Leading via virtual communication: a longitudinal field experiment on work team creativity in an extreme context

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Abstract

COVID-19 has prompted diverse responses from governments and created an extreme context for organizations to operate. In this context, company leaders face fluctuated macrolevel policies, endure physical separation from their members, and must rely on virtual communication to conduct teamwork. Yet little is known about what and how leader communication can be effective in inducing team creativity to survive the extreme context. Building on the affective events theory and the literature on media richness, we develop a theoretical model explicating how leaders' rich (as opposed to lean) virtual communication can mitigate the negative impact of stringent government responses to COVID-19 on work team creativity via a sequential mediation process: first by inhibiting team anxiety and then by facilitating team information elaboration. Data from a three-stage eight-day longitudinal field experiment, in combination with an experience sampling method with 251 employees, on a chain preschool in eight Chinese cities, provide strong support for the hypothesized model.

Keywords Extreme context · Richness of leader virtual communication · Stringency of government responses to COVID-19 · Team anxiety · Team information elaboration · Team creativity

Introduction

Since the breakout of COVID-19 in early 2020, over 100 countries had issued pandemic policies and 436 million firms had suffered from serious disruption in daily operation (Hale et al., 2020; International Labor Organization, 2020a). The *stringency of government responses to COVID-19*, which refers to the strictness of policies a government places to prevent the spread of the pandemic (e.g., workplace

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closures, travel restrictions, and stay-at-home orders; Hale et al., 2020), creates an *extreme context*, involving remote work, lasting environmental threats, and fluctuated macrolevel policies, for firms' survival (Hannah et al., 2009).

In extreme contexts, creativity is often instrumental for firms' survival (Chen et al., 2018). According to the report from International Labor Organization (2020b), during COVID-19, 78% of the 4,530 surveyed firms across 45 countries introduced certain creative solutions to survive. In China (our research context), for example, the new retail platform Freshhema (盒马生鲜) created an employee sharing business model, in which it collaborated with department stores and restaurants to engage their idle employees to handle the soaring online orders (Xinhua, 2020). The commercial vehicle manufacturer Yutong (宇通) invented smart buses to upgrade its products' performance in protection against coronavirus (Urban Public & Transport, 2020). Numerous companies imported the corporate communication and office tool WeCom to facilitate remote working (Cui, 2020). As stringent government responses to COVID-19 cause the sudden stop of normal business and the dramatic changes of work mode, traditional ways of business operation, service delivery, and employee management often fail. Finding new and creative solutions thus becomes especially essential in this context.

In extreme contexts, leadership plays a critical role to facilitate employee creativity for firms' survival. Organizational scholars have found that leaders are effective in extreme contexts when they can help members to make sense of the complex contexts, improve problem-solving and resilience, facilitate learning, or foster positive changes such as building psychological safety, compassion, and coping with negative emotions (Hällgren, Rouleau, & de Rond, 2017; Hu et al., 2020; James et al., 2011). During COVID-19, when local governments varied substantially in their responding speed to COVID-19, stringency of responses, and intervals of policy adjustments, such variation provokes uncertainty and equivocality that exceeds work teams' coping capability, which tend to trigger members' anxiety and activate their withdrawal and self-protective behaviors (Grant & Wade-Benzoni, 2009; Weiss & Cropanzano, 1996). Meanwhile, partly due to the lockdown and social distancing orders, the physical separation between leader and member and between member and member creates communication difficulties due to information loss and feedback delay (Avolio et al., 2000; Bell et al., 2019; Liao, 2017). As ambiguous extreme situations often induce a desire to be with others (Schachter, 1959), a lack of close in-person interactions heightens the psychological threats of the pandemic and thrusts leaders' virtual communication into the spotlight.

In this paper, we examine how stringent government responses to COVID-19 impact work team creativity and how the richness of leaders' virtual communication would moderate such impact. *Virtual communication* is characterized by virtuality, commonly referring to an entity's use of information technologies to facilitate cross-boundary communication to accomplish critical tasks (Gibson & Gibbs, 2006; Kirkman & Mathieu, 2005; Raghuram et al., 2018). In this paper, we define *leader virtual communication* as leaders' communication behaviors via the use of information technologies to exert social influence on members (Avolio et al., 2000, 2014; Larson & DeChurch, 2020; Liao, 2017). This definition draws on theoretical insights from the media richness literature that highlights media capabilities to reduce communication

barriers caused by physical separation (Daft & Lengel, 1986; Dennis et al., 2008; Short et al., 1976; Sproull et al., 1991; Yoo & Alavi, 2001). Accordingly, leaders can adopt *rich virtual communication* based on communication means – their choice of communication medium that delivers rich symbols (i.e., video conferencing delivering verbal and non-verbal symbols vs. text messaging delivering verbal symbols only) – and communication content – the extent to which the communicated information is valuable for team effectiveness (i.e., informational value) (Daft & Lengel, 1986; Kirkman & Mathieu, 2005). To explicate the social influence exerted by the richness of leader virtual communication, we differentiate the outcome of team creativity from its process. Specifically, *team daily ideation* refers to a process of generating novel and useful ideas (the diverging aspect) and selecting ideas that may lead to solutions (the converging aspect) (Basadur et al., 1982; Gielnik et al., 2012; Kier & McMullen, 2018; Perry-Smith & Mannucci, 2015), while *team creative solution* refers to the outcome of that process indexed by the solutions' novelty and usefulness (Amabile, 1996; Shin & Zhou, 2007).

Drawing from the affective events theory (Weiss & Cropanzano, 1996), we propose that the events of government responses to COVID-19 trigger team members' negative emotion of *anxiety*, which is one of the most described emotional states that arise from the presence of uncertain, unpredictable, and ambiguous events (Lazarus & Lazarus, 1991; Lerner & Keltner, 2000; Lerner et al., 2015). Team anxiety would then negatively impact team cognitive functioning, manifested by *team information elaboration* – "the exchange of information and perspectives, individual-level processing of information and perspectives, the process of feeding back the results of this individual-level processing into the group, and discussion and integration of its implications" (van Knippenberg, de Dreu, & Homan, 2004). We then integrate the literatures on team virtuality and media richness to propose that when leaders adopt rich (as opposed to lean) virtual communication, compared to pre-intervention conditions, the negative impact of stringent government responses to COVID-19 on team anxiety will be weakened, which would facilitate team information elaboration, result in better team ideation in daily operation, and eventually lead to more creative solutions for the work team.

We conducted a three-stage longitudinal field experiment in China during COVID-19 from February to April 2020, by randomly introducing leader virtual communication interventions (rich vs. lean) to 32 work teams in 12 chain preschools across eight cities, where local governments intensively responded to COVID-19 and differed in the stringency of their policies across time. To explore the mechanisms underlying team creativity, we adopted an experience sampling method (Beal, 2015) by using eight-day survey data on daily fluctuations of team anxiety, team information elaboration, and team daily ideation.

Our paper makes notable contributions to the literature on leadership and team dynamics in extreme contexts. We focus on leader communication behaviors to study their influence on team functions in an extreme context where governments must respond to COVID-19 and pose stringent policies on citizens, which is a common practice in the Asian Pacific region today but has never caught scholarly attention until now.

Moreover, we articulate and test the underlying affective and cognitive mechanisms that explain why leaders' rich virtual communication is effective in inhibiting team anxiety caused by the government policies and facilitating team members' information elaboration to develop creative solutions to manage crisis. By empirically testing these mechanisms in China, we also provide insights to the team management literature for collectivist countries in the Asian Pacific region where people accept power distance and are more likely to appreciate leaders' rich virtual communication in extreme contexts.

Finally, we enrich the emotion and creativity literature by exploring a discrete emotion, i.e., anxiety, and its relationship with creativity at the team level, and by distinguishing team daily ideation process from team creative outcome. Our findings also demonstrate the importance of facilitating team cognitive process of information elaboration in a virtual environment, which should involve interdependent actions of multiple team members rather than the conventional view of an individual's own emotional reaction to extreme contexts.

Theoretical background and hypotheses

Stringency of government responses to COVID-19 and team anxiety

The affective events theory states that events are proximal causes of affective reactions that influence people's attitudes and affect-driven behaviors. While the primary appraisal of an event determines its relevance and valence to one's goals, the secondary appraisal involving sensemaking of an event elicits emotions (Weiss & Cropanzano, 1996).

According to this theory, we argue that stringent government responses to COVID-19 may heighten employees' awareness of the obstruction of the pandemic to their valued goals such as health, money, job security, and social connectedness (i.e., the primary appraisal). Studies have shown that governments' lockdown policy increased people's mental distress (Sibley et al., 2020) and the society's unemployment (Auray & Eyquem, 2020); their announcement of social distancing orders reduced stock market returns (Ashraf, 2020); their restrictive economic policies enhanced perceived vulnerability to COVID-19 (Badea et al., 2021). Moreover, such awareness of the impact of COVID-19 policies on people's valued goals will trigger people's automatic and rapid cognitive appraisal process (i.e., the secondary appraisal; Weiss & Cropanzano 1996). In this process, employees assess the probability and magnitude of the negative consequences caused by stringent government responses to COVID-19, and the extent to which they can cope with the restrictions and alleviate different forms of threats to their own work. Strong emotions often emerge with such assessment.

Emotions are experiential, intense, and episodic (Frijda, 1993); they are context specific (Weiss & Cropanzano, 1996). One challenge of studying emotions in extreme events is to identify the relevant discrete emotions that may be elicited. For instance, the explosion in Beirut led to widespread anger at the government for being so negligent in handling thousands of tons of explosive material (Hubbard et al., 2020); but

the outbreak of COVID-19 induced fear and anxiety related to mortality as people see the rising number of deaths in social media or on TV (Hu et al., 2020). Besides the theoretical consideration of anxiety as a result of turbulent events (Lazarus & Lazarus, 1991; Lerner & Keltner, 2000; Lerner et al., 2015), we also inductively explored the type(s) of negative emotions people experienced in this context. We conducted a preliminary study with an open-ended question on experienced emotions during the pandemic (see Methods). While participants reported several negative emotions such as fear, despair, and helplessness, anxiety was the emotion identified by the majority (>80%) as a salient emotional experience.

We expect that team anxiety is likely to emerge from team members' anxiety resulting from the events of government policies. Such emergence may rise from a bottom-up process. Previous studies show that individuals can recognize others' emotional cues in the workplace (for a review, see Barsade et al., 2018), even with text-only communication (Butts et al., 2015). They then show an automatic tendency to mimic each other's affects and behave similarly (Bandura, 1986; George, 1990; Gump & Kulik, 1997; Kelly & Barsade, 2001). Facing uncertainty and equivocality, they may also search for confirmation and certainty from each other on what they should behave and feel, anxiety thus can spread among team members via social contagion (Barsade, 2002). Moreover, the emergence of team anxiety from individual anxiety may also happen via a top-down approach. As the pandemic has induced fear and anxiety among the whole society (Hu et al., 2020), the anxious social climate provides information cues for team members to construct and interpret the events of stringent government policies (Salancik & Pfeffer, 1978). For example, team members may talk about death and infections of the pandemic during their meetings and interpret the stringent government policies as a sign of the increasingly severe pandemic, focusing on the threatening aspects of the COVID-19 policies on their work or life in general. These negative cognitions are likely to associate with anxiety (Cheng & McCarthy, 2018), which may result in the individual experiencing the same anxiety within a team.

Governments responded to COVID-19 differently, ranging from the most stringent policies such as total lockdown in which everyone was rigorously enforced to stay at home, to least stringent policies such as only releasing nonbinding recommendations to decrease citizen's mobility. These responses also changed over time as the severity of pandemic fluctuated. The more stringent government responses to COVID-19 entail higher levels of uncertainty and equivocality. They are likely to induce the feeling of loss of control in employees, which lead to higher team anxiety. For instance, the stringent total lockdown policy takes away the opportunity for face-to-face communication and improvisational interactions in the workplace. It also fundamentally changes work routines, making past experiences less relevant. The closure of social life such as entertainment and public transportation also prompts people to wonder if they are losing freedom and distorts their judgment toward great negativity. But when the government responses become less stringent, people may expect that the pandemic would be over soon, and they can have their life back in control. Meanwhile, as individual mobility is not strictly forbidden, work team members can choose to meet in person, albeit in face masks and with social distancing (alleviating some affiliative concerns). We thus reason that team members are likely to experience

more (less) anxiety caused by higher (lower) uncertainty and equivocality on the days when the government releases more (less) stringent policies on COVID-19 (Lerner et al., 2015; Weiss & Cropanzano, 1996). Formally, we propose:

Hypothesis 1 The stringency of government responses to COVID-19 will be positively related to team anxiety: when government responses to COVID-19 become more stringent, a work team will experience higher anxiety.

Team anxiety, team information elaboration, and team daily ideation

In line with the affective events theory (Weiss & Cropanzano, 1996), Lerner and Keltner propose that activated emotions can trigger "a cognitive predisposition to appraise future events in line with the central-appraisal dimensions that triggered the emotion" (Lerner & Keltner, 2000). This appraisal-tendency process suggests that feeling anxious will lead to appraisals of loss of control of future events (Lerner et al., 2015). As such, it will activate members' behavioral withdrawal and inhibit their information sharing, discussion, and integration (i.e., team information elaboration) (Grant & Wade-Benzoni, 2009). As emotions are intense and episodic (Frijda, 1993; Weiss & Cropanzano, 1996), we expect that such an appraisal-tendency process would happen on a daily basis.

Specifically, when anxiety triggers the appraisal tendency of situational uncertainty, team members will direct their attention to specific cues to quickly address the emotion-eliciting negative events (Fredrickson, 1998; Fredrickson & Branigan, 2005). In the pandemic, the triggered anxiety could narrow team members' scope of attention to the pandemic-relevant information (e.g., positive cases of COVID-19 on that day, workplace hygiene, workplace human-to-human transmission of coronavirus), rather than on work assignments. Moreover, when team members feel anxious, they may engage in self-protective behaviors by withholding information or reducing job engagement (Grant & Wade-Benzoni, 2009; Hu et al., 2020). They may also ignore diverse information (Gladstein & Reilly, 1985), discount domain-specific expertise (Gardner, 2012), discourage divergent conversations (Gersick, 1988, 1989), or reduce confidence in coming up with useful information to address the uncertainty (Schwarz & Clore, 2003). These reactions will hurt the breadth and depth of team information elaboration.

In addition, studies on information technology use suggest that anxious people are likely to resist the adoption of new technology because anxiety could decrease the perceived ease of use and usefulness of virtual tools (e.g., online teaching for toddlers during the lockdown). Anxiety also reduces one's self-efficacy in using new technology and creates psychological distance with the technology (Beaudry & Pinsonneault, 2010; Thatcher & Perrewé, 2002). In sum, team anxiety elicited by government responses to COVID-19 would decrease team information elaboration, not only because team virtuality limits the breadth and depth of knowledge sharing as information is often contextual and tacit (Cramton, 2001; Gibson & Gibbs, 2006), but also because anxious team members are less willing to use virtual technology in executing and coordinating their work. Taken together, we propose:

Hypothesis 2 Team anxiety will be negatively related to team information elaboration: when a team feels more anxious, they will be less likely to engage in information elaboration.

In addition, team daily ideation involves a process of generating and selecting creative ideas which may lead to creative solutions (Basadur et al., 1982; Gielnik et al., 2012; Kier & McMullen, 2018; Perry-Smith & Mannucci, 2015). Previous studies conducted in normal work contexts have suggested that a team's creative ideas often arise from the recombination of diverse information and viewpoints and the interagtion of this information into a joint solution, rather than individual contributions (Hoever, Zhou, & van Knippenberg, 2018; Oldham & Cummings, 1996; van Knippenberg et al., 2004). As such, team information elaboration is key to team daily ideation.

Compared to those in a stable environment, in the turbulent environment where previous work routines can no longer be relied upon, knowledge sharing and information integration become more essential for teams to come up with creative ideas (Resick et al., 2014; Sung & Choi, 2012). The uncertainty and equivocality caused by the pandemic heighten the importance of in-depth deliberation and integration of each team member's unique ideas in generating new ways to address emerging problems and unpredictable environmental demands. We therefore expect that teams with less information elaboration will do worse on team daily ideation during the pandemic.

Taken together, we propose:

Hypothesis 3 Team information elaboration will mediate the negative effect of team anxiety on team daily ideation: when a work team experiences more anxiety, its members are less likely to engage in information elaboration, which in turn will impair team daily ideation.

The moderating effect of leaders' rich virtual communication

Communication is one of the key aspects of leadership (Mintzberg, 1973). Via coordinating different activities or people, the purpose of communication is to reduce interpersonal, task, or environmental uncertainties to achieve collective goals (Gardner et al., 2001). As the stringency of government responses to COVID-19 induces team anxiety, one essential function of team leadership is to manage members' anxiety so that they can cope effectively. Though emotion management could be achieved via various leadership behaviors (for reviews, see Hällgren et al., 2017; James et al., 2011), in the pandemic, leaders can only rely on virtual communication.

Based on the affective events theory (Weiss & Cropanzano, 1996), we argue that when team anxiety is elicited by the events of stringent government responses to COVID-19, leaders' use of rich virtual communication can help inhibit team episodic anxiety, because the means and content of leaders' rich virtual communication together are likely to provide social certainty and task certainty. Specifically, virtual communication medium differs in its capabilities to deliver information and facilitate

the communication process (i.e., the means, Dennis et al., 2008). Different from an information-lean medium such as text messaging that sends explicitly coded message, an information-rich medium such as video conferencing contains more natural symbol sets such as physical, visual, non-verbal, and verbal symbols that are faster to encode and rich in meanings (Dennis et al., 2008). By using information-rich medium, leaders can convey personal feelings via non-verbal cues (Short et al., 1976; Yoo & Alavi, 2001), increase leader-member psychological closeness, and maintain or strengthen social bond. Moreover, communication information differs in its value for team effectiveness (i.e., the content, Kirkman & Mathieu 2005). More valuable information provides clearer and more meaningful guidance. It helps facilitate team members to reach a mutual understanding (Richard, 1986). By delivering such valuable messages, remote leaders can elaborate on team goals, help make sense of the on-going uncertainty as needed, and facilitate team coordination.

Moreover, as leaders provide social certainty and task certainty to members via the rich means and content of virtual communication, members are less likely to feel that their valued work goals such as social connectedness and job security are threatened by the stringent government policies (i.e., the primary appraisal; Weiss & Cropanzano 1996). Moreover, these two types of certainties would also reduce team members' feeling of loss of control in the process of the secondary appraisal (Weiss & Cropanzano, 1996) on the stringent government policies. For example, with the concrete and accessible help from leaders via rich virtual communication, they may feel more confident in coping with the policy restrictions and alleviating potential threats to their teamwork. As a result, teams would feel less anxious. Taken together, we propose.

Hypothesis 4 Leaders' virtual communication richness will moderate the positive relationship between the stringency of government responses to COVID-19 and team anxiety: when leaders use rich virtual communication, compared to the pre-intervention condition, the positive effects of the stringency of government responses to COVID-19 on team anxiety will be weaker.

As proposed in Hypothesis 3, team information elaboration mediates the negative effect of team anxiety on team daily ideation. Building on the moderating effect of leaders' virtual communication richness proposed in Hypothesis 4, we propose a moderated sequential mediation regarding how the stringency of government responses to COVID-19 interact with leader virtual communication richness to eventually affect team daily ideation. Formally,

Hypothesis 5 Team anxiety and team information elaboration are two sequential mediators between the joint effects of the stringency of government responses to COVID-19 and team leader's virtual communication richness on team daily ideation: when a team leader uses rich virtual communication, the team anxiety caused by the stringency of government responses to COVID-19 would be less severe, the team will engage in more information elaboration, and in turn will achieve better daily ideation (moderated sequential mediation).
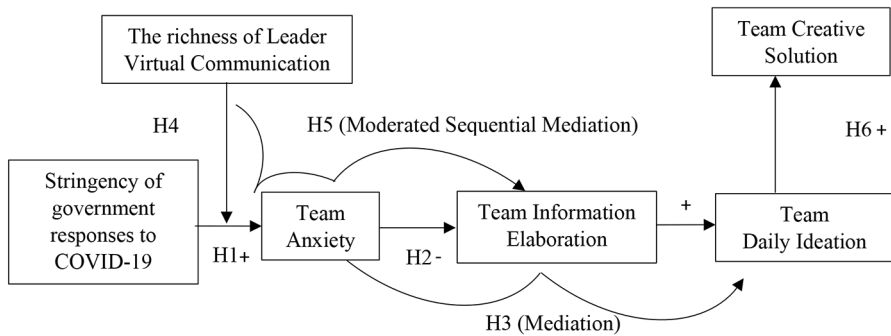
Fig. 1 Theoretical Framework

Team daily ideation and team creative solution

Prior research on creativity has distinguished creative outcome from process (Amabile, 1988; Amabile & Pratt, 2016): team creative solution is the outcome of successfully implementing creative ideas generated and selected during the team ideation process. We expect that higher team daily ideation would eventually reflect in better team creative solutions as the outcome, as by generating and selecting novel and useful ideas every day, at the end of the team project, teams should have accumulated a better, if not larger, pool of creative ideas. We therefore propose:

Hypothesis 6 Team daily ideation will have a positive effect on team creative solution.

The overall theoretical model is presented in Fig. 1.

Method

Research context and participants

We conducted a three-stage longitudinal field experiment in the preschool education industry in China during COVID-19 from February 24 to April 24, 2020. With support from the CEO of a chain preschool, we recruited all 251 employees in 12 subsidiary preschools across 8 cities in six provinces. These preschools were equivalent in organizational structures, staff composition, and managerial systems. They organized daily work on team basis (see Appendix A for typical teamwork and leaders' use of virtual communication media before COVID-19). Our experimental tasks were introduced as part of their daily work for existing work teams. The chain preschool had a total of 32 work teams with a mean size of 7.84 employees (*s.d.* = 4.01) and an average team leader experience of 5.71 months (*s.d.* = 4.68). Team leaders were principals or vice principals and were appointed by the headquarter. Team members took diverse job roles, such as teachers, childcare workers, and support staff (e.g., chef, driver, security guard). Their majors included education, childcare, linguistics,

management, IT, law, and art. Of the sample, 73.7% had a bachelor or more advanced degree; 97.6% were female. The average age was 27.61 years old (*s.d.* = 9.98) and organizational tenure was 18.84 months (*s.d.* = 12.81).

The impact of COVID-19 on preschools

During COVID-19, all students were staying at home because of school closure mandated by the government, creating a sudden extreme context. The schools stopped most daily operations (see Appendix A for operations) and only maintained those without offline interactions with students, such as new student recruitment in our study, as the schools aimed to use social media to attract new students who were willing to pay for the tuition deposit during COVID-19 and join the schools afterwards. New student recruitment was vital to improve the schools' cash flow to survive in the pandemic. Yet, the sudden stop of normal business and government restrictions had left the schools with no choice of traditional ways to recruit new students (e.g., an open class, a home visit, distributing leaflets in local malls) but must figure out new and creative solutions. Therefore, team creativity became the key factor for the school's survival in the pandemic.

The impact of COVID-19 on teamwork

Employees either worked entirely from home, or went to the office as usual but practicing social distancing, depending on the headquarter's decision on remote work for each school. The decision was made based on a comprehensive evaluation of the market, customers, competitors, employees, and the government policies. Of the teams, 56% kept working from home during the experimental period. The rest 44% worked in the office at Stage 1 and Stage 2 and then worked from home at Stage 3. Due to the government restrictions on practicing social distancing and the fear of potential human-to-human transmission of the coronavirus, our preliminary field study shows that, regardless of the working place (home or office), team members completely relied on WeChat (WeChat video conferencing or WeChat text messaging) to virtually communicate with each other during the experimental period. As teams with different locations used the same communication channels and both entailed the characteristics of virtual teams (Kirkman & Mathieu, 2005), we also empirically tested whether work locations matter in this context. We used two indicators. One was work location (1 = home, 0 = office). The other was the change of work mode (1 = changed across three stages, 0 = not changed). We did not find the impact of either indicator on the dependent variables in all models. We thus excluded this superfluous control variable from the models.

Incentives

Various incentives were provided. First, the headquarter promoted this Golden Idea Project as one of the most essential daily tasks in the experimental period. Consistent with the preschool's performance evaluation system for any task, project outcomes were formally evaluated, ranked, and openly announced. Second, one team with the

most creative proposal in each stage was selected as the "Golden Idea" winner and every member in that team received rewards from the headquarter. We, as outside researchers, also provided university souvenirs as presents for individual employees to fill in daily surveys.

Experimental design, manipulation, and procedure

Experimental tasks and stages

Our field experiment adopted a three-stage, within-subjects design. The experimental task is a creative proposal to increase student enrollment, called the Golden Idea Project. It aligns with the school's strategy to restore the number of incoming students after a sharp drop caused by COVID-19 (see Fig. 2). It was formally announced by the headquarter as the most essential daily tasks. Teams were given a same definition of creativity tailored to this context as being novel (i.e., a proposal that had not been proposed by the headquarter before) and useful (i.e., attracting students and improving the school's reputation). To achieve the final goal of increasing student enrollment, students must first be attracted and show interest, then pay the tuition deposit. Therefore, the task in Stage 1 was to design a novel and useful plan to attract potential students during COVID-19. The task in Stage 2 was to either improve the plan created in Stage 1 or design a new plan with the same goal. The task in Stage 3 was to design a specific plan to make those students who had been attracted by the creative plans in Stages 1 and 2 pay the tuition deposit.

Aligning with the school's work arrangements, we conducted the first two-stage experiments across two consecutive weeks. Stage 1 was from Feb 24 to Feb 27 and Stage 2 was from March 2 to March 6. We conducted the third stage experiment six weeks later from April 20 to April 24, right after the school finished the implementation of the creative plans produced in Stages 1 and 2.

Experimental procedure

Within each stage, tasks were assigned to team leaders from the headquarter. Team leaders then assigned the tasks to their members following the instructions for the experimental condition they were in. The deadline for submitting the team proposal was the noon of the last day. Table 1 provides descriptive statistics of teams under different experimental conditions. It also shows how the experimental conditions changed over the three stages.

Experimental design

Stage 1 served as a control condition in which leader virtual communication was not manipulated. In Stage 2, we used stratified sampling technique, which allowed us to lower the overall variance in the population and get more precise results of leader virtual communication. First, we followed the school's decision on working locations and got two subsamples: teams working from home and teams working in the office. Then we randomly assigned half of the work teams in the schools that worked from
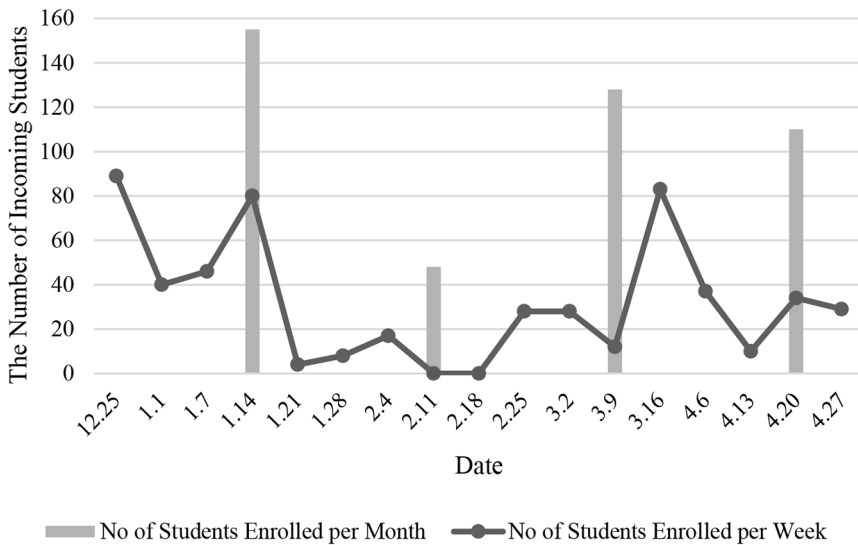
Fig. 2 The Number of Incoming Students before and during COVID-19
Note: (a) incoming students were defined by the preschools as those who had paid for the tuition deposit and would join the school after COVID-19. (b) the timeline: on Jan 23rd, 2020 when Wuhan was closed off, COVID-19 started to impact the daily life in China. Jan 25th to Feb 2nd, 2020 was the Chinese New Year holiday. On Feb 10th, 2020, the employees in this preschool were back to work (either worked from home or practiced social distancing in the office). Feb 24th to Feb 27th was the first stage of our field experiment. March 2nd to March 6th was the second stage. April 20th to April 24th was the third stage

home into "leaders using rich communication" condition and the other half into the "leaders using lean virtual communication" condition. We did the same for the work teams that worked in the office. In Stage 3, we continued the same treatment for the same teams. For each team, we compared the treatment condition (i.e., rich or lean leader virtual communication) with the control condition (i.e., the natural condition without any experimental manipulation). Such an approach could reduce the carry-over effect that the effect from a previous stage's experimental treatment may carry over onto the next stage and subjects may be no longer experiencing the treatment.

Experimental manipulation of leader virtual communication

We manipulated leaders' virtual communication via communicative means and content. Regarding the means, we asked leaders to either use the information-rich medium of WeChat video conferencing at least twice a day or the information-lean WeChat text messaging no more than once per day (Daft & Lengel, 1986). The combination of medium and frequency indicates the total symbol sets a team received per day (e.g., physical, visual, non-verbal, and verbal symbols; Dennis et al., 2008).

Regarding the content, we first gave all teams an information sheet with the same basic information and description of the project, including three goals of the project (i.e., creating a proposal which is novel and useful in content, delivery means, and

Table 1 Descriptive Statistics for Teams under Different Conditions and Randomization Checks

Team Status at Experimental Stage 2	All Teams	Rich LVC, Working from home	Lean LVC, Working from home	Rich LVC, Working in the Office	Lean LVC, Working in the Office	ANOVA Test for Difference
	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	Mean (s.d.)	
Team Characteristics						
Team size	7.84 (4.01)	7.44 (3.84)	8.56 (3.78)	9.00 (6.19)	6.29 (0.76)	$F_{(3, 28)} = 0.648$
Members' age	27.89 (5.54)	25.24 (3.25)	30.83 (6.80)	26.78 (6.44)	28.63 (3.96)	$F_{(3, 28)} = 1.798$
Members' team tenure	6.21 (5.95)	9.88 (7.96)	6.72 (7.40)	3.80 (4.16)	5.48 (4.35)	$F_{(3, 28)} = 1.290$
Members' organizational tenure	18.84 (12.81)	21.35 (12.61)	15.58 (15.01)	7.93 (4.75)	15.98 (10.62)	$F_{(3, 28)} = 1.748$
Leader's leadership tenure	5.70 (4.68)	4.51 (6.43)	5.57 (8.02)	2.16 (2.84)	2.29 (2.56)	$F_{(3, 28)} = 0.675$
Team diversity - grade	0.09 (0.19)	0.00 (0.00)	0.12 (0.25)	0.06 (0.15)	0.19 (0.23)	$F_{(3, 28)} = 1.502$
Team diversity - role	0.52 (0.20)	0.50 (0.14)	0.50 (0.30)	0.58 (0.18)	0.51 (0.15)	$F_{(3, 28)} = 0.291$
Team diversity - gender	0.04 (0.10)	0.00 (0.00)	0.05 (0.11)	0.07 (0.14)	0.07 (0.12)	$F_{(3, 28)} = 0.808$
Team diversity - education	0.45 (0.14)	0.40 (0.16)	0.49 (0.07)	0.41 (0.19)	0.52 (0.12)	$F_{(3, 28)} = 1.353$
Team diversity - major	0.37 (0.25)	0.22 (0.27)	0.48 (0.24)	0.30 (0.14)	0.48 (0.22)	$F_{(3, 28)} = 2.909$
School size	22.66 (11.60)	22.33 (10.69)	25.67 (11.27)	24.71 (17.16)	17.14 (5.01)	$F_{(3, 28)} = 0.788$
Team ideation before the project	4.55 (1.41)	4.44 (1.37)	5.00 (1.81)	3.54 (0.74)	5.11 (0.96)	$F_{(3, 28)} = 2.108$
Team creative solution at Stage 1	5.40 (2.29)	5.44 (2.22)	5.45 (1.04)	6.53 (3.30)	4.18 (2.22)	$F_{(3, 28)} = 1.258$
Team Status across Three Experimental Stages						
Stage 1 (control condition)		Working from home		Working in the office		
Stage 2		Rich LVC, Working from home	Lean LVC, Working from home	Rich LVC, Working in the office	Lean LVC, Working in the office	
Stage 3		Rich LVC, Working from home	Lean LVC, Working from home	Rich LVC, Working from home	Lean LVC, Working from home	
Number of Teams	32	9	9	7	7	

Note: LVC = leader virtual communication

the generating process) with six measuring items (see Appendix B). Then in the rich virtual communication condition, to create valuable information, we added nine additional items with all-inclusive information to further illustrate the six basic items. All information was context-free, meaning that we left the teams flexibility to figure out

whether the information was novel or useful for their proposals (e.g., an open class, a useful student recruiting approach before the pandemic, was no longer feasible; using the social media bilibili.com, a seemly creative approach, was not new in this school). Leaders discussed verbally about this 15-item information sheet via WeChat video conferencing in the rich virtual communication condition (vs. leaders discussed about the 6-item information sheet via WeChat text messaging in the lean condition). We asked members in the rich condition to submit the 15-item sheet daily and those in the lean condition to submit the basic 6-item sheet after the project ended.

Randomization

We did an ANOVA on whether teams under different experimental conditions differed in their basic characteristics, including *team size*, team members' *average age*, *team tenure*, *organizational tenure*, the leader's *leadership tenure*, *team diversity*, and *school size* (i.e., number of employees), and baseline creativity, including team ideation before the experiment, and team creative solution at Stage 1 (control condition). *Team diversity* was measured by Blau's (1977) index of heterogeneity, including diversity in grade, role, gender, education background, and major. The equation is $(1-\sum p_i^2)$, where p_i is the proportion of team members in each of the *i* categories. *Team ideation before the experiment* was assessed by team leaders via a four-item scale developed by Shin & Zhou (2007). Sample items included "how well does your team produce new ideas?" and "how useful are those ideas?" (1=*poorly*, 7=*very much*, $\alpha=0.967$). *Team creative solution at Stage 1* was assessed by two top executives from the headquarter based on teams' proposals (see Measures). The results in Table 1 show that team characteristics and baseline team creativity did not systematically vary across teams in different experimental conditions. Because the randomization checks did not show any pretreatment differences that might contaminate the design of our field experiment, we did not include these superfluous control variables.

Data and measures

We collected data from multiple sources. Before, during, and after the field experiment, we collected interview and observation data as the background information (see Appendix C). We also collected archival data on employee and team demographics for randomization check, and on government announcements for stringency of government responses to COVID-19.

During the experiment, we used an experience sampling method and asked employees to answer an end-of-work survey with the same set of variables (team anxiety, team information elaboration, and team daily ideation) at 7:30pm every day, resulting in eight days' data in total. The purpose was to explore mechanisms driving the results of the field experiment. We slightly adjusted the wordings in the measurement scales to fit the daily context by adding "In today's work…". We also included an attention test item "This question is to test your attention, please choose the answer '1 strongly disagree' for this question." The questionnaires from those who failed this test were deleted from the data analysis (167 out of 1,660 complete questionnaires). Like other daily diary studies, some participants skipped some daily

surveys, though they all participated in the experimental task as team members. The overall response rate, calculated by 1,493 valid daily observations divided by a possible 2,008, was 74.4%. In order by day, the daily response rates were 82.9%, 72.1%, 77.7%, 86.1%, 87.3%, 58.2%, 62.2%, and 68.5%. Following Goodman and Blum's (1996) procedure, we checked the potential effects of subject attrition and found that sample attrition did not impact the results.

Stringency of government responses to COVID-19

Stringency of government responses to COVID-19 reflected extreme events happening in the extreme context of the pandemic. We created a daily-variant index from local governments' official announcements on their COVID-19 policies. First, we manually collected these announcements during the experimental period from local governments' official websites and websites of Municipal Health Commission. We covered all 61 counties in six provinces in China where the 12 preschools were located, as people were impacted by policies not only in their cities but also in nearby cities in the same province. Next, we used an open-coding approach and conducted a content analysis of these announcements (Miles & Huberman, 1994). We also used existing measures for reference (Hale et al., 2020). Eight indicators emerged from the data, including school closing, entertainment closing, workplace closing, essential facility closing, restrictions on public events, restrictions on movement within the city, restrictions on movement within China, and international travel controls. We used a four-point scale to code each indicator (0=*not mentioned*; 1=*mentioned, but no need to close*; 2=*suggest closing*; 3=*must close*). The sum of eight indicators at a given day was used to measure a county's government responses to COVID-19 on that day. The mean score of indexes for all counties within a same province was used as the stringency of government responses to COVID-19 for a particular preschool. The larger the number, the stronger the stringency on a particular day. Notably, the stringency of government responses to COVID-19 is positively related to the severity of COVID-19, but they are not the same. For example, we collected objective data on the severity of COVID-19 and found that the correlation between the stringency of government responses to COVID-19 and the number of daily death cases was only 0.47, and that between the stringency of government responses to COVID-19 and the number of daily new infections was only 0.49.

Team creativity

We used two indexes: team creative solution and team daily ideation. *Team creative solution* was rated by two top executives from the headquarter (Aggarwal & Woolley, 2018; Aime et al., 2013; Hoever et al., 2018). These executives were familiar with each team's work history (e.g., whether an idea was proposed for the first time), but we purposefully did not tell them each team's experimental condition. They independently rated each team's proposal on its novelty (ICC(1)=0.46, ICC(2)=0.63, mean r_{wg} = 0.80) and usefulness (ICC(1)=0.60, ICC(2)=0.75, mean r_{wg} = 0.82) (1=*not novel/useful at all*; 5=*very novel/useful*). Novelty and usefulness each was measured by one overall evaluation and two sub-items: novelty as the extent to which a pro-

posal was (a) original or (b) creatively recombining existing materials, and usefulness as the degree to which a proposal achieved two goals described in the task instruction: student enrollment and the preschool's reputation. We used the product of mean scores of novelty and usefulness as an indicator of a solution's overall creativity at each stage (Hoever et al., 2018). The average α across days was 0.96.

We collected *team daily ideation* data by asking team leaders to rate the team's novelty and usefulness on a particular day's work using Shin and Zhou's (2007) four-item scale (1=*poorly*, 5=*very much*), the same scale for pre-experiment team ideation as described above. The average α was 0.93.

Team anxiety

To identify discrete team emotions, we conducted interviews with team leaders at the beginning of this field experiment (see Appendix C). We also included one open question in the questionnaire in Stage 1, by asking "if you use one word to describe your team's emotion at work today, the word would be_____." Of the employees who used words describing negative emotions, 78.9% reported anxiety (the rest words included isolated, tired, confused, and other idiosyncratic negative words.). To measure team anxiety, we asked team members to rate "In today's work, the extent to which our team felt anxious" (1=*very low*; 5=*very high*). We used the mean score of all members' daily rating to measure team anxiety on a particular day (ICC (1)=0.20, ICC (2)=0.71, mean r_{wg} = 0.71). We did a post hoc check on r_{wg} for leaders' lean communication condition (mean r_{wg} = 0.70) and rich communication condition (mean r_{wg} = 0.72). The strong agreement indicates that leaders' lean communication would not hinder team members to agree on their teams' shared experience of anxiety (LeBreton & Senter, 2007).

Team information elaboration

We measured team information elaboration using a 4-item scale (Kearney & Gebert, 2009). A sample item was "In today's work, our team complemented each other by openly sharing our knowledge" (1=*strongly disagree*, 5=*strongly agree*). Team members' mean score was calculated to measure a team's daily information elaboration (ICC (1)=0.13, ICC (2)=0.59, mean r_{wg} = 0.73). The average α across days was 0.89. Like team anxiety, leaders' lean communication did not hinder team members to agree on their teams' shared experience of team information elaboration (lean: mean r_{wg} = 0.75; rich: mean r_{wg} = 0.76) (LeBreton & Senter, 2007).

Analytical approach

Because our study applied a nested design (multiple time points nested within teams), we conducted multilevel analysis with random coefficient modeling (Raudenbush & Bryk, 2002). We started with a series of unconditional means models to examine whether a hierarchical linear model (HLM) was appropriate to test our hypotheses (Raudenbush, Bryk & Congdon, 2004). First, as time was nested within teams, teams within schools, and schools within cities, we started with a four-level HLM. The

result showed that less than 0.01% of the variability in team daily ideation was at the school level. It did not reach 5%, the suggested threshold for HLM (Bliese, 2000). By fitting a three-level HLM instead (level 1: time; level 2: team, level 3: city), we found that 34% of the variability in team anxiety, 21% in team information elaboration, 17% in team daily ideation, and 18% in team creative solution resided at the city level (Level 3), while 31% in team anxiety, 38% in team information elaboration, 27% in team daily ideation, and 23% in team creative solution resided at the team level (Level 2). Thus, the three-level HLM modeling was appropriate (Bliese, 2000). As all variables changed after the baseline Stage 1, we positioned them at Level 1. Level 2 indicated between-team variations. Level 3 indicated between-city variations. We used group-mean centering for Level 1 variables to examine within-team fluctuation while controlling for between-team confounds (Enders & Tofighi, 2007; Hofmann et al., 2000; Raudenbush & Bryk, 2002). We also compared models with and without random effects of independent variables. ANOVA shows that the model with random effects did not fit the data better than the model without them ($\chi^2 = 22.98$, $p = .290$). Thus, we excluded random effects of independent variable (Raudenbush & Bryk, 2002). The multilevel analysis was conducted with the software R package "lme4" (Bates et al., 2021).

We used the software R package "Mediation" (Tingley et al., 2019) to test the indirect effects. "Mediation" provides an approach that generalizes the Baron-Kenny procedure (Baron & Kenny, 1986). This approach yields more valid estimates of causal mediation effects than traditional mediation tests (e.g., the Baron-Kenny procedure; Baron & Kenny 1986; the MacArthur approach; Chmura Kraemer et al., 2008), and allows for quantifying the robustness of empirical findings (Imai et al., 2010). We used the Monte Carlo Method for constructing confidence intervals for indirect effects (Preacher & Selig, 2010).

Results

Descriptive statistics and manipulation checks

Table 2 presents the descriptive statistics.

We manipulated the richness of leader virtual communication based on its definition of three components (i.e., the use of different media, the frequency of medium use, and the level of richness of task information contained in the communication). The results from the equality of proportion hypothesis test show that the percentage of people in leaders' rich virtual communication condition reported more daily communication with team leader (64% vs. 36%) ($\chi^2 = 9.58$, $p < .01$), more use of video communication (74% vs. 26%) and less use of text-only communication (29% vs. 71%) ($\chi^2 = 23.91$, $p < .001$) than those in the lean virtual communication condition. These results suggest that our manipulation is effective.

Table 2 Descriptive Statistics

Variables	N	Mean	SD	1	2	3	4	5	6	7
1. Team creative solution	96	7.07	4.09		0.03	-0.21*	0.64***	-0.33**	-0.19	0.17
2. Team daily ideation	256	3.78	0.83	0.19		-0.17**	0.06	0.09	-0.23***	0.46***
3. Stringency of government responses to COVID-19	256	6.44	2.39	-0.29**	-0.16*		-0.29***	-0.33***	-0.02	-0.03
4. Leader rich virtual communication [a]	256	0.38	0.49	0.67***	0.01	-0.19**		-0.57***	-0.07	0.08
5. Leader lean virtual communication [a]	256	0.38	0.49	-0.38**	0.07	-0.11	-0.60***		-0.15*	0.17**
6. Team anxiety	256	3.74	0.57	-0.18	-0.26***	-0.07	0.06	-0.17**		-0.48***
7. Team information elaboration	256	4.32	0.46	0.15	0.49***	0.01	-0.08	0.20**	-0.51***	

Note: All variables are at Level 1. The coefficients below the diagonal are Pearson correlation coefficients. The coefficients above the diagonal are partial correlation coefficients controlling for team ID (Level 2) and city ID (Level 3)

a. Reference group is the pre-intervention condition

* $p<.05$, ** $p<.01$, *** $p<.001$

Hypothesis testing

The effects of the stringency of government responses to COVID-19 on team anxiety (Hypothesis1). Model 2a in Table 3 shows that when teams encountered stronger stringency of government responses to COVID-19, they experienced higher anxiety ($\beta=0.06$, $p<.001$), supporting Hypothesis 1.

    Mediation effects of team information elaboration between team anxiety and team daily ideation. Hypothesis 2 stated that team anxiety would negatively affect team information elaboration. Model 3b in Table 3 shows that when teams experi-

Leading via virtual communication: a longitudinal field experiment on…

Table 3 Multilevel Models on Team Daily Ideation and Team Creative Solution

	Team Daily Ideation					Team Anxiety			Team Information Elaboration		Team Creative Solution
Predictor	Model 1a β (s.e.)	Model 1b β (s.e.)	Model 1c β (s.e.)	Model 1d β (s.e.)	Model 1e β(s.e.)	Model 2a β (s.e.)	Model 2b β (s.e.)	Model 2c β (s.e.)	Model 3a β (s.e.)	Model 3b β (s.e.)	Model 4 β (s.e.)
Intercept	3.64*** (0.16)	3.64*** (0.16)	3.64*** (0.17)	3.62*** (0.17)	3.59*** (0.17)	3.77*** (0.14)	3.77*** (0.14)	3.69*** (0.14)	4.36*** (0.10)	4.34*** (0.10)	7.11*** (0.83)
Stringency	-0.06** (0.02)	-0.05* (0.02)	-0.05 (0.05)	-0.02 (0.05)	-0.01 (0.05)	0.06*** (0.01)	0.05*** (0.01)	0.09*** (0.02)	-0.06* (0.02)	-0.03 (0.02)	-0.75*** (0.16)
Rich		0.36** (0.13)	0.31 (0.26)	0.36 (0.26)	0.38 (0.25)		-0.13 (0.07)	0.17** (0.14)	-0.08 (0.13)	-0.04 (0.12)	
Lean		-0.26 (0.13)	-0.19 (0.30)	-0.12 (0.30)	-0.01 (0.29)		-0.02 (0.07)	0.21** (0.16)	-0.28 (0.15)	-0.23 (0.14)	
Rich * Stringency			0.06 (0.17)	-0.02 (0.17)	-0.09 (0.17)			-0.24* (0.08)	0.22** (0.08)	0.17* (0.08)	
Lean * Stringency			-0.07 (0.22)	-0.13 (0.22)	-0.23 (0.22)			-0.17 (0.12)	0.26* (0.11)	0.22* (0.10)	
Team anxiety				-0.34** (0.13)	-0.23 (0.13)					-0.23*** (0.06)	
Team information elaboration					0.45** (0.14)						
Team daily ideation											0.60* (0.27)
Variance Components (Random Effects)											
Level 3	0.12	0.12	0.12	0.12	0.13	0.11	0.11	0.10	0.04	0.04	3.15
Level 2	0.19	0.20	0.20	0.20	0.20	0.11	0.11	0.10	0.09	0.09	5.05

Table 3 (continued)

	Team Daily Ideation					Team Anxiety			Team Information Elaboration		Team Creative Solution
Residual	0.39	0.37	0.38	0.37	0.35	0.11	0.11	0.11	0.09	0.08	6.53
Deviance	543.80	531.36	530.82	523.61	513.10	235.36	232.13	225.48	175.90	161.29	495.29

Note: (1) Level 1: time level, n=256 for Models 1a to 3b; n=96 for Model 4; Level 2: team level, n=32; Level 3: city level, n=8 cities. All variables were at level 1. (2) Leader virtual communication is a time-variant variable at level 1. Reference group is pre-intervention condition. (3) Stringency=Stringency of government responses to COVID-19; Rich=leaders' rich virtual communication; Lean=leaders' lean virtual communication. * $p<.05$, ** $p<.01$, *** $p<.001$
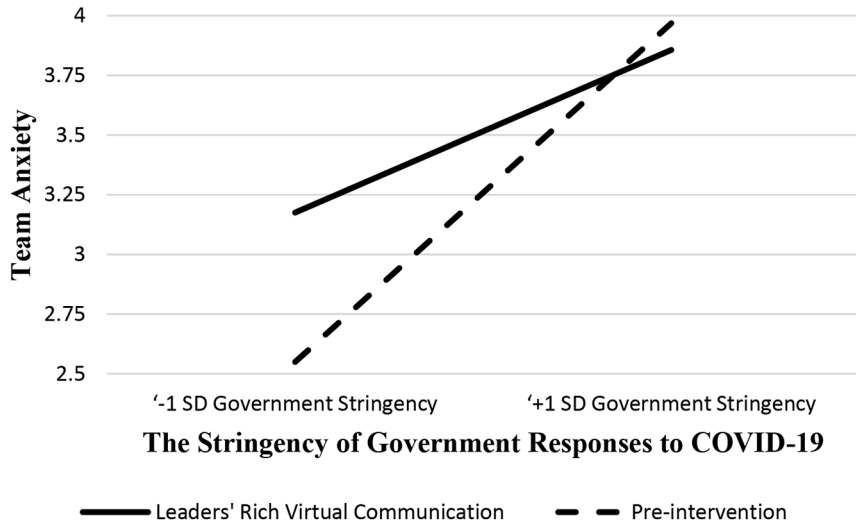
Fig. 3 The Moderating Effect of Leaders' Rich Virtual Communication on the Relationship between the Stringency of Government Responses to COVID-19 and Team Anxiety

enced higher team anxiety, they engaged in less information elaboration ($\beta = -0.23$, $p < .001$), supporting Hypothesis 2.

To test Hypothesis 3 about the mediation effect of team information elaboration on the relationship between team anxiety and team daily ideation, we followed Tingley et al.'s (2019) and Imai et al.'s (2010) approach and conducted 20,000 Monte Carlo replications. The results show an indirect effect of team anxiety on team daily ideation via team information elaboration (indirect effect$=-0.104$, CI_{95} [-0.195 -0.030], direct effect$=-0.231$, CI_{95} [-0.482 0.020]), providing strong support for Hypothesis 3.

Moderation effects of leader virtual communication. Hypothesis 4 stated that leaders' rich virtual communication would moderate the relationship between the stringency of government responses to COVID-19 and team anxiety. Model 2c in Table 3 shows that compared to pre-intervention conditions, leaders' rich virtual communication weakened the impact of the stringency of government responses to COVID-19 on team anxiety (interaction term: $\beta = -0.24$, $p < .01$). As a comparison, leaders' lean virtual communication did not significantly weaken such impact (interaction term: $\beta = -0.17$, $p = .146$), As illustrated in Fig. 3, the moderating effect of leader rich virtual communication was stronger than that of the pre-intervention condition. These results support Hypothesis 4.

To test the moderated sequential mediation effect proposed in Hypothesis 5, we used Edwards and Lambert's (2007) moderated path analysis approach and calculated conditional indirect effects of the stringency of government responses to COVID-19 on team daily ideation via team anxiety and team information elaboration at rich or lean leader virtual communication. Results show that the indirect effect was significant when teams received leaders' rich virtual communication (indirect effect$=-0.05$,

CI_{95} [-0.102 -0.010], direct effect=-0.171, CI_{95} [-0.329 -0.010]), but not when teams received leaders' lean virtual communication (indirect effect=-0.004, CI_{95} [-0.015 0.000], direct effect=0.065, CI_{95} [-0.131 0.000]). The difference between these indirect effects was significant ($\Delta b=-0.05$, $p<.05$, CI_{95}[-0.102 -0.009]). Therefore, our findings provide strong support for Hypothesis 5.

In addition, Model 1a in Table 3 shows that the stringency of government responses to COVID-19 negatively influenced team daily ideation ($\beta = -0.06$, $p<.01$). When team anxiety was added in Model 1d, that effect became insignificant ($\beta = -0.02$, $p=.678$). When team information elaboration was added in Model 1e, that effect became insignificant ($\beta = -0.01$, $p=.927$), so did the effect of team anxiety (team anxiety: $\beta = -0.23$, $p=.069$; team information elaboration: $\beta=0.45$, $p<.01$). These results together indicate that although the stringency of government responses to COVID-19 negatively impacts team daily ideation, leaders' rich virtual communication helped reduce this negative impact through reducing team members' anxiety and increasing team information elaboration, and it is the latter that explains how this chain effect works.

The effect of team daily ideation on team creative solution (Hypothesis6). We aggregated the team-day level data to the team-stage level, as team creative solution was collected at the end of each stage. Model 4 in Table 3 shows that team daily ideation has a positive effect on team creative solution ($\beta=0.60$, $p<.05$), supporting Hypothesis 6.

Supplementary analyses: between-team variation

Beyond the change of team creativity for a given team pre and post the intervention of leader virtual communication, we conducted a supplementary analysis on whether our experimental intervention influenced team creative solution. Specifically, we conducted between-subjects ANOVA to explore the impact of leader virtual communication (rich vs. lean) on team creative solution at Stages 2 and 3. In Stage 2, one-way ANOVA showed a significant difference of team creative solution between conditions of leaders' rich ($m=9.18$, $s.d. = 4.34$) and lean virtual communication ($m=4.11$, $s.d. = 2.65$) ($F_{(1,30)}=15.90$, $p<.001$). In Stage 3, one-way ANOVA also showed that team creative solution was significantly higher in leaders' rich ($m=12.64$, $s.d. = 2.58$) than lean virtual communication ($m=5.68$, $s.d. = 2.72$) conditions ($F_{(1,30)}=55.18$, $p<.001$). These results again suggest the effectiveness of leader rich virtual communication in facilitating team creative solutions.

Discussion

This study examines how the richness of leader virtual communication mitigates the negative impact of the stringency of government responses to COVID-19 on team creativity. By conducting a three-stage longitudinal field experiment in a chain preschool in China, we find that leaders' rich virtual communication helps work team cope with daily anxiety, facilitate information elaboration and daily ideation, and

eventually improve team creative solution, which is vital for team survival in a turbulent environment.

Theoretical contributions

Our study primarily contributes to the literature on leadership in extreme contexts, which calls for more empirical studies to explore its mechanisms in different contexts (for reviews, see Hällgren et al., 2017; Hannah et al., 2009; James et al., 2011). As specific leadership behaviors matter in specific extreme contexts (e.g., 9/11 attacks, James & Wooten 2010; Mount Everest Kayes 2004; fire disasters, Dutton et al., 2006; Weick, 1993; military, Eberly et al., 2017), we extended previous studies by exploring an extreme context where macrolevel government policies fluctuated intensively over a short period of time and leaders must maintain physical separation with members and their managerial effectiveness is bounded by the limited means they could use (i.e., virtual media).

Building on the literatures on team virtuality and media richness, we introduce rich virtual communication as leaders communicating valuable information via the frequent use of videoconferencing. We develop and test a theoretical framework that shows the sequential affective and cognitive mechanisms explaining how leaders' rich virtual communication mitigates the negative impact of the stringency of government responses to COVID-19 on team creativity: it first helps teams curb anxiety and then facilitates team information elaboration. These findings highlight the importance of emotion management (affective aspect of leadership) and media richness (socio-material aspect of leadership, Larson & DeChurch 2020) in facilitating teamwork in an extreme context. As COVID-19 has prompted a wide range of responses from governments especially in the Asian Pacific region, our findings are enlightening in that they suggest that even when the external environment is harsh and team members are highly anxious, team creativity does not have to suffer if leaders use rich virtual communication to manage team emotion and information processing. The results also suggest that the benefits of leaders' rich virtual communication are more profound under more extreme context, that is, when government responses to COVID-19 become more stringent.

Interestingly, although sheltering-in-place prevails during COVID-19, we did not find a significant effect of working from home, initiated by the company, on team creativity. Our findings suggest that it is leaders' rich virtual communication, rather than the companies' work-from-home decision, that ultimately influences team processes and outcomes in the pandemic. As the literature frequently documents the negative impact of remote work on group effectiveness (Baltes et al., 2002; Maznevski & Chudoba, 2000), it is plausible that this concern might become a phenomenon of the past as new smart phones have video conferencing technology embedded in their operating systems, and Zoom meetings are widely accessible. It also urges future studies to go beyond the paradigm of comparing leadership in face-to-face versus virtual teams, but to experiment on new ways of integrating the role of virtuality with leadership theories, as what we did in this study, because physical separation and virtuality may occur anywhere even working in the same office building.

Meanwhile, our study contributes to the literature on creativity in significant ways. First, different from the existing literature that focuses only on informational processing in team creativity (e.g., Hinsz et al., 1997; Hoever et al., 2018; van Knippenberg 2017), we integrate both the affective and cognitive perspectives to explain teams' creative process. Drawing from the affective events theory (Weiss & Cropanzano, 1996), we theoretically articulated how team anxiety emerges via team cognitive appraisal (Lerner & Keltner, 2000) in the response to government policies on COVID-19, and why such anxiety could avert members' attention from the tasks at hand and inhibit team information processing that is vital for them to generate creative ideas. To the best of our knowledge, this study is among the first that incorporates both emotions and cognitions in examining team creative ideation.

Moreover, unlike previous research on the emotion-creativity relationship that focuses on positive or negative emotions, we studied a discrete emotion—team anxiety. The equivocal findings from emotional effects on creativity might be caused by studying general rather than discrete emotions. For example, studies have shown that negative emotions are positively, or negatively, or not significantly related to creativity at all (for reviews, see Anderson et al., 2014; Davis, 2009). As we indicated earlier, extreme events can arouse different negative emotions such as fear, anger, or anxiety, which differ significantly in their characteristics because anger is often related to certainty and the activation of action whereas fear or anxiety is related to uncertainty and the activation of behavioral withdrawal (Lerner et al., 2015). By studying a discrete emotion, we provide precise reasoning in establishing the logical connection between team anxiety and team information processing. Indeed, as different events trigger different emotional responses (Lerner et al., 2015), we encourage future studies to move beyond the paradigm of studying general positive or negative emotions, but instead, choose to study different discrete emotions (e.g., anxious, envy, angry, happy, surprised, enthusiastic) and how they respectively influence team information processing and team creativity. For instance, envy may distort team information processing because it inhibits the sharing of individual knowledge, while excitement may distort team information processing because they enhance groupthink (Janis, 1982). Future research could explore different mechanisms and contingency factors behind the emotion-information-processing-creativity relationship, to provide a more nuanced understanding of the affective influence on team creativity.

Furthermore, we differentiate team daily ideation from team creative solution. Interestingly, though after controlling for the stringency of government responses to COVID-19, we find a significant impact of team daily ideation on team creative solution as proposed in Hypothesis 6, the direct correlation between these two variables is rather weak ($r=.19, p=.067$). We speculate that from daily ideation to final production, teams may need to go through a process of further elaboration on the pros and cons of ideas, selecting the most relevant and practical ideas, and integrating these ideas into a coherent solution. As prior creativity studies using the experience sampling method commonly measure creativity by the ideation process (Bledow et al., 2012), we call for more future studies to explore whether team daily ideation could translate to actual creative work outcomes, and its boundary conditions.

Thirdly, our study contributes to the team management literature in the Asia Pacific region. Although some studies conducted in the Western countries indicated that

leaders' frequent use of information-rich medium may increase employees' negative perceptions of being monitored, controlled, and mistrusted (Anteby & Chan, 2018; Perlow, 1998; Stanko & Beckman, 2015), our study provides empirical evidence that in the Eastern countries valuing collectivism and power distance (Hofstede, 2001), leaders' rich virtual communication could produce positive impacts on team management, especially in extreme contexts when uncertainty and equivocality prevail. We speculate that it is because compared to people in high individualistic cultures, Chinese people are more likely to value group cohesion, communion, and interdependence with each other. The stringent COVID-19 policies such as social distancing and lockdown may be more likely to elicit peoples' feeling of social isolation and uncertainty which increase anxiety. However, when leaders provide rich virtual communication to increase social certainty and task certainty, anxiety would be more likely to reduce. Moreover, people in the culture with high power distance tend to depend on authority and are obedient. When leaders use rich virtual communication in the extreme context of the pandemic, their behaviors are more likely perceived by employees as caring and responsible than controlling and monitoring. Therefore, we call for more future studies to explore the cultural factors and cross-culture comparisons in team management.

In addition, our study makes contributions to the affective events theory in three ways. First, affective events theory is often used to explain individual emotions and behaviors caused by the events (Weiss & Cropanzano, 1996). By applying this theory to the team level and demonstrated the impact of the events of stringent government responses to COVID-19 on team anxiety, team information elaboration, and then team creative behaviors, we provided new evidence on the scope and value of affective events theory in understanding employees' collective emotions and behaviors. Moreover, though theoretically scholars have pointed out that events influence behaviors through emotions and cognition (Lerner & Keltner, 2000; Weiss & Cropanzano, 1996), empirically studies often focus on the impact of events on emotions, rather than cognition (Lanai & Jennings, 2020; Reich & Hershcovis 2015). By testing the chain mediation model incorporating both emotions and cognition, our study provides a more holistic and nuanced understanding of the black box of the impact of events on behaviors. Furthermore, we introduce the moderating effect of leaders' rich virtual communication on the chain mediation effect between events and behaviors. Our results suggest that the negative chain mediation effect is less significant when leader virtual communication is richer, indicating the effectiveness of managerial practices and leadership behaviors in managing team members' reactive emotions, cognition, and behaviors resulting from external events.

Lastly, our study makes methodological contributions to leadership research. Unlike most leadership studies adopting a survey approach that cannot rule out alternative explanations or infer causal effects, we conducted a rigorously designed field experiment, with an experiential sampling method tracking eight-day fluctuations of team emotions, cognitions, and behaviors under different leader virtual communication manipulations. Our study design allowed us to make causal inference regarding the role of leader virtual communication on moderating the impact of the stringency of government responses to COVID-19 on team creativity, as well as to explicate the psychological mechanisms underlying the causal effect. We also collected data

from multiple sources, including archival data from government announcement, employees' self-reported daily survey, ratings from leaders and external experts (i.e., top executives in the headquarter), interviews and unobstructive observations, and experimental manipulation. Overall, our study design ensures that our findings are reliable, credible, and robust.

Practical implications

Given that coronavirus may stay with us for the years to come, governments have released a wide range of policies on dealing with COVID-19. Meanwhile, companies like Google, Microsoft, and Facebook have announced that they would extend the 'working from home' policy, and some even indicated that they would make certain types of work on-line permanently. Our study thus has several practical implications for managing teams in such an extreme context.

First, our findings highlight that emotion management matters in an extreme context. Leaders need to pay attention to different event-elicited emotions and their cognitive and behavioral consequences. In an ambiguous extreme context like the pandemic where macrolevel policies restrict business activities and employee behaviors, the key to leadership is to provide certainty to ease team anxiety and the subsequent appraisal of uncertainty of future events. Our study provides two possible pathways. First, leaders can increase their social presence during the unexpected extreme events by using video conferencing and increasing the frequency of their online interactions with team members, to reduce the leader-member psychological distance, passing confidence and assurance to members and increasing social certainty. Second, leaders can provide nuanced information valuable for team effectiveness to increase task certainty. The information sheet in our study (see Appendix B) provides a good example that shows clear standard but leaves the means to achieve them to team members to figure out, thus providing structure and flexibility beneficial for teams to find creative solutions. Leaders should design their concrete information sheet, according to their team characteristics, task requirements, team goals they aim to achieve, and the extreme context they are facing.

Second, our study suggests that when using media to manage teams with physical separation, leaders need to evaluate the benefits and challenges of capabilities of different media and select the right medium to fit the situational team needs. For instance, though text messaging has the benefits of re-processability and easiness of use in a normal work setting (see Appendix A), in extreme contexts like the pandemic, video conferencing is more beneficial because it can deliver richer information and facilitate rich communication. Moreover, compared to face-to-face interactions which can be quite casual, virtual communication is often around tasks, more instrumental and downward (e.g., orders from leaders). Leaders should recognize these issues and schedule extra meeting time for socializing. The instructions used in our study, in which we ask leaders to communicate with members via the information-rich medium and ask members to submit the information sheet daily, provide one way to facilitate mutual communication between members and their leader.

Finally, our study suggests that ultimately, it is team information elaboration—team members' knowledge sharing, discussion, and integration of diverse task-relevant

information within a team—that explains the value of leader virtual communication on team creativity in an extreme context. This insight has implications for team design to facilitate team information elaboration pre-, during-, or after- the happening of extreme events, including but not limited to leadership, team structure (e.g., diversity), climate, reward systems, among other possibilities.

Limitations and directions for future research

While our longitudinal field experiment is rigorously designed and executed to warrant causal inference, we recognize a few limitations. First, all participants were from a single organization. This approach ensures sample compatibility and reduces noise but threatens the generalizability of our findings. For example, preschool work often involves heavy face-to-face interactions with parents, children, and colleagues, the aroused ambiguity for teachers might be especially strong when moved online unexpectedly and government responses to COVID-19 were unpredictable. Thus, the impact of leaders' rich virtual communication may be more apparent as it provided task and social certainties to an unstructured situation. Moreover, majority of our participants were young (mean$=27.61$ years old, $s.d. = 9.98$) and internet-savvy, they might be quicker to adapt to a virtual work environment than other older generations of employees. Furthermore, we did not find the significant impact of work locations (home or office, or the change of work mode) on all dependent variables in our preliminary data analysis, as teams with different work locations relied on the same virtual communication media and worked as virtual teams. We speculated that it was because the study was conducted right after the breakout of COVID-19. Out of fear, plus students were locked down at home and schools' normal daily work was stopped, offline interactions were not prerequisite for work completion nor preferred by employees working in the office. In addition, our sample size is constrained by the company size as we did a field experiment and all employees participated in this experiment. Future research should examine the validity of our findings in other industry contexts with a larger sample of different demographics and with different event timing.

Moreover, it is possible that our findings are subject to country specific factors. For example, China is the first place that COVID-19 broke out. Governments were learning by doing and were more likely to issue increasingly stringent policies when they accumulated more knowledge about the contagiousness and deadliness of this virus. As the public were also new to this virus, such government responses were more likely to strengthen people's feeling of loss of control and anxiety, making the results of Hypothesis 1 more significant. However, we also recognized that in other countries during other time periods when the world knows more about coronavirus, stringency of government responses to COVID-19 may decrease team anxiety because of perception about governments' effectiveness in dealing with COVID-19. Moreover, in a collectivist country like China, leaders' rich virtual communication may be more likely appreciated by team members, as people in such cultural context value power distance and are obedient. The leader using rich virtual communication is more likely perceived as caring and responsible than controlling and monitoring.

We recommend future studies to test our model in other cultural contexts or time periods.

Furthermore, we examined team creativity only, though we differentiated team daily ideation from creative solution. Yet it is reasonable to expect that the moderating role of leader virtual communication on mitigating the negative impact of the stringent government responses to COVID-19 on team outcomes will extend beyond creativity, as reducing uncertainty and equivocality is a common prescription for management in extreme contexts. We encourage future research to expand our model to include other team outcomes, such as operational performance, leadership effectiveness, team resilience, and members' well-beings. Future research could also empirically test teams' situational needs proposed in our study, including a need for task certainty and a need for social certainty.

In addition, as we did a field experiment, the time lags between experimental stages were determined by the school headquarter based on their work arrangements. Although we were able to conduct the first two-stage experiments across two consecutive weeks, the third stage experiment was conducted six weeks later, indicating a relatively long lag. Recognizing that time lags may matter for team interactions, we encourage future research to retest our model with the same length of time lags between different stages.

Conclusion

The COVID-19 pandemic has created an extreme context for work team management. Findings from our rigorously designed field experiment reveal that leaders' rich virtual communication is highly effective in mitigating the negative impact of the stringency of government responses to COVID-19 on team creativity, because such rich virtual communication helps the work team to cope with anxiety and facilitate information elaboration. Our findings advance the literature on leadership in extreme contexts and provide practical implications for managers to develop effective virtual communication to foster team creativity to survive and thrive in the age when stringent government responses to COVID-19 prevail.

Appendix A: Typical Teamwork and Leaders' Use of Media before COVID-19

Typical teamwork before COVID-19. The teams were work teams (Cohen & Bailey 1997), referred to as continuing work units responsible for offering early childhood education and providing childcare. Teamwork typically (i.e., before COVID-19) proceeded as follows. Every morning, the headquarter assigned tasks and set up daily goals to team leaders by text messaging via *WeChat*, one of the most popular instant messaging applications in China. Sample tasks included organizing classroom activities, decorating the classroom, contacting parents, recruiting new students, and advertising on social media. Leaders then detailed the goals and assigned specific task(s) to specific team member(s), which typically needed coordination. Tasks were

commonly assigned in a routine morning meeting unless leaders were out of the office. In that case, tasks would be directly assigned via WeChat text messaging. At the end of the day, leaders would summarize what teams had achieved on that day and report it back to the headquarter via WeChat text messaging. Performance evaluation by the headquarter was team based and performance ranking was openly announced among 12 preschools. Rewards including salary increase and bonus were provided every half a year based on the performance evaluation. Leaders had discretion in distributing differentiated rewards among team members. In short, in this chain preschool, like other traditional work teams, team members were interdependent in their tasks and shared responsibility for outcomes; they had limited autonomy in that most of the decisions were made and directed by the team leader (Cohen & Bailey 1997).

Examples of leaders' use of virtual communication media. Before COVID-19, leaders' use of virtual communication media (mostly WeChat text messaging) was ubiquitous in this preschool. Based on our preliminary qualitative study (see Appendix C for the design), we identified four typical scenarios that leaders use media in daily work: (a) when leaders were on business trips; (b) when leaders worked away from the office due to outdoor school events or personal matters (e.g., morning traffic jam, family emergencies); (c) when leaders worked overtime (e.g., late night, weekends), and (d) when leaders and members were not in the same workspace. The reason for WeChat text messaging, rather than WeChat video conferencing, to be the most popular virtual communication medium was its easiness of use, and re-processability feature (i.e., enabling a message to be reexamined or processed again, Dennis et al., 2008), which helped leaders to deliver important information regardless of members' availability at the moment (e.g., in the middle of teaching). We also noticed that the virtual communication via WeChat text messaging was often downward and infrequent; it was limited to basic content, such as posting announcements, checking work attendance via WeChat's clock in or out function, addressing urgent work issues, carbon coping work reports, and openly praising or criticizing members in the team's WeChat group.

Appendix B: An Information Sheet

	Project Evaluation (Your personal (not team) evaluation)
# Overall, how novel is your team proposal? (e.g., propose a brand-new idea; creatively recombine existing materials)	low ----- mediocre ----- high 1 2 3 4 5
How novel is your team proposal to attract potential parents and students? (e.g., compare to other pre-schools' activities, or to what you have done before)	low ----- mediocre ----- high 1 2 3 4 5
# Overall, how useful is your team proposal? (e.g., attract more parents and students; improve the preschool's reputation)	low ----- mediocre ----- high 1 2 3 4 5
How useful is your team proposal to attract potential students? (e.g., be catered to parents' and students' needs; fit students' characteristics)	low ----- mediocre ----- high 1 2 3 4 5

	Project Evaluation (Your personal (not team) evaluation)
How rich and concise is the information delivered to parents and students? (e.g., signal the preschool's teaching quality, student life, study environment, faculty)	low ----- mediocre ----- high 1 2 3 4 5
# Overall, how novel is your team proposal? (e.g., a poster, an event, a video, and an open class)	low ----- mediocre ----- high 1 2 3 4 5
How novel is the media your team selects to deliver the proposal? (e.g., the usage of text, sight, sound, immersive experience)	low ----- mediocre ----- high 1 2 3 4 5
How novel is the means of advertising suggested in your team proposal? (e.g., social media, local communities, word of mouth)	low ----- mediocre ----- high 1 2 3 4 5
How novel is the technology your team selects in delivering your team proposal? (e.g., WeChat, bilibili.com, phone, email)	low ----- mediocre ----- high 1 2 3 4 5
# Overall, how feasible is your team proposal? (e.g., the school's human, materials, finance, and technology resources)	low ----- mediocre ----- high 1 2 3 4 5
# In generating creative idea/ideas, **how novel is your team's work process?** (e.g., the way of task coordination, the way of communication)	low ----- mediocre ----- high 1 2 3 4 5
# In generating creative idea/ideas, **how useful is your team's work process?** (e.g., improving work efficiency, boosting new ideas)	low ----- mediocre ----- high 1 2 3 4 5
How many novel ideas did your team come up with in team discussion?	low ----- mediocre ----- high 1 2 3 4 5
In identifying the most creative idea, **how deeply does every team member engage in team discussion**? (e.g., everyone expressed his/her opinions)	low ----- mediocre ----- high 1 2 3 4 5
In producing the proposal, **how effective does your team work together**? (e.g., paying attention to the specialty of each team member, time management, multi-task management)	low ----- mediocre ----- high 1 2 3 4 5

Note: items with # were the items used as the basic information form for all teams. Items without # were used in the leader rich virtual communication experimental condition.

Appendix C: The Qualitative Study during the Field Experiment

We did three rounds of interviews before, during, and after the field experiment.

Round 1: Pre-experiment interviews and observations. We began this project before COVID-19 in October 2019. We conducted observations offline in the pre-school and online in the school WeChat groups, as well as semi-structured interviews with 12 principals. The purpose of this preliminary study was to understand leaders' use of virtual communication media in the real world and team creativity relevant and essential in this context, thus improving external validity (Edmondson & McManus

2007). Before conducting these semi-structured interviews and observations, we also informally interviewed two top executives in the headquarter with open-ended questions at the end of September 2019. The purpose was to get to know this school.

Specifically, for the non-participant observation, we joined the preschool's 13 WeChat groups as external experts from October 2019 to April 2020 (213 days in total) and observed team virtual interactions daily. WeChat group was the major virtual tool used in this preschool for work arrangement, information sharing and team coordination/communication. Each subsidiary preschool formed a WeChat group involving all employees in that preschool. The headquarter also formed a WeChat group involving team leaders in 12 preschools and top managers in the headquarter. In addition, one of us also visited two subsidiary preschools and the headquarter monthly from October 2019 to December 2019 before the field experiment. These field observations were used as background information to better understand the daily operation, work design and employees' work in this chain preschool.

We conducted 12 semi-structured interviews with principals by video call and phone in December 2019. The purpose of the interview was to let the principals provide rich and descriptive data on their perspectives on team creativity and management in a virtual environment in their schools. On average, the interviews lasted 22.8 min ($s.d. = 6.22$). They were conducted in mandarin, tape recorded and transcribed. We used an open ended and inductive analytical approach to analyze the interview data (Strauss & Corbin 1997).

The findings from the interviews and observations at this round were specifically used in the main study to (a) identify typical scenarios that leaders use virtual communication media in daily work in this school, and (b) generate an information sheet (see Appendix B) to manipulate valuable information in the leader virtual communication.

Round 2: During-experiment interviews and observations. At the end of the first day of the field experiment, we informally interviewed 32 team leaders with a check-in question "How is everything going today?", and a probe "How do you [plural] feel today?". The purpose of this interview was to search for the most relevant discrete emotion used in the main study. During the experiment, we also continued the online non-participant observations on team virtual interactions daily in the school's WeChat groups, but stopped the offline school visit due to the pandemic. These field observations were used as background information to better understand the impact of our field experiment in this chain preschool.

Round 3: Post-experiment interviews. After the field experiment, we did a follow-up semi-structured interview on 24 employees, including 9 leaders and 15 team members in August 2020. The purpose of this interview was to get a nuanced understanding of our quantitative findings. We randomly selected two employees (regardless of leaders or members) from all 12 schools, respectively. On average, the interviews lasted 19.33 min ($s.d. = 4.12$).

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