limited.

While these empirical findings may seem distinct and were not necessarily designed to provide insights into the use of different communication channels, they underscore the importance of a more in-depth investigation into how various communication channels can influence behavior and decision-making.

3 Insights into how Different Communication Channels affect Human Behavior and Decision-making

This section discusses experimental findings on how face-tof-face and different virtual communication channels impact human behavior and decision-making, which is becoming increasingly important in economic research (see Figure 1). Table 1 presents a comprehensive overview of key papers investigating this question. Moreover, Figure 2 illustrates the frequency with which different communication channels are compared across these papers.

As discussed before, the benefits of communication may depend on the nature of the interaction and the respective research context. To achieve a more comprehensive understanding, the empirical findings discussed in this review were structured into four categories: i) two-way communication in interdependent strategic interactions, ii) two-way communication in creativity tasks, iii) non-verbal information in one-way communication, and iv) honesty and promises in one-way communication.

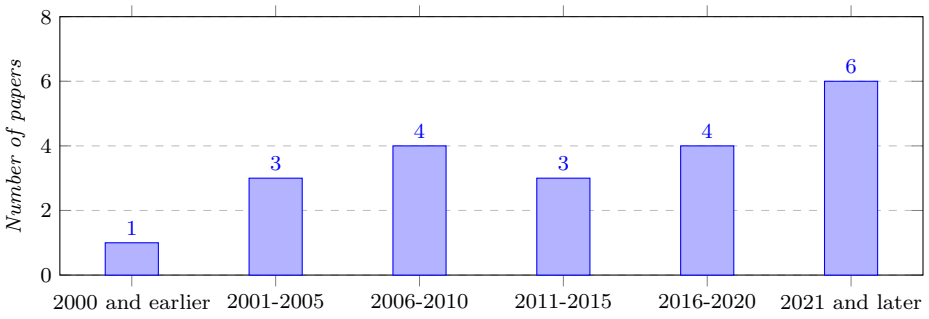
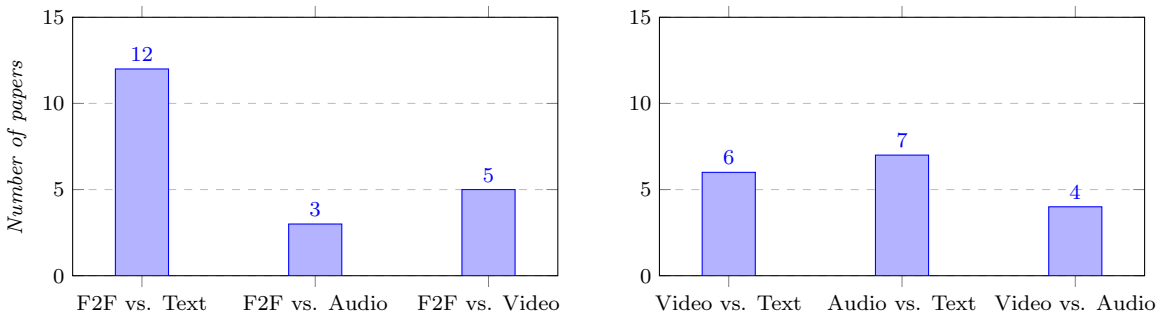


Figure 1: Number of papers that compare different communication channels over time



(a) Face-to-face vs. virtual channels

(b) Only virtual channels

Figure 2: Number of papers by compared communication channels

3.1 Two-way Communication in Interdependent Strategic Interactions

Standard economic paradigms, such as the public goods game, the trust game, or bargaining games, represent interactions between two or more individuals in which individuals' payoffs depend not only on their own decisions but also on the decisions of others. Such interactions are common in companies and organizations, for example, when buyers and suppliers negotiate prices or team members collaborate on large company-wide projects.

A common challenge in teamwork is the phenomenon of free-riding, where some team members contribute minimal effort while still benefiting from the efforts of others, leading to an unequal distribution of rewards. This problem is also crucial in providing public goods, where individuals tend to contribute less, and others must bear the costs. Communication can decrease such uncooperative behavior (Isaac et al., 1985; Isaac and Walker, 1988). However, studies that allowed game-relevant pre-play communication showed that face-to-face leads to significantly higher or at least equal group cooperation compared to text communication in public goods games (Abatayo et al., 2018; Bochet et al., 2006) but also in a prisoner's or social dilemma (Frohlich and Oppenheimer, 1998; Rockmann

and Northcraft, 2008). One possible explanation is that face-to-face communication fosters higher levels of trust, mediating the relationship between the communication channel and cooperation (Rockmann and Northcraft, 2008). This would be consistent with previous findings, highlighting the crucial role of trust in facilitating cooperation (Balliet and Van Lange, 2013). Still, studies have not identified a clear mechanism explaining the superiority of face-to-face communication in group cooperation. Both communication channels seem equally effective in ensuring an understanding of the game. Using an impartial prisoner's dilemma compared to a standard prisoner's dilemma, in which the conflict between group and self-interest was absent, resulted in no differences between both channels (Frohlich and Oppenheimer, 1998). Similarly, when subjects could punish other subjects' behavior, such as free-riding, differences in cooperation were no longer significant (Bochet et al., 2006). Thus, only when subjects had the possibility of free-riding with no risk of punishment did face-to-face communication have a higher positive impact on cooperation than text. Since face-to-face and text differ in anonymity and Bochet et al. (2006) explicitly forbid subjects to reveal their identity, anonymity might have hampered the impact of communication in text communication. This would be in line with findings showing that identification decreased free-riding in a public goods game (Andreoni and Petrie, 2004) and significantly enhanced cooperation in a prisoner's dilemma (Bohnet and Frey, 1999a).

Findings by Brosig et al. (2003) and Rockmann and Northcraft (2008) indicate that this difference in cooperation between face-to-face and virtual communication can be overcome using richer communication channels, such as video channels, which reduce anonymity in virtual communication. In an adapted version of a "disarmament exercise," cooperation was similar via video compared to face-to-face and improved significantly compared to communication through text (Rockmann and Northcraft, 2008). Again, differences in trust mediated this effect. In contrast, in a business-oriented dilemma, group cooperation was similar in video and text communication but significantly lower than in-person communication. Yet, in both studies, the video technology did not allow for real-time visual interaction, as images were refreshed only every three to four seconds. This affected the synchronicity of communication and the ability to convey non-verbal information, which likely influenced group cooperation. Brosig et al. (2003) further supports the implication that video communication tools can be an effective alternative to face-to-face for group cooperation.

Authors	Communi-cation channels	Between-subject	Groups	Group Size	Game-related content	Restricted content	Same verbal content	One-way/ Two-way	Pre-Play	Duration	Focus of Task/Game	Findings	Additional information
Abatayo et al. (2018)	F2F & Text	✓	✓	4	✓	✗	✗	Two-way	✓	10 min	Cooperation	F2F ≈ Text	
Abatayo et al. (2020)	F2F & Text	✓	✓	4*	✓	✗	✗	Two-way	✓	10 min	Trust and Reciprocity	F2F ≈ Text	*Communication in groups of four and decisions in groups of two
Abeler et al. (2014)	Audio & Text	✓	✗	-	✓	✓	✓	One-way*	✗	-	Honesty	Audio ≈ Text	*Communication of outcome to experimenter
Babutsidze et al. (2021)	Video, Audio & Text	✓	✓	2	✓	✗	✓*	One-way**	✓	-	Trust	Video $\gtrapprox$ Audio Video > Text Audio $\gtrapprox$ Text	*Verbal content homogenized **Pre-play messages from agents to principals
Bicchieri et al. (2010)	F2F & Text	Within	✓	2	✓ / ✗*	✓**	✗	Two-way	✓	F2F: 2 min Text: 5 min	Trust and Reciprocity	F2F $\gtrapprox$ Text	*Varied between treatments **No information on identities
Bochet et al. (2006)	F2F & Text	✓	✓	4	✓	✓*	✗	Two-way	✓	5 min	Cooperation	F2F > Text	*Text: no information on identities
Brosig et al. (2003)	F2F, Video & Audio	✓	✓	4	✓	✗	✗	Two-way	✓	10 min	Cooperation	F2F ≈ Video F2F > Audio Video > Audio	
Brosig et al. (2004)	Video & Text	✓	✓	2	✓	✓*	✗	Two-way	✓	10 min (Video), 15 min (Text)	Bargaining	Video $\gtrapprox$ Text	*Text: no information on identities
Brucks and Levav (2022)	F2F & Video	✓	✓	2	✓	✗	✗	Two-way	✗	6 min (Lab), 60 min (Field)	Creativity	F2F $\gtrapprox$ Video	
Cohn et al. (2022)	Audio & Text	✓	✗	-	✓	✓	✓	One-way*	✗	-	Honesty	Audio ≈ Text	*Communication of outcome to experimenter
Conrads and Lotz (2015)	F2F, Audio & Text	✓	✗	-	✓	✓	✓	One-way*	✗	-	Honesty	F2F ≈ Audio F2F $\gtrapprox$ Text Audio ≈ Text	*Communication of outcome to experimenter
Conrads and Reggiani (2017)	F2F, Audio & Text	✓	✗	-	✓	✓	✓	One-way*	✗	-	Promise-making/ Promise-keeping	F2F ≈ Audio F2F ≈ Text Audio ≈ Text	*Communication of decision to experimenter
Frohlich and Oppenheimer (1998)	F2F & Text	✓	✓	5	✓	✗	✗	Two-way	✓*	n/a	Cooperation	F2F $\gtrapprox$ Text	*Communication before rounds 1 to 8
Greiner et al. (2014)	F2F & Text	✓	✓	2	✗	✓*	✗	Two-way	✓	5 min	Bargaining	F2F $\gtrapprox$ Text	*No information on identities
Grözinger et al. (2020)	F2F, Video & Text	✓	✓	3	✓	✗	✗	Two-way	✗	30 min	Creativity	F2F ≈ Video F2F > Text Video > Text	
Grund et al. (2025)	F2F & Video*	✓**	✓	2	✓	✗	✗	Two-way	✗	8 min	Creativity	F2F $\gtrapprox$ Video	*2-phase experiment **Also within-subject with F2F and video
Lev-On et al. (2010)	F2F & Text	Within	✓	2	✓	✓*	✗	Two-way	✓	2-10 min**	Trust and Reciprocity	F2F $\gtrapprox$ Text	*No information on identities
McGinn et al. (2003)	F2F & Text	Within	✓	2	✓	✗	✗	Two-way	✓	F2F: 6 min Text: 13 min	Bargaining	F2F ≈ Text	
Nieken (2023)	Video, Audio & Text	✓	✗	-	✓	✓	✓**	One-way***	✓	-	Real Effort	*Video < Audio Video < Text Audio $\gtrapprox$ Text	*Findings in the neutral set-up **Varied between treatments ***Task instructions
Rockmann and Northcraft (2008)	F2F, Video & Text	✓	✓	2, 4 or 6	✓	✗	✗	Two-way	✓	5 or 10 min	Cooperation	F2F $\gtrapprox$ Video F2F > Text Video $\gtrapprox$ Text	
Zylbersztejn et al. (2024b)	Video, Audio & Text	✓	✗	-	✓	✓	✓	One-way*	✓	-	Donations	Video ≈ Audio Video ≈ Text Audio > Text	*Pre-recorded and standardized message addressed to potential donors

Table 1: Overview of experimental studies investigating how different communication channels impact human behavior and decision-making

In a ten-round public goods game, groups achieved similar levels of cooperation with video and face-to-face communication. Both yielded significantly higher cooperation and greater stability compared to audio communication. Further analyses by the authors revealed that differences in communication content could not explain the higher group cooperation in the video compared to the audio treatment. Moreover, the authors concluded that differences in social distance were not a possible mechanism. They used an identification treatment in which group members could visually identify each other but could not communicate. This did not result in higher cooperation compared to the baseline without communication, indicating that identification without the possibility for communication was not effective in increasing cooperation (Brosig et al., 2003), which is in contrast to other studies (Andreoni and Petrie, 2004; Bohnet and Frey, 1999a). Still, it is possible that (visual) identification and the presence of non-verbal cues, combined with strategically discussing the game, enhanced cooperation, which may explain the superiority of video over audio communication. Although there is no clear consensus on which features of communication channels are most important in cooperative situations, findings suggest that while text-based communication can decrease cooperation, video communication tends to mitigate this effect and achieve cooperation levels similar to in-person interaction.

Another challenge besides free-riding is establishing trust, as individuals must decide whether to rely on others without assured reciprocity. Trust fosters cooperation (Balliet and Van Lange, 2013), yet uncertainty about others' intentions can lead to hesitation, while a lack of trustworthiness—where individuals prioritize self-interest—can hinder collective actions and the enforcement of social norms (Fehr and Gächter, 2000). Communication is an essential driver of trust and reciprocity as it shapes expectations and influences decisions through promises and agreements (Ben-Ner and Putterman, 2009; Charness and Dufwenberg, 2006). When comparing the effect of communication between face-to-face and text in the trust game (Berg et al., 1995), trust levels did not significantly differ. These results were observed irrespective of i) the use of a between-subject or within-subject design, ii) group size, or (iii) the relevance of the communication content to the game (Abatayo et al., 2020; Bicchieri et al., 2010; Lev-On et al., 2010). Results in a two-stage sequential bargaining game support that text had a similar effect in establishing trust than a richer video communication channel. Subjects primarily used pre-play communication to reach an agreement on the efficient equal split outcome, and the behavior of the first movers did not significantly differ between video

and text communication (Brosig et al., 2004). Overall, the results suggest that although face-to-face or video communication is richer, more synchronous, and allows higher social presence compared to text channels, trusting behavior in interdependent interactions was not affected.

Findings on second movers' behavior on reciprocity in such interactions, however, can be impacted by using different communication channels. While in a between-subject design, Abatayo et al. (2020) found no significant difference in the amount sent back between face-to-face and text treatments, in within-subjects designs, receivers' reciprocity decreased in text compared to in-person interactions (Bicchieri et al., 2010; Lev-On et al., 2010). Again, findings from a two-stage sequential bargaining game support the superiority of richer communication channels (Brosig et al., 2004). Although the first movers' behavior was similar between video and text communication, fairness concerns were higher in video communication because significantly more equal-split outcomes were achieved, indicating an increased prosociality. This negative effect of text communication was primarily caused by the second movers, who tended to break their agreement four times more often than agreeing via video, indicating lower reciprocity. Again, there is no clear evidence as to why reciprocity was affected by using different communication channels. In all three studies, subjects were not allowed to reveal their identities, emphasizing the higher anonymity in text communication as a possible explanation. Findings from Eckel and Petrie (2011) support the importance of anonymity, as reciprocity significantly increased when receivers could see a picture of senders' faces. Furthermore, face-to-face and video channels might be better for establishing trustworthiness, as they allow for facial expressions such as a genuine smile, which can signal higher trustworthiness (Centorrino et al., 2015).

Moreover, in an ultimatum game, the effect of communication was significantly reduced in text compared to face-to-face interaction, even when the pre-play communication content was irrelevant to the game. Proposers' offers and responders' payoffs were marginally significantly higher in face-to-face than in chat communication (Greiner et al., 2014). Thus, even when communication could not be used to discuss strategies, face-to-face communication had a higher positive impact on prosocial behavior in a bargaining setting. However, this positive effect depends on the context of bargaining. In a one-stage, simultaneous bargaining game that included a buyer-seller pair with private information, the likelihood of a trade and bidding strategies after game-relevant pre-play communication did not significantly differ between face-to-face and written communica-

tion (McGinn et al., 2003). Note that compared to other studies discussed above, the degree of anonymity was not different between the treatments because identities were disclosed in all treatments. Still, the higher richness in face-to-face did not yield a higher efficiency in this bargaining context.

In summary, while text communication may have similar effects on human behavior and decision-making in some settings as face-to-face communication, e.g., in terms of trust, several studies suggest that the shift from face-to-face to virtual communication may have negative behavioral implications in some interdependent strategic interactions. Text communication can facilitate free-riding, hinder reciprocity, or reduce prosociality. High levels of anonymity and the limited richness of text communication are possible drivers of these differences. However, the decline in virtual communication can be overcome using richer video communication channels that enable group cooperation similar to face-to-face interactions. Given that only Brosig et al. (2003), Greiner et al. (2014) and Rockmann and Northcraft (2008) compared virtual communication (text, audio, and video), insights into how different virtual communication channels affect behavior and decision-making in strategic interactions are limited, indicating opportunities for future research.

3.2 Two-way Communication in Creativity Tasks

In the following, this paper examines communication in team creativity tasks.[3] Three studies that explicitly compared different communication channels emphasized the importance of media richness to increase creative output (Brucks and Levav, 2022; Grözinger et al., 2020; Grund et al., 2025).

Grözinger et al. (2020) used a highly visual, collaborative task in which teams of three subjects communicated via text, video, or face-to-face. While video and face-to-face communication resulted in similar levels of creativity, creative performance was significantly lower when using a less rich text-based chat. This difference was primarily due to variations in the usefulness of ideas and less so based on uniqueness and aesthetic values. Interestingly, differences in combined measures that included uniqueness, aesthetic value, and usefulness were only significant when comparing video and chat (e.g., for excellent ideas) and not when comparing face-to-face and chat.

[3]Team creativity tasks share similarities with public goods games discussed earlier, as both involve collective contributions toward a shared outcome. This review distinguishes them, noting that creative tasks rely more on idea-sharing, making behavior less strategic due to the absence of explicit incentives and quantifiable contributions.

Brucks and Levav (2022) and Grund et al. (2025) pointed out the importance of face-to-face interaction compared to rich video communication. In a two-phase experiment, Grund et al. (2025) used the *Unusual Uses Task* (Torrance, 1966) to examine the effect of different work settings (face-to-face in the lab vs. video communication from home) on creative performance in dyadic teams. Results indicate that at least one in-person phase is crucial for high creative output. While creativity in the first phase did not differ significantly between teams that worked solely face-to-face or via video, qualitative creativity in the second phase was significantly higher when both phases were conducted face-to-face. Similarly, hybrid settings, where teams switched between video and face-to-face interaction, also led to significantly higher creativity in the second phase than fully work-from-home teams, highlighting the importance of at least one face-to-face meeting. This effect was primarily driven by differences in very rare answers as an indicator of unusual, innovative thoughts. Further analysis ruled out trust and sympathy as moderating factors. However, self-selection partially mitigated the negative impact of working via video. Teams that chose a fully work-from-home setting exhibited higher qualitative creativity than those assigned to it exogenously (Grund et al., 2025).[4]

A lab and a field study employing idea generation tasks support differences between face-to-face and video communication (Brucks and Levav, 2022). Additionally, they highlighted an underlying mechanism explaining why video communication impeded creative output. In the lab study, pairs were instructed to generate creative uses for a product and thereafter select the most creative idea. The number of creative ideas in the video treatment was significantly lower than in the face-to-face treatment. In contrast to the creative performance, the decision quality was better for video pairs as they selected a significantly higher-scoring idea than face-to-face pairs. The authors analyzed why creativity was impacted and examined several alternative explanations, such as verbal and non-verbal behaviors, mimicry, or eye gaze. They ruled out trust as a possible mechanism because the level of trust measured in an economic trust game did not vary depending on the communication channel. Interestingly, the authors suggested that the physical nature of video, compared to in-person communication, narrowed the visual focus of the subjects, hindering idea generation. This insight was achieved using state-of-the-art technology to measure the subjects' eye movements. To assess whether the findings in the lab are generalizable, Brucks and Levav (2022) conducted a field

[4]Notably, the experimental design also varied peer presence, as face-to-face teams worked simultaneously with other teams in the lab, while video teams worked alone from home, potentially influencing results beyond the communication channel.

study in a large telecommunications infrastructure company in five countries. The setting was similar. Teams of two engineers participated in an ideation workshop and worked on this task via video or in person. They had to generate product ideas and then select and submit one idea as a future product innovation for the company. In all five countries, pairs generated significantly less creative ideas when collaborating via video than face-to-face.

Given the limited number of studies, current findings can only offer initial insights into how creativity may be influenced by virtual compared to face-to-face communication. While richer video communication can serve as an alternative to mitigate this difference, face-to-face interaction can be crucial to encourage high creativity in teams.

3.3 Non-verbal Information in One-way Communication

The previous findings focused on scenarios involving interactive, two-way communication between two or more individuals. However, communication can also be one-way, such as when messages are sent to motivate employees. Research on leadership revealed that simple text messages aimed to motivate employees actually decreased performance (Fest et al., 2021), and regardless of the communication content, charismatic speeches had a higher motivational effect on performance than neutral speeches (Antonakis et al., 2022). In strategic situations, simple one-way messages can be used to influence the expectations and behavior of others by making promises, which can help to increase reciprocity (Charness and Dufwenberg, 2006; Charness and Gneezy, 2008). Such messages can be transmitted via text, audio, or video, whereby the different channels differ in the presence of non-verbal and para-verbal information. The studies by Babutsidze et al. (2021), Nieken (2023), and Zylbersztejn et al. (2024b) have in common that they isolated the effects of non-verbal information on human behavior and decision-making by keeping the communication content constant, thus providing causal insights into using different virtual communication channels.

Although the results for trust in two-way communication showed no differences between face-to-face and text communication, richer messages had a positive impact on increasing trust (Babutsidze et al., 2021). The authors used a hidden action game (Charness and Dufwenberg, 2006), and before deciding on trust, principals received a text, audio, or video message from agents. Note that only the principals' trust decisions were considered, and these decisions did not influence agents' payoffs. The significance of the positive impact of auditory cues on trust varied according to whether or not

the messages entailed a promise. Trust rates were significantly higher for audio messages than for text messages only when the messages contained a promise to act trustworthy. Without a promise, auditory cues were not enough to significantly increase the trust of the principals. Adding non-verbal cues had similar positive effects compared to audio messages. Interestingly, video messages led to significantly higher trust than text messages, regardless of whether the messages included an agent's promise to act trustworthy, pointing out the importance of visual cues, especially when messages conveyed a promise. Given that the verbal content was homogenized in this experimental setting, the authors could draw a causal inference that auditory and visual cues helped increase trust.

In contrast to these findings, Nieken (2023) and Zylbersztejn et al. (2024b) suggest that video messages can pose some risks. Zylbersztejn et al. (2024b) presents insights into how different virtual communication channels influence prosociality in the context of donations. They examined how a pre-recorded and standardized message with varying amounts of non-verbal cues in the form of a text, audio, or video message affected the prosocial behavior of potential donors. Adding auditory cues in an audio message compared to a simple text message significantly increased average donations by nearly 40%. This positive impact decreased when using a richer video message, including visual cues. While there is no significant difference between a video and an audio message, compared to a text message, a video message increased donations by only 20%, which was no longer significant. Further analysis revealed that ratings on individual characteristics of the charity members in the messages could not explain the differences in donation behavior. Thus, the authors suggest that the reduced anonymity in the audio messages promoted prosocial behavior.

In the gig economy, Nieken (2023) investigated whether instructions presented via text, audio, or video impacted subjects' performance in a subsequent text transcription task. In addition to the virtual communication channel, the author varied whether instructions were neutral or enriched with charismatic leadership tactics (CLTs). While all charisma instructions contained verbal CLTs such as metaphors, non-verbal CLTs such as animated tone of voice, body gestures, or facial expressions were added depending on the richness of the channel. Although one might expect the video instructions to be superior, such richer communication, including non-verbal cues and signals, backfired in the neutral setting compared to text and audio instructions, as the quantitative output significantly decreased when variables for moderating effects and control variables were

added. Auditory cues and signals in audio instructions helped to marginally significantly increase the quantitative performance compared to standard text instructions. In contrast, qualitative performance was similar across the different instructions in the neutral settings. If instructions included CLTs, quantitative and qualitative output did not significantly vary between text, audio, and video. When comparing the effect of CLTs within a communication channel, performance did not differ after text or audio instructions, depending on whether CLTs were present. However, the output significantly increased after the charisma video instructions compared to the neutral video instructions. Based on these findings, Nieken (2023) suggests that, especially when communication is transmitted via video messages, verbal and non-verbal signals must be aligned and balanced to convey a congruent and holistic message. Otherwise, it can be disadvantageous.

3.4 Honesty and Promises in One-way Communication

Communication is intended to transmit information in various everyday situations where honesty is crucial. However, incentives for dishonesty may also be present. Policyholders may have financial incentives encouraging dishonesty when reporting insurance claims. Job applicants may exaggerate their experience, skills, or qualifications in application documents to enhance their chances of getting hired or obtaining a higher salary. Such scenarios align with economic models of dishonest behavior, exemplified by experimental paradigms like the die roll task (Fischbacher and Föllmi-Heusi, 2013) or the coin toss task. Research has shown that dishonest behavior is influenced by various factors, including observability, the magnitude of the lie, and potential monetary gains or losses (Abeler et al., 2019; Dufwenberg and Dufwenberg, 2018; Gneezy et al., 2018). In the context of communication, individuals also exhibit a preference for not being seen as liars (Abeler et al., 2014; Khalmetski and Sliwka, 2019), and such image concerns might be impacted when communication channels vary the degree of anonymity or social distance.

Conrads and Lotz (2015) examined how different communication channels (text, audio, and face-to-face) affect dishonesty when subjects report the results of a coin toss task to the experimenter. They revealed that payoff maximizing lying increased when communication channels allowed for higher anonymity and social distance. However, pairwise comparisons on maximum lying were only significant when anonymity and distance were greatest, with subjects reporting their results via text from home compared to face-to-face in the lab. This is in line with research showing

that human presence is vital in honest behavior. Dishonesty was significantly less prevalent when subjects verbally reported their outcomes compared to self-reporting without interaction with the experimenter (Pascual-Ezama et al., 2015), and individuals lied significantly less when interacting with a human compared to a machine (Cohn et al., 2022).[5] Abeler et al. (2014) and Cohn et al. (2022) support the findings that there are no large differences in honesty between audio and text channels. Abeler et al. (2014) showed that only extreme lying behavior was significantly more frequent when outcomes were reported to the experimenter by text-based selection than via phone. The overall results on dishonesty did not differ significantly. Furthermore, subjects were similarly honest when reporting the result of a coin toss task to the experimenter via chat as when they reported it via Skype call (Cohn et al., 2022). Overall, the transition from face-to-face communication to highly anonymous text-based channels may influence honest reporting. However, this effect can be diminished by using less anonymous and richer communication channels, such as audio.

There is little evidence about promising and keeping promises, but it does shed light on the importance of media synchronicity (Conrads and Reggiani, 2017). In a non-binding set-up without formal obligations (taking part in a short online survey),[6] different communication channels that varied according to media richness and synchronicity did not influence behavior regarding keeping a promise. But, making a promise was affected. More synchronous face-to-face, audio, and chat channels yielded similar promise-making rates, indicating that media richness had no impact. However, communication channels with higher media synchronicity compared to asynchronous text channels (online survey in the lab or from home), in which subjects had more time to think about making a promise, resulted in significantly higher promise-making rates.

In summary, anonymous text channels that allow asynchronous communication can increase the risk of dishonest behavior and weaken promise-making. However, using less anonymous and more synchronous communication methods, such as audio, especially when virtual communication is necessary, may help diminish these risks.

[5]The results by Nieken and Walther (2024) support the importance of human presence. They showed that subjects chose text messages significantly more often than video messages when being dishonest compared to being honest and suggested a lower perceived human presence in text messages as a possible mechanism.

[6]The authors intentionally did not financially incentivize promise-making and promise-keeping since they were interested in genuine promises as a pure commitment to help.

4 Discussion

The empirical results suggest that shifting from face-to-face to virtual communication can influence human behavior and decision-making. However, there is some evidence that richer communication channels, such as video or audio, can mitigate these effects and achieve effectiveness comparable to face-to-face communication, especially in two-way communication. In the following, I discuss the empirical results presented in this paper in the context of the ongoing debate about the trend from in-person to virtual work in companies, organizations and research. Thereafter, I address limitations and point out future research opportunities.

In recent years, remote and hybrid work arrangements have gained significant prominence (Barrero et al., 2023; Gallup, 2024). Beyond traditional employment, online labor platforms like Upwork and Amazon Mechanical Turk have also experienced substantial growth (Kässi et al., 2021). Studies suggest benefits such as increased job satisfaction and reduced attrition without compromising performance (Bloom et al., 2022, 2024). Yet, many firms aim to enforce full-time office returns, reflecting a divide between employer and employee expectations (Barrero et al., 2021). This ongoing debate on the future of work is shaped by evolving communication dynamics and reliance on virtual communication channels (Yang et al., 2022). The empirical findings in this paper contribute to this discussion.

In two-way interdependent strategic interactions, especially in group projects or negotiations, selecting appropriate communication channels is crucial. Relying solely on text channels can be risky and decrease group cooperation (Bochet et al., 2006; Frohlich and Oppenheimer, 1998; Rockmann and Northcraft, 2008), prosocial behavior (Greiner et al., 2014) and reciprocity (Bicchieri et al., 2010; Lev-On et al., 2010). Although evidence is still scarce, video channels can close this gap compared to face-to-face communication, particularly when cooperation is essential (Brosig et al., 2003; Rockmann and Northcraft, 2008). In settings where creativity and innovation are vital, empirical evidence suggests that fully remote work environments may pose challenges. While video communication channels can be just as effective as face-to-face interactions in a highly visual creative task that requires collaboration (Grözinger et al., 2020), research highlights the advantages of face-to-face communication in fostering creativity (Brucks and Levav, 2022; Grund et al., 2025), which is consistent with the findings of a comparison of office, remote, and hybrid work arrangements (Gibbs

et al., 2024). However, these caveats can be mitigated by switching from fully remote to hybrid settings (Grund et al., 2025), which supports adopting hybrid work as an effective working arrangement (Choudhury et al., 2024). For dishonest behavior in one-way communication, there seem to be no large differences when transitioning to virtual communication, nor when comparing audio and text-based communication (Abeler et al., 2014; Cohn et al., 2022; Conrads and Lotz, 2015). But, when aiming to shape the behaviors of others, e.g., to motivate online workers or to increase donations via messages, findings are more mixed. In such contexts, for instance, when CEOs address employees, politicians communicate with the public, or researchers provide instructions to subjects, more cues or signals are not always better. Video messages that include non-verbal cues and signals are not always beneficial and can be less effective than less rich messages via text or audio (Nieken, 2023; Zylbersztejn et al., 2024b). It is crucial to ensure that verbal and non-verbal information is aligned to convey a consistent message (Nieken, 2023). In summary, this paper shows that relying solely on virtual communication channels when working remotely can present challenges. However, these challenges can be mitigated by adopting proper communication strategies, suggesting that traditional office work is not necessarily required. Hybrid working arrangements that leverage the benefits of remote and in-person work can be an effective approach to exploit the full potential of communication.

Beyond its implications for the workplace, this review offers valuable suggestions for experimental research involving communication. The shift from physical laboratories to online environments has been accelerated by platforms such as Prolific and Amazon Mechanical Turk (Douglas et al., 2023). In 2022 alone, over 150,000 studies were published on Prolific (Tomczak et al., 2023), illustrating the growing reliance of researchers on virtual communication channels for conducting research. During the design phase of a study, selecting a particular communication channel, whether for interaction between subjects or for transmitting information from experimenters to subjects, is a critical decision that should not be neglected. This choice can significantly influence how subjects behave, potentially introducing unintended effects. Furthermore, when comparing and discussing findings across different studies in literature reviews or meta-analyses, the used communication channel might impact the comparability of results (e.g., as demonstrated in Balliet (2010)). Consequently, overlooking this factor, where communication plays an important role, may lead to overly simplistic conclusions.

It is important to emphasize that this review is only a first step towards understanding how face-to-face and various virtual communication channels influence human behavior and decision-making. One limitation is that empirical findings from only 21 experimental studies are synthesized, implying that the current state of research limits the conclusions and implications. The impact of communication channels in cooperative environments has been studied more extensively, revealing some mixed findings. While Abatayo et al. (2018) found no significant differences between face-to-face and text communication in fostering cooperation within a public goods game, several other studies have demonstrated the superiority of face-to-face communication and richer communication channels in enhancing group cooperation (Bochet et al., 2006; Brosig et al., 2003; Frohlich and Oppenheimer, 1998; Rockmann and Northcraft, 2008). Although the experimental settings differed to a greater or lesser extent, such as in the experimental task or group size, the more recent findings by Abatayo et al. (2018) may suggest that individuals have become increasingly accustomed to virtual communication, potentially diminishing the differences observed in earlier research. However, further studies are needed to gain a more comprehensive understanding of this possible phenomenon. Besides cooperation, there is still a lack of research on trust, reciprocity, negotiation, and creativity. Moreover, behavior in some key economic settings has yet to be studied in the context of various communication channels, including coordination (Brandts and Cooper, 2006; Van Huyck et al., 1990), lying between subjects (Gneezy, 2005; Gneezy et al., 2013), or competitive behavior in contests (Konrad, 2009). Therefore, this paper emphasizes that expanding research across different settings and communication channels is essential to fully understand how communication affects behavior and decision-making.

Another limitation is identifying mechanisms that explain why different communication channels influence behavior and decision-making in certain situations. Communication channels can vary in several characteristics. This makes it difficult to draw causal conclusions or derive mechanisms, especially when comparing rich face-to-face or video communication with text-based channels, which are compared in almost half of the experimental studies reviewed in this paper (see Figure 2). Some studies addressed this challenge by using standardized messages to isolate the effects of para-verbal and non-verbal information, thus allowing a more distinct understanding (Babutsidze et al., 2021; Nieken, 2023; Zylbersztejn et al., 2024b). They reveal that it is possible to identify mechanisms when thoroughly designing experiments. For instance, future research could compare audio com-

munication without photos of subjects' faces with audio communication including subjects' faces to isolate the effect of anonymity and identification. In addition, Brucks and Levav (2022) conducted in-depth analyses using state-of-the-art eye-tracking technology to show that the physical nature of video communication was a mechanism that hindered creativity in teams. Such technologies might also reveal interesting outcomes when comparing text, audio, and video communication channels. Moreover, using methods such as latent Dirichlet allocation (Blei et al., 2003) or other communication content analysis tools allows the analysis of the communication content in interactive settings without restricting communication or employing standardized one-way messages.

5 Conclusion

This paper presents a comprehensive literature review examining current empirical findings on how face-to-face and virtual communication channels affect human behavior and decision-making. I focused on three virtual communication channels—text, audio, and video—alongside face-to-face. The experimental findings revealed that in two-way communication, shifting communication from face-to-face to virtual communication channels can reduce the positive impact of communication. This can be reduced by utilizing more rich video communication channels. In one-way messages, higher media richness is not always beneficial. In particular, video messages aimed at motivating employees or encouraging donations can be equally effective or even less effective than text or audio messages, indicating potential risks associated with increased non-verbal information. The findings presented in this paper are particularly relevant given the ongoing shift toward virtual environments in both the workplace and research. They underscore the importance of selecting appropriate communication channels to increase effectiveness in various settings and thus inform decision-makers in companies and organizations that rely on remote and hybrid work environments and researchers who conduct experiments on online platforms. However, this review serves only as an initial step toward a more comprehensive understanding of the topic, highlighting the need for further research to refine and expand these insights.

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A Methodology for this Literature Review

I conducted a literature review focusing on experimental studies within the economic discipline. The review process followed a structured methodology (Kitchenham and Charters, 2007; Webster and Watson, 2002) to ensure comprehensiveness and relevance through an in-depth understanding of the addressed interdisciplinary research topic.

Based on prior knowledge and a broad search on Google Scholar, I identified key papers investigating the effect of communication channels on human behavior and decision-making. These preliminary findings helped me to develop a search string to expand the scope of relevant studies. The final search string was: "communicat* AND (channel OR media OR mode OR form) AND experiment*." The search string was designed to capture a wide range of studies by incorporating different terminologies.[7] To get a broad picture of the relevant studies, I used Web of Science and Scopus as digital databases for my search. I included the Web of Science categories "Business," "Economics," and "Management" in my search in Web of Science (1082 hits) and the subject areas "Business, Management and Accounting" and "Economics, Econometrics and Finance" in my search in Scopus (2222 hits). In the first step, I scanned the title, abstract, and keywords (and full text when needed) and used two inclusion criteria to select appropriate studies to answer my research questions. Due to the focus of this paper, the first criterion was to include only studies that compared two or more of the following communication channels: text, audio, video, and face-to-face. The second criterion was only to include experimental studies to increase comparability. After this initial search, it became apparent that the research topic is inherently interdisciplinary and encompasses several research fields, such as economics, information systems, human-computer interaction, psychology, marketing, accounting, and decision sciences. I intended to focus on studies published in the field of economics, so I decided to develop two additional criteria. Both criteria were used to ensure that differences in methodological approaches did not overly constrain the comparability of results across the selected studies. Thus, I included papers that used standard economic paradigms (e.g., the trust game (Berg et al., 1995), public goods games, the coin toss task, the ultimatum game (Güth et al., 1982)) to investigate human behavior and decision-making. These paradigms are extensively employed in research, making them a well-established foundation for analysis (see e.g., Abeler et al., 2019; Engel, 2011; Johnson and Mislin, 2011; Oosterbeek et al., 2004; Zelmer, 2003, for meta-studies of the coin toss task, the dictator game, the trust game, the ultimatum game, or public goods games). In addition, they provide a common framework for benchmarking results across diverse studies, facilitating meaningful comparisons. Moreover, I applied a fourth criterion, regardless of whether a standard economic paradigm was used or not, and included studies in which subjects' behavior was financially incentivized, as is common in experimental economics (Azrieli et al., 2018; Burke et al., 1996; Charness et al., 2016; Harrison, 1994; Loewenstein, 1999; Voslinsky and Azar, 2021). Lastly, I applied a backward and forward search

[7] There are several alternative terminologies for "channel" in the context of communication across various research fields: communication media (see, e.g., Brosig et al., 2003; Sussman and Sproull, 1999), communication mode (see, e.g., Frohlich and Oppenheimer, 1998), communication form (see, e.g., Bochet et al., 2006),

based on the selected studies to ensure all relevant studies were included. This left me with a final list of 21 relevant papers.