Remote Workplace Interactions and Extraversion: A Field Study on Wellbeing and Productivity Among Knowledge Workers

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Since the COVID-19 Pandemic, the knowledge workplace has seen a dramatic transition from collocated-first to hybrid or fully-remote arrangements, the implications of which are yet to be fully understood. One of the biggest unknowns is how remote team communication impacts the individual worker, especially in consideration of personality type. The aim of this study is to investigate the effects of remote workplace interactions on productivity and wellbeing, and how these effects are moderated by extraversion. The study lasted for 2-3 months and involved 60 knowledge workers. The data was analyzed using a combination of quantitative and qualitative methods. We present novel findings on how remote communication affects individuals differently depending on the type of interaction, interaction agent, and personality of the individual, showing that the impact of communication on workers is far from straightforward. We contextualize these findings with an in-depth analysis of communication patterns and experiences in the remote workplace, adding to existing literature. Finally, we present suggestions for a more individualized communication approach in industry and future research.

CCS Concepts: • **Human-centered computing → Empirical studies in HCI**.

Additional Key Words and Phrases: Knowledge Work, Communication, Team Interactions, Personality, Productivity and Wellbeing

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1 Introduction

In recent years, the knowledge workplace has seen a dramatic transition from collocated-first office arrangements to hybrid or fully-remote arrangements. Though remote-first companies have existed as early as the technology for distributed and teleworking teams allowed, the COVID-19 Pandemic pushed an unprecedented number of companies towards non-collocated arrangements. Even in the

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post-Pandemic world, knowledge work employers continue to rethink and redesign their practices to adapt to the new realities of work. Perhaps one of the greatest challenges is understanding how the shift to remote impacts team communication for individual employees. Past research has highlighted the pivotal role of communication with the team, for fostering team cohesion and project success [16, 36, 50], as well as laying the groundwork for information exchange [13] and the creation of shared knowledge [50]. Understanding communication becomes all the more important in the move from collocated to remote, where interactions are facilitated primarily through digital systems, rather than more natural and familiar modes. Studies have shown how interpersonal differences, such as differences in backgrounds [25] or culture [2] affect the efficacy of remote communication. Although past works have investigated remote communication practices and challenges [53], these have been looked at from a general lens, and not from the perspective of the individual. In particular, we explore the effect of team communication on employee productivity and wellbeing, as indicated by perceived stress levels, with consideration to their levels of extraversion. This study, conducted in the first two years of the Pandemic, uniquely captures the impressions of 60 newly remote knowledge workers whose teams had, within the past year, transitioned from a collocated-first to a hybrid or remote-first format. First, we explored the impact of team communication on the perceived productivity and wellbeing of participants, where we specifically considered the type of communication (task-oriented or relational), whom the interaction was with (team or supervisor), and the personality type of the subject (introvert or extravert). This detailed analysis allowed us to understand the nuanced effects of communication among the team and individual. Second, we conducted interviews with participants to understand how communication changed after moving to a remote or hybrid format, including practices and tools teams had adopted for communication, and what challenges they faced.

The aim of this study is to investigate the effects of remote workplace interactions on productivity and wellbeing, and how these effects are moderated by personality traits, in particular extraversion. The study lasted for 2-3 months and involved 60 knowledge workers. The study consisted of daily surveys and interviews, and the data was analyzed using a combination of quantitative and qualitative methods. The results provide insight into the role of remote workplace interactions in supporting productivity and wellbeing, and how these effects may vary depending on individual differences in personality. Specifically, we focus on the following research questions:

RQ1 How did communication affect participants' reported productivity and wellbeing? Specifically, how was this moderated by the interaction type, interaction agent, and the personality of the individual?

RQ2 What did remote communication look like?

a) What were common communication practices, in terms of schedules and tools?

b) How did communication compare to before the Pandemic, what was missing or challenging?

The motivation for this work stems from a renewed need to understand remote communication, and to study it with a more nuanced, individualized approach. The COVID-19 Pandemic had marked a sudden, global-scale migration from collocated to remote work, opening up unprecedented opportunities for research: we could study more widely than ever before. While the nature of work did not typically change, what changed most was the way teams communicated. Communication at work has, from early knowledge work research, been a topic of focus [16, 21, 27, 36]. Because knowledge workers often work in large teams on complex projects, communication is key to project coordination, knowledge sharing [21], and alleviating misunderstandings [16]. It comes as no surprise, then, that communication is critical to knowledge worker productivity [49, 73]. Furthermore, communication is at the heart of building interpersonal relationships within teams and affects the stress and job satisfaction of employees [58, 63, 77]. Past research, in short, has

established communication to be central to the socio-technical success of a workplace. To gain a more complete picture, we therefore explore the effect of communication both on self-reported **productivity** as well as on **stress**, which we consider as an inverse metric for wellbeing. Research notes that workplace wellbeing encompasses several dimensions, including work engagement, job satisfaction, and psychological stress [67], as well as overwhelm and burnout [4]. While questions on work engagement and job satisfaction require the participant to reflect on an intersection of factors relating to work outside themselves (e.g., their current project, manager, or compensation) and can therefore have more confounding variables, the question on stress asks participants to look inward and assess their current state. At the same time, we validated participant self-reports of stress with weekly assessments of overwhelm and disengagement.

When it comes to the remote workplace, where interactions are mediated through ICTs, fostering effective communication is all the more important. However, understanding what type of communication is most effective is not trivial. We define *effective communication* to be communication which fosters worker thrive, i.e., it increases the productivity of its workers, while decreasing their stress. To characterize communication in a meaningful and observable way, we propose to look at it in terms of the following three factors: interaction type, the agent of the interaction, and the personality type of the individual. We have seen from prior research that communication plays both a technical and social role: facilitating projects and strengthening relationships. This comes from two flavors of communication, or **interaction types**: task-oriented versus relational. Task-oriented, or work-centric, interactions take a more formal and instrumental approach and focus on topics of work. Relational, or social, interactions take a more casual and expressive approach and focus on topics outside of work. A given interaction can lie anywhere on this scale, from fully task-oriented to a mix of the two to fully relational. These map to the communication performed for the two categories of work presented by Bjørn and Christensen: *articulation work*, which describes "efforts of coordination necessary in cooperative work, but, arguably, focuses mainly on task-specific aspects of cooperative work" as opposed to *relation work*, which focuses on the fundamental relational aspect of cooperative work [9, 19].

The **agent of the interaction** indicates the party with which one is interacting. Communication within teams can be *vertical* or *horizontal*. Vertical communication occurs between hierarchically positioned individuals (i.e., a supervisor and a direct report) and can flow upward or downward [38]. Downward communication from the supervisor, in particular, has been shown to predict job satisfaction [70] and team member efficiency [35]. A study by Carillo et al. found that leaders play a crucial role in setting the tone for remote work [15]. We therefore simplify the categories to two interaction agents from the participant's perspective: interaction with their team and interaction with their supervisor. Note that all participants were surveyed equally regardless of role: if a worker is a manager rather than an individual contributor, they would still be reporting on interactions with their team (in other words, direct reports or peers) and interactions with their own supervisor (to whom they report). While team interactions have been studied on the dimensions of vertical and horizontal communication, it is unclear how individual differences in personality moderate the effect these different interactions have on knowledge worker productivity and wellbeing.

There is a growing interest in understanding how personality affects knowledge worker teams. **Personality** is typically categorized on five dimensions: openness, conscientiousness, extraversion, agreeableness, and neuroticism, also known as OCEAN or Big 5 Personality Model [32]. An earlier study found that software development teams can be strengthened by using personality inventories to form groups [60], while another recommends that organizations analyze the personality-type compositions of these groups and help team members understand their own personal attributes [10]. Of these dimensions, extraversion is the most relevant to communication. The term "extraversion"

and its counterpart, "introversion", were originally coined by Carl Jung [20] and indicate the natural outward (extra-) and inward (intro-) focus of attention. In a study surveying 40 years of research on personality in software engineering, extraversion was the best predictor of team-related behavior and performance, with many studies finding significant correlations between extraversion and various measures including team performance [22]. While extraversion prevalence in a team has been shown to impact team performance, it is unclear how this trait moderates the effect that team communication has on an individual's perceived wellbeing and productivity.

The main contribution of this work is two-fold: first, we present novel results on the impact of remote team interactions on knowledge workers which take into account the type of the interaction (work or social), the agent of the interaction (team or supervisor), and, importantly, the personality type of the individual (introverted or extraverted). Our findings suggest that these three factors are important for understanding the impact of communication, and that communication impacts individuals differently based on their personality. Second, we contextualize these findings and add to the body of literature on the realities of team communication in the Pandemic for a diverse set of newly-remote knowledge worker teams. Like several past studies, we saw that the move from in-office to remote or hybrid was marked with both a decrease and increase in communication. This contradictory reality which has been echoed in other studies finds some reconciliation in our interview findings: workers are spending more time in meetings to make up for the context and information loss that remote communication inherently has. We conclude this paper with a discussion of recommendations that industry practitioners and researchers can apply for future work.

2 Related Work

Several areas of related literature are relevant to this work: communication and its effect on workplace productivity and wellbeing (subsection 2.1), communication in the traditional remote and, recently, pandemic workplace (subsection 2.2), and the challenges of computer-mediated communication for remote teams (subsection 2.3).

2.1 Team Communication and its Impact on Productivity and Wellbeing

Past literature on knowledge workplaces emphasizes the central role of communication in the workplace. Communication facilitates several integral functions: it aids in project coordination [6], allows for information exchange [13], and reduces misunderstandings and ambiguities [30]. Furthermore, it helps to create a shared understanding [50] and to strengthen relationships [64]. In discussing the knowledge-creating workplace, authors Nonaka and Takeuchi highlight the importance of communication in creating a "common cognitive ground" and facilitating the transfer of tacit knowledge [55]. It comes as no surprise, then, that multiple studies have identified effective team communication to be a key to **productivity** [49, 73].

Past studies likewise found that communication plays a vital role in worker **wellbeing**, for example by fostering social support [77]. In particular, social support from supervisors and coworkers was positively associated with job satisfaction and psychological wellbeing [75], while communication openness and supportiveness among coworkers were associated with lower levels of burnout, higher levels of job satisfaction [63], and increased wellbeing [58]. On the other hand, increased communication often leads to increased interruption, which is known to negatively influence productivity, increase anxiety and error rate, and reduce performance [5, 23, 48, 57]. Communication therefore has mixed effects on productivity and wellbeing, and it is not yet clear what moderates these effects.

2.2 Remote and Pandemic Communication

In 1988, Robert Johansen proposed a CSCW time-place matrix to characterize communication: in the time dimension, communication can be synchronous or asynchronous, and in the space dimension, it can occur in one-location (collocated) or multiple locations (distributed) [39]. We consider **remote team communication** to be spatially distributed synchronous or asynchronous interactions between team members. Understanding communication is especially critical in this remote work context, where it relies on Information and Communication Technology (ICT). Remote workers must be able to communicate with colleagues through means other than face-to-face, such as by email, phone, texting, instant messaging, and video conferencing [65]. Since early teleworking, a body of literature has been dedicated to communication among remote workers and distributed teams. These studies have highlighted the importance of communication, especially informal, for coordination [16, 36], knowledge sharing [21], and finding and leveraging expertise [27]. An important note is that these studies of remote workers may have had some natural sampling bias. These workers may have gravitated towards remote jobs because they had the skills or access to infrastructure to do so, or they may have been granted remote working privileges by their managers after showing competence and trustworthiness [42]. The forced lockdown of the COVID-19 Pandemic shifted an unprecedented portion of the workforce from collocated to remote, providing researchers with a much larger and more varied sample of knowledge workers. This invites the revisiting of previous research and findings. Recent studies in the fields of HCI and CSCW have therefore been especially interested in this shift in communication in the forced transition from collocated to remote work as a result of the Pandemic. Since the start of the COVID-19 Pandemic, a number of studies found that the shift to remote work was accompanied by changes in how the teams communicated [14, 28, 52, 53, 56, 76, 78]. Unsurprisingly, participants reported a decrease in face-to-face communication, together with an increase in video conferencing and chat communication [52, 53]. Meetings became shorter but were held more frequently [56]. At the same time, email, text messaging, and phone usage did not significantly change [52]. Studies indicate a general increase in collaboration [76] but also a strong shift towards asynchronous communication [76] (or decentralized work [41]) and an overall decrease in communication, possibly resulting from less initiative to proactively seek remote communication.

2.3 Challenges of Computer-Mediated Team Communication

Research in CSCW and Groupware has identified several challenges common to remote communication. This includes the loss of important informational cues, which can be categorized as a lack of awareness [1, 46]. Awareness in CSCW has been defined as "the knowledge that a person has of the activities that other people collaborating with him/her are performing" [24]. Gutwin et al. note that "workspace awareness is much harder to maintain in groupware workspaces than in face-to-face environments, and it is often difficult or impossible to determine who else is in the workspace, where they are working, and what they are doing" [33]. Furthermore, communication through digital means often lacks important context, such as facial and bodily cues. This is especially problematic for informal communication, which often relies on interactive and expressive communication channels [29, 74]. While remote communication can decrease awareness and contextual information, it has, paradoxically, also been associated with communication overload [51], contributing to the newly-coined "technostress" [3, 17, 37]. This increase in digital tools for work was accompanied by an increase in digital tools for personal purposes, leading to even more exhaustion [44], a decrease in wellbeing [66], and greater fatigue [3, 26]. With meetings moved to digital platforms, workers especially expressed exhaustion caused by video-conferencing, often referred to as "Zoom Fatigue" [3, 26, 34, 43, 72]. A study by Rudnicka et al. found that this video-conferencing fatigue

was especially salient when workers also had to become familiar with multiple tools to suit a variety of collaborators [59]. Studies also reported an increase in distraction and interruption due to colleagues reaching out more often [3]. While these studies indicate that remote communication adds more stress and strain than in-person communication, one study [40] found that the use of asynchronous communication tools, such as email and chat, was associated with lower levels of stress and higher levels of productivity among American remote workers.

These mixed findings on the effects of team communication in the Pandemic on employee productivity and wellbeing point to the need for more research to reconcile these results. One explanation may lie in interpersonal differences, and how they moderate the interactions in remote workplaces. For example, cultural differences have been shown to impact how well workers adopt hybrid work practices, as in the study by Akahori et al. on how cultural attributes such as individualism and collectivism or cultural tightness affect the likelihood of adopting hybrid norms among workers in the US and Japan [2]. A study by Tang et al. also noted how workers had differing preferences for virtual conferencing interfaces, which shaped their experiences [68]. Likewise, studies have found that how workers perceive their remote collaborators depends on whether they are "strong" or "weak" ties [76], indicating that the relationship between workers matters. A 2023 literature survey by Duckert et al. notes the challenge in remote communication caused by a difference in backgrounds, perspectives, and "lifeworlds" [25]. All this indicates the need to take into account interpersonal and situational differences in understanding the impact of communication on individuals. In our research, we take a more nuanced approach to studying team interactions, exploring the possible moderating effects of the interaction type (task-oriented or relational), the agent (manager or supervisor), and the personality type of the individual (extravert or introvert).

3 Study Design

To understand how knowledge workers communicated in their remote teams and how this affected their perceived productivity and wellbeing (measured in terms of stress), we conducted an 8-week multi-modal field study with knowledge workers. Since our goal was to capture fine- and large-grained data over a period of several months, we adapted a multi-modal methodology that has been previously used in longitudinal studies of knowledge worker teams [12, 31, 61]. This data collection apparatus combines frequent intra-day self-reports, end-of-day surveys, and monthly interviews, providing multiple time lenses. We describe the participants in our study, the survey instruments used as well as the collected data, and report on the quantitative and qualitative analysis methods we applied to the data. In the interest of transparency and reproducibility, we have posted the survey materials and the data analysis scripts on the Open Science Framework at [62]. We have not made the collected data itself public due to the risk of deanonymization, but included the corresponding survey and interview material for replication. The study was approved by the research ethics board at the leading researcher's university.

3.1 Participants

We recruited 75 knowledge workers from 15 teams of twelve companies across North America and Europe through different channels including word-of-mouth, social media, and other personal and professional contacts. Upon completion of the eight-week study period, 60 participants passed the data criteria necessary to be included in the analysis: two self-reports per day and one daily questionnaire for at least two weeks, in addition to the final survey on demographics and personality traits. Of these, 17 (28%) identified as female, 42 (70%) identified as male, and one preferred not to say. Participant ages ranged from 22 years to 63 years, with an average age of 38.9 years (±10.0). The 60 participants worked in knowledge work roles in various industries: 30 (50%) in software

Table 1. Study Participants (IC = Individual Contributor; Mng = Manager)

Team	Industry	Participants	IC	Mng
T11	Software Dev	6	3	3
T02	Software Dev	5	1	4
T12	Software Dev	5	2	3
T04	Software Dev	4	3	1
T14	Software Dev	4	3	1
T01	Software Dev	2	1	1
T06	Software Dev	2	2	0
T00	Software Dev	1	0	1
T05	Software Dev	1	1	0
T08	Insurance	10	9	1
T07	Insurance	5	4	1
T09	Insurance	4	2	2
T10	Sales	6	5	1
T03	Construction	3	2	1
T13	Business Analytics	2	1	1
Total: 15 Teams	**5 Industries**	**60**	**39**	**21**

development, 19 (32%) in insurance, 6 (10%) in sales, 3 (5%) in construction, and 2 (3%) in business analytics. The number of participants in each team ranged from 1 to 10, with an average of 4.06 (±2.37). These participants did not represent the whole team and the purpose was not to do a full-team analysis, but to have several representatives from a variety of teams in order to gain diversity while maintaining context about the different teams. In regards to roles, 39 identified as individual contributors (team members) and 21 as managers – or as someone fulfilling a managerial role such as a supervisor, project lead, program manager or vice president. In the overview of teams in Table 1, we simplify by reporting two roles to indicate individual contributors and managers. Participants in every role were given the same set of survey materials.

3.2 Survey Instrument and Collected Data

To better understand remote communication in teams, this multi-modal study incorporated bi-hourly self-reports, daily surveys, monthly interviews, and post-study follow-up surveys. Though the minimum requirement for participation was 8 weeks, all fifteen teams participated for 10 to 14 weeks, with an average of 12.02 (±1.88) weeks. In total, we collected 2030 daily surveys and 8296 bi-hourly self-reports, with an average of 34 daily surveys and 138 bi-hourly self-reports per participant. Table 2 provides an overview of the questions in the self-reports, survey and interviews. The full set of questions is included in the replication package [62].

Bi-Hourly self-reports. We provided each participant with a smartwatch to submit their bi-hourly self-reports. The bi-hourly self-reports prompted participants to report their perceived productivity, stress level, and activity categories worked on in the last hour.

Daily surveys. At the end of each workday, participants were asked to fill out daily surveys via an online website. These surveys inquired about participants' productivity and stress levels, providing visualizations generated from their bi-hourly self-reports throughout the day. Additionally, participants were asked to reflect on their team interactions, comparing the amount of interaction to usual levels and determining whether conversations were more social or work-related. The

Table 2. Self-Report, Survey & Interview Questions

Question	Answer Type
Bi-Hourly Self-Reports	
Rate your **own productivity** for the past hour	Very low (1) to Very high (7)*
Rate your **team's productivity** for the past hour	Very low (1) to Very high (7)**
Rate your own **stress** level for the past hour	Very low (1) to Very high (7)***
What were you working on?	Activity Categories****
Daily Survey	
Interactions	
How would you rate the amount/frequency of interaction you had with your **supervisor** today?	Almost None (1) to Unusually Much (5)
How much of the interaction with your supervisor today was **related to work**?	Almost Entirely Not About Work (1) to Almost Entirely About Work (5)
How much did you interact with your **team** today?	Almost None (1) to Unusually Much (5)
How much of the interaction with your team today was **related to work**?	Almost Entirely Not About Work (1) to Almost Entirely About Work (5)
Other Factors	
How much time did you spend in **meetings** today?	Hour Buckets
Was the majority of your time today spent working **remotely** (out of the office)?	Yes/No
Would you like to share **anything else** about your day?	Open-Ended
Monthly Interviews	
General Context	
Could you describe your team?	
Has this changed since you started the study?	
Could you describe the nature of your work?	
Has this changed since you started the study?	
Do you work more individually or actively collaborate with others?	
Are you currently working more **remotely** or from the office?	
Communication Patterns	
How often do you **communicate with your team** and what does this communication look like?	
How do you **coordinate/synchronize** with your team?	
Are there any **tools** that you use in particular?	
Do you have daily/weekly **standups**?	
Is it specific to the teams?	
How is the communication **different** compared to before the Pandemic?	
What are you **missing** from your communication during the Pandemic?	
What are current **challenges**, what **works well**?	

* I didn't work, No Answer; ** I don't know, No Answer; *** Not sure, No Answer; **** Activity Categories: Break, Email/Messaging, Meeting, Planning, Software Development Work, Browsing, Read/Write Documents, Other Individual Tasks, Other Team Tasks; Some questions were shortened and reordered for clarity.

surveys also included questions about various teamwork-related factors, such as time spent in meetings and on unplanned work, the negative impact of interruptions, the collaborative nature of their tasks, and any other influences on their work (open-ended question).

Interviews. We conducted interviews at the start, middle (after about a month), and end of the study. The initial and mid-point interviews primarily served to check in with participants and monitor any significant changes in their work or team dynamics. In the final interview, we asked participants to discuss team communication, the tools and patterns established, changes since moving to a remote or hybrid setup, and any challenges or areas needing improvement.

Personality test. As a final step in the study, participants were asked to complete a Big 5 [32] personality assessment of fifty questions and to submit demographic information, including age and gender. From the personality assessment, we calculated extraversion scores for each individual. We used the other four personality dimensions (openness, agreeableness, conscientiousness, and neuroticism) as control variables in our models.

4 Analysis Method

To answer our research questions, we took a combined quantitative and qualitative approach to understanding the data. Specifically, we applied the following methods to each research question:

- **RQ1**: We performed **quantitative** analysis on bi-hourly *self-reports* of productivity and wellbeing (averaged over the day) in relation to responses about interactions frequency and type from the *daily survey*, and individual extraversion scores from the *personality questionnaire*.
- **RQ2a:** To understand what team communication looked like in the remote workplace, we performed **qualitative** analysis on *interview* data (including the questions about communication tools and meeting schedules), and complemented this with **quantitative** data of average meeting hours from the *daily survey*.
- **RQ2b:** We **qualitatively** analyzed the final *interviews* to understand how participants experienced communication in their new remote environment, including what was missing and what were the challenges.

We explain our quantitative and qualitative approaches in more detail below.

4.1 Quantitative Analysis

We used the following collected metrics in our quantitative analysis: self-reported productivity and stress from the bi-hourly self-reports, interaction frequency and amount (for interactions with teams and supervisors) from the daily survey, and personality and demographic data from the personality questionnaires. To prepare the data, we normalized these values per participant using the standardization protocol: subtracting the mean and dividing by the standard deviation, where the mean and deviation were calculated per participant. This meant that the Likert-scale ratings which ranged from 1 to 7 were now centered around 0 in a range between -1 and 1, where the new values reflected how the score compared to the participant's average. To investigate how communication factors (interaction frequency, amount, and agent) affected self-reported productivity and stress, we built linear regression models for each dependent variable using the `lme4` package [7]. As controls, we included all five personality dimensions, as well as age and gender. We likewise tested the moderating effect of each personality dimension. The collected data itself is not available publicly due to the risk of deanonymizing, but for reproducibility and reference, we have posted all survey materials and scripts for data analysis here [62].

4.2 Qualitative Analysis

To contextualize our quantitative findings and understand how participants experienced communication in the remote workplace, we performed qualitative analysis on the interview responses regarding communication, specifically:

(1) How often do you communicate with your team, and what does this communication look like? (What is your team's meeting schedule, what tools are used?)
(2) How is the communication different now (remote) than before the Pandemic?
   a) Do you feel that anything is missing regarding communication during the Pandemic?
   b) What are some challenges you face in your communication? What works well? Would you want to improve anything?
   c) Do you feel that you spend too much/little time on communicating with your teammates?

For the full script of the structured interview, please see [62]. Final interviews were collected and analyzed for 52 of the 60 participants (87%): for eight participants the data was missing due to participant unavailability (6) or technical problems with the recordings (2). In analyzing the interviews, we employed the reflexive thematic analysis introduced by Braun and Clarke [11] from a critical-realist perspective in a primarily top-down (theoretical) direction, guided by the questions listed above. However, we also welcomed bottom-up insights, topics that were not foreseen when designing the questions. This analysis was conducted by the first author, with two more authors involved in an initial independent coding exercise of three interviews in order to provide additional perspective and guide future analysis. We followed the 6-step process outlined by Braun and Clarke [11]: first, we gained familiarity with the transcribed interviews by reading through each. Then, for each of the communication questions asked, we inductively coded the responses, generating codes as we came across new aspects mentioned. For example, for Question 2 some basic codes were "overloaded with meetings" and "meetings more structured" or "missing social chats". Once all interviews were coded, these codes were combined and refined. We then began to search for clusters of codes, or "themes", which spanned across the dataset. We reviewed these themes, defined and named them, and produced a summary of the three primary themes, which we describe in section 5.5.

4.3 Threats to Validity

Of our original sample of 75 knowledge workers, 60 (80.0%) completed the study. This was in line with our expectations, considering the intensive nature of the study (frequent self-reports) combined with the length (at least eight weeks). At the same time, the remaining sample of workers may contain a sampling bias. Those who did not complete the study may have been more busy or overwhelmed by their work or the transition to remote, and therefore, our remaining sample might reflect a more positive impression than reality. Even so, participants mentioned many challenges of communicating in the remote workplace. This indicates that the actual situation might be even more dire. Furthermore, our sample under-represented women (only 28.3% are self-reporting females). This may be partially explained by the software-engineering-heavy composition of the sample – an industry which is known to have a gender disbalance (women make up only about 20% of the USA software development workforce [69]). Finally, we used Thematic Analysis to analyze the participant responses to the daily surveys and interviews. One potential limitation of our study is that the open coding step for the majority of interviews was performed by a single author. To reduce bias, three authors collaborated to create an initial code set and identify and discuss potential themes.

Table 3. Effects of Interaction Amount and Type on Self-Reported Productivity and Wellbeing

	Team		**Supervisor**	
Interaction Type (More Task-Oriented)				
Productivity				
Effect	**0.16**	***	**-0.09**	*
Moderation by Extraversion	**0.10**	*	**0.10**	*
Wellbeing				
Effect	None		**0.07**	*
Moderation by Extraversion	**0.18**	***	**0.11**	**
Interaction Amount (More Frequent)				
Productivity				
Effect	**0.15**	***	**-0.08**	*
Moderation by Extraversion	None		None	
Wellbeing				
Effect	**-0.08**	*	-0.06	(.)
Moderation by Extraversion	None		None	

(.) indicates p < .1; * indicates p < .05; ** indicates p < .01; *** indicates p < .005

5 Results

All participants in our study had recently transitioned to a hybrid or fully-remote working arrangement, and we were interested in learning about the reality of team communication in the Pandemic workplace, including how it had changed and how it affected individuals. We organize our findings by our research questions: **RQ1)** how did communication correlate to the productivity and wellbeing (reduced stress) of the participants, especially taking into account the interaction type (subsection 5.1) and also the personality of the individual (subsection 5.2), and **RQ2a)** what did communication look like when the study was performed and work was remote (subsection 5.3), including the balance of task-oriented versus relational communication (subsection 5.4), and **RQ2b)** how had communication changed with the Pandemic (subsection 5.5).

5.1 Effect of Interaction Type on Productivity and Wellbeing

To understand how *interaction type* correlated to the perceived productivity and wellbeing of participants, we created two linear mixed models based on participant end-of-day survey responses. As the dependent variable we had the self-reported productivity and wellbeing. As the independent variable, we had the interaction type (on a scale from 1=relational to 5=task-oriented); and as controls, we included the five personality dimensions, age and gender of the participant, and the amount of interaction reported. The results are presented in Table 3.

Stress as a Metric for Wellbeing. Workplace wellbeing spans many short- and long-term dimensions, from job satisfaction, to physical health and alignment with workplace values. To simplify wellbeing to a meaningful, measurable metric which can be captured on a short-term (bi-hourly) basis, we chose stress as an inverse proxy for wellbeing. To validate that our stress metric correlates to other markers of wellbeing, we collected reports of disengagement and feelings of overwhelm in a weekly survey. We saw that the weekly stress scores correlated highly with *feelings of disengagement* (**0.45*****) and with *feelings of overwhelm* (**0.39*****). In the following analyses,

Fig. 1. Effect of Supervisor Interactions at Different Levels of Extraversion

The effect of interaction type on wellbeing is moderated by extraversion: for introverts, wellbeing is higher when interactions with teams are more task-oriented (positive slope), whereas for extraverts, wellbeing is higher when interactions with teams are more relational (negative slope).

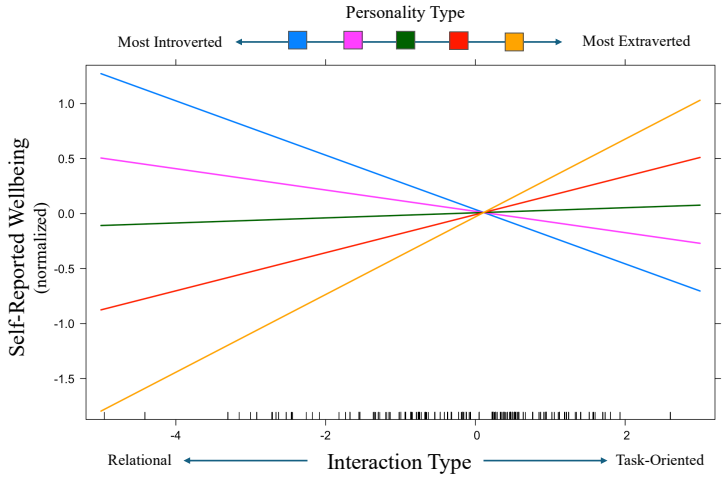
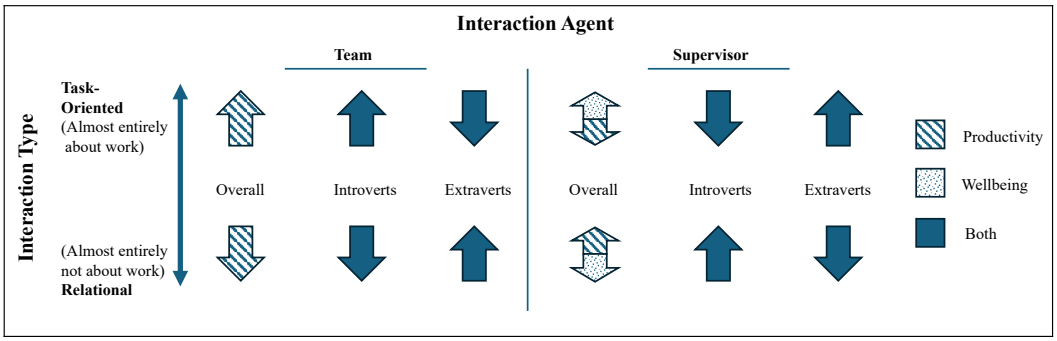


Fig. 2. Personality Moderation of Interaction Type Effects on Productivity and Wellbeing

The figure presents the effect of team and supervisor interactions on three subdivisions of participants: the overall pool, just introverts, and just extraverts. The arrow direction indicates if the effect is positive (i.e. heightened productivity and wellbeing) or negative, while the arrow fill indicates which factors (productivity, wellbeing, or both) are affected.



we use stress as an inverse proxy for wellbeing, meaning that we interpret increased stress as decreased wellbeing.

Overall, productivity is higher for task-oriented interactions with teams and relational interactions with supervisors. The productivity score was calculated as an average of the participant's end-of-day productivity rating. Our results showed that when interacting with the *team*, task-focused interactions were correlated with higher productivity and non-task-oriented interactions were correlated with lower productivity (**0.16*****). This was the opposite for interactions

with the *supervisor*. Supervisor interactions were correlated with slightly lower productivity when they were task-focused and with higher productivity when they were relational (**-0.09***). This indicates that overall, workers fared better when their interactions with the team were task-oriented, and interactions with the supervisors were relational.

Overall, team interactions were correlated with similar levels of wellbeing for task-oriented and relational interactions. We built a second linear mixed model, with wellbeing as the dependent variable, which showed that the type of interaction had little to no effect on wellbeing overall with interactions with the team. However, we saw an interesting result with regard to supervisor interactions. **Though task-oriented interactions with supervisors were negatively correlated with *productivity*, they were positively correlated with *wellbeing***. We visualize these findings in Figure 2 with the label "Overall". Note how, when looking only at introverts or extraverts, the arrows point solidly in a positive or negative direction. With the overall participant pool this is not the case, even resulting in a mixed arrow that points in two directions for "supervisor" interactions. We gain a clue to this behavior in subsection 5.2, when we consider personality as a moderator and see that introverts and extraverts may be affected in opposite ways.

Frequent interactions are productive with the team, but not with the supervisor. Although the focus of this study was on interaction type, we also looked at whether *interaction amount*, reported on a scale from 1 = "Almost Not At All" to 5 = "Unusually Much", affected perceived productivity and wellbeing. Curiously, we saw that with **teams**, frequent interaction correlated with higher productivity, but also a decrease in wellbeing. Conversely, we saw that overall frequent interaction with the **supervisor** correlated with a slight decrease in productivity and a partially significant decrease in wellbeing. The relationship direction here is unclear: one possible explanation may be that workers met with their supervisors more often than usual due to issues with performance or with overwhelm. This relationship, though interesting, needs further investigation in future studies. We investigated whether extraversion plays a moderating role on how interaction amount affects workers, but saw no evidence of this. We did, however, see extraversion play a moderating role in the effects of interaction type. We discuss this in the following sections.

5.2 Extraversion Moderates the Effects of Interactions on Productivity and Wellbeing.

Is the impact of interactions different for workers of different personality types: introverts and extraverts? We conducted a similar analysis to subsection 5.1, building regression models with the interaction type and agent, but this time we included as a moderating variable the participant's extraversion score. Interestingly, we saw that interactions had **different effects on participants of different personality type**, and not in a straightforward way. Since introverts seek out relational interaction less than extraverts, we expected them to fare better with task-oriented interactions overall. However, we saw that this depended on who the interaction was with: their team or their supervisor.

Extraverts fare better when interactions with the team are relational. We found that extraversion was a significant moderator for the effect of team interactions on the participant's productivity (0.10*) and wellbeing (0.18***). Earlier, we saw that for the overall participant pool, task-oriented team interactions were positively correlated with productivity, and had no correlation to wellbeing. However, with personality type as a factor we see that while extraverts do report higher productivity with task-oriented team interactions, introverts actually reported lower productivity with task-oriented team interactions and, consequently, higher productivity with relational team-interactions. Similarly, extraverts report higher wellbeing when their interactions with the team were more task-oriented, while introverts report higher wellbeing when their interactions with the team were more relational. Team interaction type affects introverts and extraverts in different ways, as illustrated by the opposite-pointing arrows in Figure 2.

Table 4. Team Communication Schedules and Tools

Team	Team Communication			Daily Averages Per Participant	
	Team Meeting	Social Meeting	Primary Tools	Meetings (Hrs)	% Remote Work
T12	Daily	None	Zoom, Slack	5.3	96%
T10	Once a week	Once a week	Slack	5.2	93%
T02	Once a week	Once a week	Teams	5.0	100%
T07	Once a week	Twice a week	Skype	4.5	87%
T11	Once a week	Once a week	Zoom, Slack	4.1	100%
T03	Once a week	None	Teams	3.4	34%
T14	Daily	None	Slack	3.2	100%
T08	Twice a week	Once a week	Skype	1.9	90%
T04	Daily	None	Skype	1.8	9%
T09	Once a week	Once a week	Skype	1.4	78%

Communication practices of teams with more than three participants (excluded are teams T00, T01, T05, T06, and T13).

Extraverts fare better when interactions with the supervisor are task-oriented. For supervisor interactions, we likewise found that extraversion significantly moderated the effect on the participant's productivity (0.10*) and wellbeing (0.11**). When looking at the participant pool overall, we saw a contradicting effect: task-oriented supervisor interactions were correlated with higher wellbeing, but lower productivity (as showcased by the arrow pointing up and down in Figure 2). However, when considering personality type, we see supervisor interactions affect introverts and extraverts in opposite ways. Extraverts experienced higher productivity and well-being when engaging in more task-focused supervisor interactions, while introverts experienced higher productivity and wellbeing when interactions with their supervisor were more relational. This is interesting because **it is opposite from the pattern we saw with team interactions**. We visualize this in the right half of Figure 2. Note that this figure distills two continuous variables into a binary for a clearer message: interaction type is measured on a scale from fully relational to fully task-oriented, and extraversion is measured on a scale from low (indicating introversion) to high. The arrows in the figure indicate the effects at the extremes of both scales, such as the effect of highly task-oriented interactions on highly extraverted participants. To illustrate the moderation factor, we show how the effect varies by extraversion level in Figure 1 – here, the five colored lines represent the effect at different levels of extraversion (from low, indicated with blue, to high, indicated with orange). The varying slope (from positive to neutral to negative) reflects the differing effects of supervisor interactions at different levels of extraversion, and matches the result we see with the differently pointing arrows (up for positive and down for negative) in Figure 2.

These findings suggest that the impact of interactions on workers depends on three factors: the *type of interaction* (task-oriented or relational), *the agent of the interaction* (the team or supervisor), and, crucially, the participant's *personality type* – where they stand on the extraversion scale.

5.3 Communication Patterns in the Pandemic Workplace

In the following sections, we provide descriptive insights about the state of communication patterns during the study, and add to the existing body of literature on worker experiences in the shift to remote work. RQ2a asked about the present reality of communication in the workplace: what did communication look like for participants throughout the study? Since communication frequency

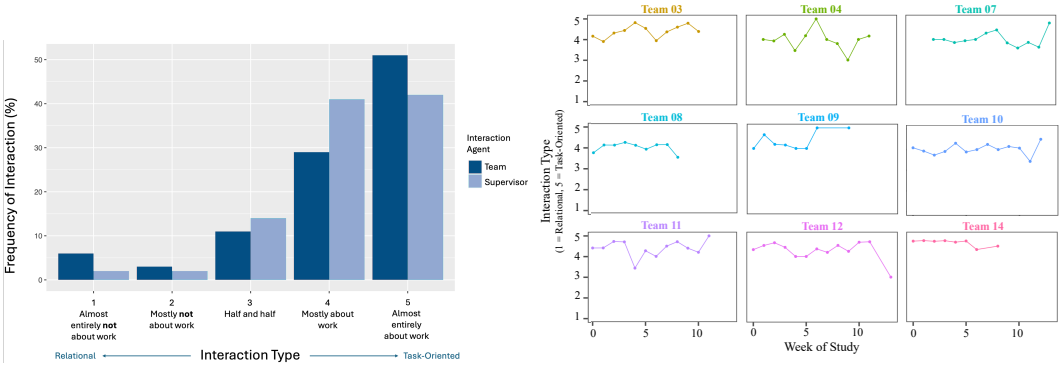
and modes depend much on the schedules and set expectations of the team (e.g. weekly stand-ups), we aggregated communication patterns by team (for the ten teams where we had at least three participants) and present them in Table 4, ordered by time spent in meetings. The data on *team communication* was collected from final interviews, where we asked specifically *what does communication look like in your team*, probing about meeting schedules and communication tools. With one exception, **the answers aligned for all members of a team** (the same communication tools and schedules were reported by all participants of a given team). The exception is Team 8, where a smaller subsection of the team met once a week, while the larger section of the team met twice a week. While the communication schedules and tools were relatively static throughout the study, the meeting time and remote work hours could vary day-by-day for workers, so we collected these *daily averages for participants* from the end-of-day survey responses for a more accurate representation.

5.3.1 Remote Work and Communication Tools. We saw that worktime was heavily-remote, with **eight of the ten reported teams working remotely at least 78% of the time**. Only two teams worked mostly from the office: Team 4 joined in the early stages of the Pandemic when their work had not yet moved to remote, and Team 3 was part of a construction firm with frequent on-site operations. With participants working remotely so much of the time, we were not surprised to find that **most communication was computer-mediated**. Under "primary tools" we list the main system(s) employed by the team for internal communication, i.e., video-/tele-conferencing and instant messaging. Every team conducted most of their communication through one (or more) of the following tools: Skype (5), Microsoft Teams (5), Slack (5) or Zoom (3). Most teams mentioned a single primary tool used for communication: Slack, Microsoft Teams, or Skype. These common third-party platforms mediate a basic set of communication modes, including instant messaging and teleconferencing. Two teams mentioned that they employ both Zoom and Slack, using Slack for messaging and Zoom for teleconferencing. All teams additionally mentioned email, and some mentioned phone calls/text and WhatsApp groups (formed for social chat).

5.3.2 Meetings. Notably, much of the reported communication took place in meetings: participants reported on average **3 hours 35 minutes of meetings daily**. This could take multiple forms: meetings with the team, supervisor, company, clients, or others. While the average times varied greatly across teams, we can see that participants of half of the reported teams spent more than 4 hours (half of a workday) in meetings. This may be partially explained by two factors, 1) *team composition*: Teams 2, 11, and 12 were at least 50% constituted of managerial roles, and 2) *industry*: the client-facing nature of Team 7 (insurance) and Team 10 (sales). A second reason for the long meeting times could be the general increase in meeting time related to the transition to remote, which participants mentioned in the interviews (more on that in Section 5.5). We see also that many teams instituted recurring **social meetings** since the move to remote working. These are optional social exchanges, commonly in the form of video calls during lunch or coffee breaks.

5.4 Balance of Task-Oriented vs. Relational Interactions

In end-of-day surveys, we asked participants to reflect on the interactions they had that day with their teams and their supervisor, and how they would characterize each set of interactions in terms of *interaction type*. They rated the type on a Likert scale of 1 to 5, 1 being very *relational* (informal, social), and 5 being very *task-oriented* (formal, work-centric). This allowed us to build a picture of daily interactions over the course of the study. Here, we asked two questions: a) were interactions more task-oriented or relational, and did this change over the course of the study? b) did the interaction type depend on the *interaction agent*, i.e., whether it was with the team or the supervisor?



(a) Histogram of Interaction Type for teams and supervisors.
For both, interactions were heavily task-oriented.

(b) Changes in the averages of Interaction Type for team interactions of nine largest teams over time.

Fig. 3. Distribution of Interaction Types (from Relational to Task-Oriented)

5.4.1 Interactions overall were heavily task-focused. We asked whether interactions were, on average, more task-oriented or relational, and whether this balance changed over the course of the study. To answer this, we first computed the average interaction type score (where 1=relational and 5=task-oriented) for each participant for each day, then averaged the scores over the team to produce communication trends for each team. We saw that overall, the mean interaction type for communication across managers *and* teams was **4.19 (±0.985)**, where a score of 4 means the interaction was "mostly about work" and a score of 5 means it was "almost entirely about work". Across all teams, interaction was heavily on the side of work-centric. Mapping out the averages over the course of the study, we saw no significant trend for how this interaction type changed over time. In Figure 3b, we visualize the interaction type timelines for nine teams. We can see that the pattern of interactions varied from week to week, but with no clear trend across teams overall. We do see, however, that the average ratings per week per team were quite high (usually 4 or higher) for all teams, which indicates that interactions were largely task-oriented.

5.4.2 Manager and team interactions were similarly task-focused. In the previous section, we calculated an average of all interactions, manager and team combined. We next looked at whether the *agent of the interaction* (manager or team) affected the *interaction type*. Note that, regardless of role, all participants reported who the collocutor was from their own perspective: a fellow team member or someone they report to. Managers would thus report interactions they had with their own managers. We built a linear regression model with the interaction type score as a dependent variable, including as control variables the age and gender of the employee as well as the five personality variables (extraversion, openness, neuroticism, agreeableness, and conscientiousness). We saw that the agent (manager or team) did not have a significant moderating effect on the overall work-relatedness of conversations (B=-0.00, SE=0.03, $t(2697)$=-0.02, $p<1$). This was echoed in the averages we saw for interaction types per agent: for interactions with the team, the average interaction type was **4.20** (±0.86), and for interactions with the manager, the average type was **4.18** (±1.11). As visualized in Figure 3a, we see a similarly work-centric trend for both team and manager interactions, though manager interaction types did have slightly more variance.

5.5 Changes Since the Pandemic

To better understand how communication had changed since the start of the Pandemic, we asked a series of open-ended communication questions (see section 3), including what communication in their teams looks like now, what is different from before, and whether there is anything missing or any particular challenges. We performed thematic analysis on all 52 collected interviews and found that 1) though more time is dedicated to communication than before the Pandemic, this communication is lacking in depth and quality, 2) one aspect especially missing is the social conversations within the team, and 3) though participants report being more intentional than before in the ways they communicate, they feel there are still areas for improvement. We elaborate on these themes below.

5.5.1 Communication Both Increased and Decreased. A paradoxical sentiment echoed by many participants was that while communication has been increased in remote times (in terms of hours spent in meetings and instant messaging), this communication comes with an information loss. It seems **remote communication lacks the completeness and depth of in-person communication**, which likely leads to the need for increased communication time. Indeed, many participants reported having more meetings than before, with at least three teams reporting changing their meeting schedule to be more frequent. A participant of one team mentioned that in addition to the scrum frequency ramping up from weekly to daily, the meeting also became more interactive: 💬 *Previously, it was just kind of like a form for [our team lead] to say, Hey, here's what's going on. And he's modified that so everybody's giving an individual report of what's going on (S183).* The need for more meetings stems from several factors. On the one hand, without the possibility to trot up to a teammate's desk and ask a quick question, **information exchange now relies heavily on appointments**: 💬 *We are having more meetings now than we would've if we were in the office. 'Cause before, you could just like grab somebody real quick (S292).* 💬 *And you can't say, come on, I'll just run over to the other wing or I'll [. . .] drop by and we'll have a chat about it. You don't have that. So there are only Skype appointments (S449).* Quick, ad-hoc questions are now delegated to scheduled video calls.

Furthermore, knowledge which might have spread through the office floor naturally, such as who is working on what, what is new, what is broken, now requires an explicit medium in the form of scheduled briefings. **The number of meetings has thus ramped up in the effort to maintain the information flow**. Yet even with the increased meeting time, multiple participants felt that they are missing the tidbits, the news nuggets, the kind of information one gleans from hallway conversations and watercooler talks. 💬 *[Before], you always met people you know, where you just say hello, how are you? And then you're told something or overhear something or even if you're walking through the aisles and someone or two are already talking and you're asking a colleague something and you just listen and say, "That's interesting, what's going on there? Can you explain that to me briefly?" You don't have all that anymore. Now you proactively make exchanges, appointments, of course [. . .] So a lot of information that you had before falls by the wayside (S449).* Another participant said, 💬 *It just takes up more time in my day rather than me just like overhearing something which surprisingly can provide quite a bit of context (S237).* 💬 *You'll have a coffee together and a chit chat and you'll get many, many information you are not aware about. And that's all missing at the moment (S153).*

In addition to a loss of context, participants mentioned that remote communication makes it difficult to read the body language and facial expressions of your conversation partners. 💬 *I lost my superpowers when we went remote. 'Cause I cannot read the room. This is very anxiety-inducing for me because sometimes I do a presentation for 20 people and I cannot read the room. It's like navigating in the dark... I'm not a big fan of body language, but it's quite useful sometimes (S229).* 💬 *Maybe it's not so bad if you can't see that the other person has rolled his eyes. But these are the little things*

that make a lot of difference in such conversations (S175). Important cues are lost in translation with the move from in-person to digital.

5.5.2 Participants Missed the "Water Cooler" Talks. Of the sentiments expressed by participants regarding communication changes in the transition from office to remote, the most common feeling was that social interactions significantly declined. "I would say communication is almost limited to work now", participant S236 states. With face-to-face interactions being replaced by online calls and digital messages, the topic of conversation has **shifted away from social chat to being mostly work-centric.** It is especially those serendipitous interactions – the water cooler or coffee talks, the casual check-ins before and after meetings – that lost their place in the remote workday. 💬 *Well I think all of those sort of happenstance, personal connections that are a function of sharing a workplace, sharing a work environment, those are all gone. So everything is much more sort of deliberate and scheduled and, you know, not impulsive (S456).* Participant S355 estimated that communication changed from being 20-30% social-focused during office times to just 2-5% in remote times. "I mean we don't have any more of that water cooler talk, you know, just hanging out in the kitchen or the lounge chatting about things", they explain. In fact, the serendipitous nature of social conversation may make it hard to have a foothold in scheduled conference calls. Communication in the remote workplace was mostly reduced to scheduled meetings, without the chance of hallway encounters with colleagues or spare chat time around the coffee machine. 💬 *It's a lot more scheduled and ... you don't have the sort of water cooler drop in talk (S192).* 💬 *The coffee chat has slipped away. That's what really changed (S127).* Without the serendipity of office encounters, **social communication needs to be planned and scheduled.**

This is true not only for real-time conversations, but also for messages. In remote work, instant messaging platforms such as Slack and Teams have become a major channel for asynchronous information exchange. With the overload of incoming messages, participants of multiple teams reported being more conscious of how they use it — for example, by grouping multiple messages into one and making the content be more to-the-point (in other words, with less off-topic social content). 💬 *[Instant Messages] before were more casual, you'd be like, Hey, let's get lunch, or Hey, how was your weekend? Or Hey, let's talk in another room. And then now it's more like you, you craft like an entire paragraph for your question. (S156).* In fact, some participants stated that they are **actively trying to bring back the social aspect** of communication with their colleagues, either by bringing in social chat into their existing meetings or by scheduling social meetings 💬 *I try to weave the private aspects into the discussion (S218).* 💬 *So you have to make a lot of effort yourself to stay on the ball. Yes. In order not to lose the thread and not to lose contact with the others (S417).* 💬 *I'm currently already trying to consciously think about who I haven't talked to in a long time and then call people really briefly and say we haven't heard from each other in a long time, how are you? (S463).*

There have likewise been **interventions on a team-scale**, with some teams organizing regular social chats or simply keeping in mind the importance of the personal factor in team meetings. 💬 *Two days in the week organized our "open dates", so a kind of coffee round meeting (S404).* 💬 *We kind of keep our team meetings to a lot of just connecting as people and worrying less about any major kind of work updates. That's been kind of an important learning of working remotely: this aspect of just staying connected as a team as people is really important (S519).* Still, some lament that though they try to encourage social aspects, it is difficult. 💬 *I want to do more social hangouts, but it's just hard, it's hard to get people to do that. And plus everyone's just on a Zoom call, so it's a little weird (S126).* **It can be hard to force the free-spirited serendipitous social chat into the confines of formalized, scheduled meetings**. Yet the importance of social interactions for team cohesion

and personal wellbeing makes it an important question to consider as we adapt to a remote or hybrid work reality.

6 Discussion

6.1 Task-Oriented vs. Relational Interactions in the Remote Workplace

The overwhelming response to the interview question *"is there anything missing from communication today?"* was that communication was not relational, or social, enough. Participants lamented about the lack of connection with peers in non-work-related conversations, like the "water cooler talks" which in remote conversation did not have a natural place. These interview findings were supported by the quantitative daily ratings data, which showed that interactions with the team and manager were mostly task-oriented. Over half of the participants mentioned that their teams had taken the initiative to institute social time, which was facilitated either through chat groups or scheduled regular social video chats. This transition of water cooler talks from adhoc in-person into regular online meetings echoes the findings from several studies of Pandemic working run at this time [18, 34, 53]. It was therefore all the more interesting to find that participants were missing social conversation. This indicates that the current initiatives for social time – though likely helpful – are not enough to match the social time of the collocated workplace. A 2021 study by Miller et al. found a similar paradox in that participants reported both an increase in meetings while lamenting the lack of social interaction [53] . This may be explained by a recent finding by Mohlin and Chatzipanagiotou, in that the digital tools which hybrid employees used for everyday work were effective for conducting their work, but not for fostering social interaction. These workers described social interaction in the workplace as "an activity of physical nature", which may explain why digital technologies were not sufficient for this purpose [54]. This was echoed in interviews with our own participants, where we heard two sentiments which contribute to this pattern. First, communication in the Pandemic times became very structured – in contrast to the casual and spontaneous nature of hallway and water-cooler conversations, most meetings were now video conference calls that had been scheduled in the worker's schedule in advance. An affordance-perspective study by Waizenegger in 2020 explained this phenomenon in that "knowledge workers no longer naturally bump into each other anymore to engage in ad-hoc conversations about their current projects, their tasks, or their daily life [...] The withdrawal from the environmental affordances of the office space reduced the frequency of ad-hoc meetings due to the lack of spontaneity. It led to a more planned and orchestrated collaboration" [72]. Second, though participants were spending more time communicating during the Pandemic, they felt that the richness of the communication had decreased. The subtle, but important, contextual cues that would come from overhearing surrounding conversations or from seeing the body language of their interlocutor. Roughly speaking, the information gained per minute of conversation was decreased in the move from collocated to remote conversation. A study of work-from-home experiences by Cho et al. notes that this loss of context can disproportionately impact new employees, who are still getting acquainted with the team and company culture [18]. The third point is a natural consequence from the first two: participants were now spending more time in scheduled meetings, with about half of the workday categorized as meeting time. It is then understandable that workers would want to make meeting time as efficient as possible, which usually means getting straight to the point of the meeting agenda. Relational conversation, though important, may be harder to justify when it does not contribute to immediate progress.

6.2 Communication Affects Individuals Differently

A surprising result of our study was that the correlation between communication and worker thrive is highly individual. We saw that all three factors: *interaction type* (relational vs. task-oriented), the *agent of the interaction* (the team or the supervisor), and the *personality type* of the individual moderated the communication effect. We expected that, perhaps, introverts would report better wellbeing and productivity with task-oriented conversations as opposed to relational, and when interacting with their supervisor rather than the team. However, the findings were not so straightforward. Instead, we saw that introverts fared best with task-oriented conversations with their team and with relational conversations with their supervisors. Extraverts, on the other hand, fared best with relational conversations with their team and task-oriented conversations with their supervisors. One possible explanation is that introverts are more comfortable in one-on-one conversations (and are therefore happier having relational conversations with their manager), whereas extraverts are more comfortable in group conversations (and are therefore happier having relational conversations with their team). However, further research is needed to understand this dynamic. In either case, these findings point to the need for a more nuanced approach to team communication research, one which takes into account the interaction type, interaction agent, and personality differences of the individual.

6.3 Understanding Individual Differences for Better Communication in Teams

One paradox is that communication requires two or more people, and yet those people may be impacted differently by that communication. This makes the situation much more difficult than simply prescribing one solution for the entire team. However, we suggest that understanding individual differences can be beneficial for both individual contributors and managers. As an individual contributor, for example, one may try to sway the relational-task-oriented balance slightly in their favor. While they cannot reasonably opt out of a work-oriented conversation, they can perhaps opt in or out of social conversation with their team (letting others discuss last night's game and joining only when the work conversation has started). With their supervisors, they can also try to initiate more social conversation, or wrap up the social conversation more quickly. Managers, on the other hand, can benefit from taking a more tailored approach when conversing with their team members. Instead of assuming a one-size-fits-all formula for their one-on-ones, where they might, for example, try to have five minutes of casual conversation before diving into 25 minutes of work-centric conversation, managers could instead be more aware that different individuals may benefit from a different ratio of conversation. While the manager might not know the exact personality type of their team members, or their communication preferences, simply tuning in and trying to understand what the individual needs might go a long way.

6.4

Based on our findings, we offer the following recommendations on team communication towards industry practitioners. For **knowledge workers in the industry**, we suggest first and foremost **building self-awareness**. We have seen that communication affects individuals in different ways, depending especially on the type of interaction, who it is with, and the personality type of the individual. We suggest that workers learn their extraversion type so they can better understand their natural predisposition towards interaction. This can then help to determine the approach a worker should take in interacting with their team — whether to encourage a more social or work-oriented conversation with peers and supervisors. Second, we recommend that managers adopt an **individualized approach** towards interactions in 1:1 meetings, adjusting to each direct report. Although the manager may not have knowledge of their report's personality type, it could

already help to tune in and be more thoughtful about how their style of interaction is affecting this specific worker, rather than resorting to a one-size-fits-all conversation formula such as a 5-minute conversational warm-up before getting down to business. Some employees might benefit from a more relational conversation, while others may be better off with a conversation that is more task-oriented.

For **teams**, we suggest to rethink meetings: both relational and task-oriented. Our findings showed that remote workers spent over half of their days in meetings, yet despite this felt that they were missing contextual information and spontaneous social interaction. The solution would most likely involve a combination of **cutting down on unnecessary meetings** (a recommendation which has been repeated in past literature, but still seems not to be solved), as well as rethinking exchanges. One idea would be to introduce a platform for contextual information: for example, a channel where members can casually exchange updates or bits of news (similar to hallway conversations). Another would be to have a channel for spontaneous social meetings, where members can pop in during a coffee break (rather than having a scheduled recurring social break).

6.4 Implications for Groupware Technology Design

In interviews, we overwhelmingly heard dissatisfaction with relational interactions, rather than task-oriented interactions. Without the possibility of ad-hoc in-person conversations, such as coffee chats, relational communication assumed the same rigid, scheduled format of work meetings. Recent work in CSCW sheds light on why digital tools fail in fostering social interaction, more so than with work-focused interaction. First, these digital tools have too much of a work connotation (rather than a specifically social symbolism) and second, they lack the spontaneity and sensory inputs of physical interaction [54]. This suggests the need to design social work applications separately from work communication channels, both to place them in a separate sphere and to integrate physical context and awareness. The comments we heard from participants about not being able to "read the room" and having to "navigate in the dark" reflect this problem, and past studies have suggested several ways to bring back some of what is lost in the lack of physical embodiment and spontaneity of interaction. For example, Lee et al. and Venolia et al. have proposed telepresence devices (an embodied social proxy) to help coworkers connect across distances in more natural and expressive ways, and to have impromptu interactions [45, 71]. Beuthel et al. outlined and explored five strategies for reintroducing non-digital, analog and bodily means into communication [8]. In helping to solve the problem of awareness and to lessen communication overload, Ackerman et al. suggested the use of social activity indicators to guide workers into which social channels they should monitor, and which they can ignore [1]. Furthermore, a growing body of literature is addressing the question of how to design groupware technologies which will be effective across interpersonal differences. One challenge that we have seen with our participants and has been echoed through multiple Pandemic studies is the loss of context in the move from collocated to online, resulting in a lack of common ground and mutual understanding. Even twenty years prior, a study of distributed group-to-group work by Mark et al. [47] found that teams enter collaborative work with their own culture, perspectives, and practices, and that this makes it difficult to create a shared understanding. This phenomenon, notes a 2023 literature survey by Duckert et al., is prominent even in the collocated setting (where it is known as "collocated distance"), but it is especially exacerbated with the geographical distribution introduced by hybrid work. It is therefore imperative to design groupware technology which will foster communication in a way that helps workers "navigate multiple lifeworlds, assumptions, languages", and more [25]. Indeed, like personality differences, cultural differences have been shown to impact how well workers adopt hybrid work practices, as in the Akahori et al. study of how cultural attributes such as individualism and collectivism or cultural tightness affect the likelihood of adopting hybrid norms

among workers in the US and Japan [2]. It is imperative to design communication solutions which account for interpersonal differences, rather than creating one-size-fits-all solutions. One example is the approach explored by Tang et al. on how differing preferences for virtual conferencing interfaces can shape the design for virtual space which makes everyone happy [68].

For **communication tool designers**, we therefore suggest to build approaches that can be tailored or customized to the individual communication needs. One idea would be to incorporate a Personal Operating Manual (POM) into communication tools, which would allow the user to specify their communication preferences. Another idea would be to automatically categorize conversations in team chat channels and threads with the supervisor. The tool could then display a dashboard to see trends in their interaction types, and recommend what kind of interactions they should seek out more of (e.g., a social chat with a colleague).

Finally, we suggest that **future researchers** consider three factors when conducting team communication research: the interaction type, agent, and personality type of the individual. We suggest that without this level of detail, the effects of communication can be mixed or misleading. Considering these three factors can help researchers better understand the full picture.

7 Conclusion

This longitudinal study of 60 remote knowledge workers across North America and Europe sheds new light on the dynamics and impacts of team communication in the remote workplace. We saw that the effects of communication on the productivity and wellbeing of knowledge workers are not as straightforward as they originally seemed. These effects depend on three factors: the type of interaction (task-oriented or relational), the agent of the interaction (the team or supervisor), and the personality type of the individual (introvert or extravert). Specifically, we saw that introverts fared best when their interactions with the team were task-oriented and their interactions with supervisors were relational. Extraverts showed the opposite relationship: they reported higher productivity and lower stress when their interactions with supervisors were task-oriented and their interactions with the team were relational. These findings indicate that these three factors – interaction type, agent, and personality differences – should be considered in team communication research going forward. Furthermore, this work adds to the body of knowledge on communication during the Pandemic, helping to resolve some of the contradictions in previous works. Participant sentiments paradoxically echoed both an overwhelm from communication and a want for communication, but a deeper analysis showed that this stemmed from the overall change that communication went through in the transition from in-person to remote: it became more scheduled and rigid, while losing contextual richness and social spontaneity. Overall, this work points to important directions for future team communication research in the remote and hybrid workplace.

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