Towards contextualizing stressors in technostress research

Completed Research Paper

Stefan Schellhammer
University of Münster
Münster, Germany
wistsc@wi.uni-muenster.de

Russell Haines
Old Dominion University
Norfolk, Virginia USA
rhaines@odu.edu

Abstract

The literature on "technostress" posits that information and communication technology (ICT) contributes to feelings of strain by increasing the speed of work, having to adapt to technological change, and/or the poor usability features of the ICT. Most technostress research builds on surveys distributed across organizations. Thus, stressor-related questions cannot differentiate between how strain might be experienced in different roles assumed in the workplace. This paper aims to investigate, by means of an experiment, how different roles in a work arrangement affect the perception of strain. Our results show that the mere quantity of tasks does not serve as a good predictor of strain. We posit that the perception of strain and stressors is influenced by the context in which the tasks are embedded. These findings underline the need to investigate the ways in which ICT alters the organization of work instead of focusing on how ICT may support specific tasks.

Keywords: collaboration, organizational issues, technostress

Introduction

Information and communication technology (ICT) permeates the modern workplace in a way that renders the technology virtually invisible. The usage of email, instant messaging and/or collaboration suites has become second nature for a growing number of employees. Organizations continuously seek to introduce new technological innovations that will allow for more effective and efficient work processes. Knowledge intensive work is seen as an area in which ICT has not reached its full potential. The increased usage of ICT by knowledge workers is thought to not only serve organizations' interests but also to improve working conditions in the employee's interest (Cisco, 2009). Technology providers market their collaboration software as a means to free workers and organizations alike from the constraints of time and space.

Just as computer controlled production allowed for significant productivity gains in manufacturing, knowledge intensive processes were supposed to follow suit (Drucker, 1999). Through the use of ICT, employees should be able to collaborate seamlessly across time and space. ICT is portrayed as a means to (1) facilitate closer collaboration across the organization, (2) speed processes due to improved communication, and (3) respond more flexibility to changing external conditions. Higher levels of productivity are thought to result from ICT-based support of knowledge intensive work processes.

By implementing ICT supported work processes, employees are capable of entering into more flexible work arrangements. This means that work arrangements can be designed that are capable of fulfilling individual preferences regarding time and place of work. This is believed to have a positive effect on the employee's quality of life (Cisco, 2009).

As a challenge to these beneficial effects of ICT-enabled work arrangements, the growing literature on technostress (Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Tarafdar et al., 2011; Tarafdar et al., 2007) investigates potentially negative effects of these forms of work on employees' well-being. Work overload

features prominently in these studies. ICT is found to directly and indirectly contribute to feelings of being overloaded due to the dynamics of technological change and its increasing complexity, which means employees are directly confronted with additional demands to integrate ICT in their work habits. Indirectly, ICT is thought to engender a feeling of having to work faster, because it increases the pace as well as the quantity of communication that needs to be handled.

It is important to note that theoretical models of stress conceptualize work overload as "perceived" work overload. Thus, it may not be the mere quantity of work that leads to strain, but rather the individual's perception and evaluation of whether or not it exceeds their capabilities. The knowledge worker is especially prone to these effects when using ICT.

The term knowledge worker is rather broad, circumscribing tasks that range from simple handling and passing on of information all the way up to highly coordination-intensive joint problem solving tasks. In this paper we seek to differentiate between the different tasks and roles a knowledge worker might assume, and how those different tasks and roles would affect their perceived overload and other established stressors. For that purpose, we have chosen a realistic task situated in the healthcare sector that requires participants to collaborate and coordinate closely by electronic means in an experimental setting. This allows us to investigate which stressors are most prominent given a specific role in a work arrangement.

The paper is structured as follows: Section 2 reviews the relevant research on technostress in the IS literature and how stressors are currently thought to influence knowledge workers. The next section introduces our typology of different forms of knowledge work and how work(over)load might be differently perceived among them. Next, we present the research design of our experiment, in which participants filled different knowledge worker roles in a simulated medical team, followed by the results of the experiment. Finally, we discuss the results of the experiment and offer conclusions for managers and for future research.

Research on stress in the IS-literature

Stress and technostress

While "technostress" is a relatively new and emerging topic in information systems research (cf. Riedl et al., 2012), the term was actually coined in the 1980s. Brod (1984) defines it as the "inability to cope with new computer technologies in a healthy manner." (p. 16). Weil and Rosen (1997) conceive of it as "any negative impact on attitudes, thoughts, behaviors, or body physiology that is caused either directly or indirectly by technology." (p. 5). In investigating possible negative consequences of ICT on workers' health, IS researchers have been influenced by work originating in the fields of Psychology and Organization Science. Research on stress in organizations has investigated several categories of sources of stress, such as physical working conditions, task related stressors, stressors originating from role ambiguity or stressful change processes (cf. Sonnentag and Frese, 2003).

In line with Ayyagari et al. (2011), we refer throughout this paper to stress as an overall process rather than a particular phenomenon. Stressors are stimuli – events or conditions that lead to strain. Strain is thus conceived of as the individual's response to these stimuli.

Research on technostress aims to identify what specifically about the use of technology leads to higher stress levels of individuals. Several ICT-related sources of stress have been identified in the literature (cf., Ragu-Nathan et al., 2008): (1) the constant connectivity of employees extends the normal work day and forces a continual exposure to requests onto employees, (2) mobile ICT and collaborative tools have lead to a routinization of multi-tasking, (3) due to competitive pressures, new ICT is constantly introduced into the workplace which consequently requires employees to appropriate these innovations on a regular basis, (4) ICT products and tools already in use are frequently updated, which requires constant learning and instills ambiguity in regard to job demands, and (5) most ICT products require a certain amount of modification to become a useful tool in the tasks at hand, meaning tasks often have to be done with inadequate tools leading not only to frustration but strain as well.

In a recent literature review of technostress in the IS discipline, Riedl (2013) identified three major groups of reseachers that published in IS outlets, all of which drew on survey data and focused mainly on either antecedent, moderating, or outcome variables.

For example, Ragu-Nathan et al. (2008) argue that technostress arises out of a shift in the ways individuals interact with their workplace. Individuals struggle to establish new routines that question traditional conceptions of the workplace (ibid, p. 418). Job satisfaction, organizational commitment and turnover are outcome variables found to be affected by stress. Their sample consisted of 608 end-users in five different organizations.

Wang et al. (2008) similarly employed a large-scale survey in order to investigate the relationship between technostress and different organizational environments. Based on 951 responses, they found that the level of centralization and innovativeness of the organizational environment moderates the perception of technostress.

In a more recent study, Ayyagari et al. (2011) investigated what characteristics of technology induce strain. For that purpose, they drew on established stressors from the organizational stress literature and selected those relevant for the investigation of technostress in their study. 661 individuals from various industries took part in their survey. Their findings, summarized in Table 1, suggest that ICT increases stress levels by aggravating factors like work-home conflict, job-insecurity, role ambiguity and/or work overload. The latter two represent the most important predictors of strain in their study.

Table 1: Stressors in the technostress literature

Stressor	Effect of ICT-features
Work-home conflict	ICT allows for a constant connectivity that is perceived as an encroachment of personal space.
Job insecurity	Given the constant changes in technology, it becomes challenging for workers to maintain mastery over their tools.
Role ambiguity	Due to its proliferation and rapid changes, disruptions of work and situations of conflicting demands become more likely.
Work overload	ICT may lead to work overload as it raises the pace of work, which in turn contributes to the stressor 'work overload'.

Reviewing this literature leads to the impression that ICT, in many cases, facilitates work arrangements with potentially negative effects on employees' health. Most studies emphasize that the usage of ICT increases the pace of work, the complexity that needs to be handled, and the necessity to cope with a constantly changing workplace. Of the stressors that are fed by these developments, work overload and role ambiguity feature most prominently in technostress studies. Stressors rooted in team arrangements and (ICT-mediated) communication networks are largely ignored in current technostress research. The present study. aims to enlarge the list of potential stressors to include those pertinent to communication networks and team arrangements that are faciliated by ICT (see the next section).

Methodologically, stressors have been established by making use of surveys as a data collection method (cf. Ayyagari et al., 2011; Ragu-Nathan et al., 2008; Wang et al., 2008). Some studies restricted their sample to IT professionals and managers from different industries (Moore, 2000; Weiss, 1983). While large sample sizes and the inclusion of a variety of industries gives a good impression of the prevalence of technostress as well as the validity of certain stressors, it falls short in how exactly ICT contributes to feelings of being overloaded. By necessity of the survey method questions are abstract in order to be applicable to a variety of work arrangements. Questions like "I feel busy or rushed due to ICTs." (Ayyagari et al., 2011, p. A3) or "I am forced by this technology to work much faster." (Ragu-Nathan et al., 2008, p. 426) do not take into account the multiplicity of ways in which ICT is capable of interconnecting people. For instance, whether or not email instills a different feeling of being rushed when compared to synchronous media has not been investigated. Furthermore, the context of work might have a significant impact on the extent to which a stressor affects an employee. A project manager may experience work overload due to emails coming in from various contexts and expectations to respond quickly. On the other hand, a customer service representative may receive twice as many emails as the project manager, but might not feel overloaded because the emails are all from customers with similar problems and therefore

relatively routine. In spite of these potential differences, different usage of ICT resulting from different roles in work arrangements has not been a phenomenon of interest in these broad survey studies.

In contrast to these survey based studies, experiments have been used to investigate psychological and physiological reactions to stressors as well. Riedl et al. (2012) measured cortisol levels of users to establish that system breakdowns are bodily experienced as stressful. Mark et al. (2012) studied the effects of cutting off email usage for one group of users over a time period of five days, and found that ICT, in the form of email, contributed to bodily experienced stress levels. Furthermore, email usage not only sped up work but also led to a higher degree of multitasking. Without email, their particants reportedly were more focused and relaxed.

Unfortunately, these experiments did not distinguish between different ICT-enabled work arrangements and their impact on established stressors. This is partly due to the idea that participants in an experiment should be subject to the same simulated context in order to maximize the reliability of the findings. The aim of our study was to experimentally investigate how different roles and positions in ICT-enabled work arrangements lead to different perceptions of being overloaded, different role conflicts, and subsequently, different impacts on whether the individual feels strain.

Technostress and the Knowledge worker

Today, the term "knowledge worker" is frequently employed to depict a mode of work that is particularly affected by ICT (cf. Murray and Greenes, 2007). It describes not only a major outgrowth of the information society but represents the prime target of ICT support. Software vendors portray products like Microsoft Sharepoint™ or Lotus Connections™ as means to intensify collaboration and communication across a company and its locations. Interaction, collaboration and communication at anytime from anyplace are the optimal characteristics of the modern workplace from a software vendor's point of view.

Practitioner-oriented studies (e.g., Manyika et al., 2012) have pointed out that by facilitating the exchange of ideas, bringing together dispersed expertise and allowing real-time cooperation, the organization gains productivity and significant reductions in costs via ICT. A study by Cisco (2009) found that ICT-enabled work arrangments (i.e., telecommuting) not only increased employees' quality of life but their quality of work as well. The study estimated savings of $277 million for Cisco.

Ubiquitous access to ICT infrastructures facilitates new forms of telework, culminating in the "nomadic worker," who can be seen as the epitome of a highly flexible, highly mobile workforce (Lyytinen and Yoo, 2002; Garrett and Danziger, 2007). Thereby ICT is believed to render work more flexible and establish a "new way to work together."[1] ICT in the form of communication and collaboration software is supposed to lead to the emergence of new communication networks that overcome old boundaries of space and time: "Organizations have steadily evolved a physically distributed workforce, project-based structures and less enduring team arrangements" (Breu et al., 2005, p. 1).

Of particular salience is that today's knowledge workers are embedded in multiple communication networks irrespective of when and where they work. The organization of work in such projects and teams can bring together the necessary expertise for the task at hand, and ICT has become a natural tool to enable such collaboration. At the same time, the number of communication networks an employee is in increases with each project and each team. Jarvenpaa and Lang (2005) observed that technologies like mobile phones have become common place in today's work environment with undisputable positive effects. Paradoxically, while employees said that they would not miss mobile phones, they experienced the downsides of permanent connectivity and increasing dependence on the technology (ibid). In similar vein Besseyre des Horts et al. (2012) found similar paradoxical consequences in the use of Blackberrys. "some users expressed a love/hate relationship with the BlackBerry refleting on their ability to exercise greater control over their work, on one hand, and an inability to meet increased work demands, on the other." (p. 27). Finally, Perlow and Porter (2009) illustrated how an "always-on" mentality can lead to a self-enforcing cycle of 24/7 responsiveness among team members that can only collectively be broken. This underlines the importance of social processes in teams in regard to the use of ICT and the resulting stress.

[1] http://office.microsoft.com/en-us/microsoft-sharepoint-collaboration-software-FX103479517.aspx

Categories of stressors that address the particularities of team-work (mediated by ICT) have not featured promimently in technostress research. The present paper seeks to address this gap in the literature by specifically investigating stressors in team settings. In addition to "role ambiguity" and "work overload" as established stressors from the technostress literature, we propose adding "indispensability" (i.e., the feeling that one's effort has a direct effect on the performance of one's team) and "situational constraints" (i.e., the feeling that the processes within one's team are contstraining the team's performance) as potentially relevant stressors on knowledge workers that are working in teams and therefore embedded in communication networks.

The following section introduces these proposed stressors by distinguishing among different types of knowledge intensive work. Thereby, we depict, on a general level, the resulting differences in regard to the perception of stressors. This is then used in the latter part of the paper as the model upon which our experiment was designed. Our aim is to study the different types of team-embedded knowledge work and their effect on feeling overloaded.

Theorizing the effect of ICT on different types of knowledge work

In the following we distinguish analytically between different roles and tasks among knowledge workers by means of a simple "thought experiment" in the setting of a medical emergency response team. By analyzing a rather simple division of labor, we seek to highlight how employees assuming different roles might experience stressors arising from the use of ICT differently.

Emergency medical response typically involves members with specialized medical knowledge, and follows three general steps. First, a patient receives an initial examination and triage from a nurse or paramedic who makes an initial assessment of the patient's symptoms and gauges the severity of the patient's condition (Anantharaman and Han, 2001). Next, an emergency room doctor performs an initial examination and orders any needed medical tests or images. Finally, the emergency room doctor or a specialist reviews the results of the test and decides on a course of treatment (Bal et al., 2007).

Thus, the communication network consists of three different roles and their associated tasks: (a) the nurse, (b) the doctor, and (c) the laboratory technician (lab tec). The work arrangement is depicted in Figure 1. For purposes of this scenario, we assume that each person processes their portion of the task (i.e., processes a patient) in the same amount of time.

The scenario allows to derive assumptions about potential stressors and the likely experience of these stressors for the people filling the different roles. In the following we develop these hypotheses in regard to (1) work overload, (2) role ambiguity, (3) indispensibility, and (4) situational constraints. As noted earlier, the first two represent well-established stressors from the technostress literature. In addition to these we deem it worthwhile to include potential stressors that would arise out of the necessity to collaborate in a team by means of ICT. Indispensability captures the individual perception of pressure to work harder because others (the team) rely on the individual's performance (Kerr and Hertel, 2011). Situational constraints refer to inadequate communication patterns that might arise out of the necessity to collaborate by means of ICT. Inefficient communication practices and the constraints set by the communication technology may hinder the team's performance and instill strain on the individuals.

Work overload

In our scenario (Figure 1), the nurse has a set of tasks in the form of patients to be interviewed in the waiting room. One by one he/she engages with the different patients and sends the results (i.e., completed interviews with vital signs) onwards to another person, the doctor, for further processing. The nurse's workload consists of the sheer quantity and complexity of the patients and their conditions. After completion of an interview he/she initiates a communication event by sending the result onwards.

The employee assuming the role of lab tec receives orders from the doctor for medical tests to be carried out and is expected to send back the results. The workload of the lab tec depends on the number of incoming requests from the doctor. This in turn is dependent on how many patients the nurse interviewed and how many the doctor examined. Each request is associated with at least one incoming (request) and one outgoing (response) communicative event

The third role, a doctor, receives the interview results from the nurse, evaluates them and decides what medical tests to order from the lab tec. Furthermore, he/she receives the test results from the lab tec, and uses them to determine the final diagnosis for a patient and to guide a course of treatment. The output is thus combined by the doctor to complete the processing of a patient.

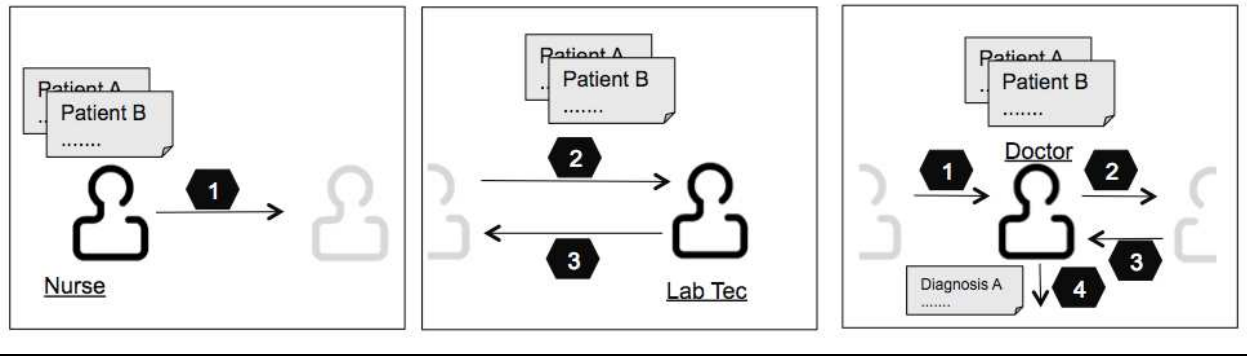

Figure 1: Knowledge workers: a) nurse b) lab tec c) doctor

Using this stylized example, we can see that measuring the perceived as well as the actual workload for a knowledge worker is far from trivial. The nurse may have a huge number of patients to interview, while the other two are awaiting his/her interview results. From a simplistic perspective where only the number of patients processed mattered, the nurse should be the only one that could be overloaded – the others would always have slack time. Taking the analysis up a level, we can take into account the number of communicative events that have to be processed by each role. The communication of the nurse consists entirely of outgoing messages, while the lab tec must process an incoming message and then send an outgoing message. In workload terms, the additional communication might be enough for the lab tec to feel overloaded even while the nurse did not.

This applies to an even greater degree to the doctor. In contrast to the lab tec the doctor has to coordinate his/her actions between requests coming in from the two other roles. The complexity of this coordination consists in the necessity to monitor incoming messages as well as to shift attention to them according to their priority. The doctor is aware that the efficiency of this set-up depends on his/her coordinative capabilities. Thus, we can expect that the doctor might not only feel more overload than either the nurse or lab tec, but also is more likely to feel strain as a result of having to coordinate more processes. Thus, we hypothesize:

> *H1: Perceptions of (a) overload and (b) strain will be higher for team members that are more embedded in ICT-mediated communication networks.*

Of course this example provides an idealistic distinction of roles that is not typically found in reality. Yet, we deem such analytical distinction useful to illustrate and investigate the effect of ICT on such work arrangement. For that purpose we deliberately did not specify by which medium communication unfolds. Without doubt, ICT would facilitate a faster transmission of messages between the different roles. Secondly, ICT can be used to increase the transparency of the workflow, i.e. the doctor might be able to view how many requests the lab tec still has to work on. Such support could improve coordination under conditions of geographic isolation, and might include the gathering of awareness information that would better enable the nurse and/or the lab tec to pace their work and communication in order to avoid overloading the doctor (Dabbish and Kraut, 2008).

Much research to date has focused on factors that influence stress. There is general agreement that the degree to which the pace of work exceeds the comfortable level of employees leads to stress (Mark et al., 2012). We have noted earlier that contextual differences, specifically the degree to which one is dependent on communication via ICT to coordinate one's work with others, will have a direct impact on the degree to which one feels that his/her pace of work exceeds their comfort level. Speaking in a general sense,

however, we would expect that those who feel less overload will also feel less stress; likewise, those that feel more overload will feel more stress. Thus, we hypothesize:

> *H2: Perceptions of stress will be linked to perceptions of overload for all members of teams that use ICT to communicate.*

Role ambiguity

The previous subsection on work-overload assumed that every individual has a clear sense of what tasks and responsibilities their role entails. Yet, the very idea of project-based organization of work implies that teams are formed based on the individual expertise needed for the success of the project. In ad hoc teams, roles have to be negotiated anew, and again in changing teams. Individuals often lack complete information about what is expected from them. In the context of our thought-experiment, even the description of the tasks in the subsection above may not suffice as it does not specify how specifically the team members are supposed to interact and what kind of performance would be acceptable. The feeling that one does not have clear objectives is termed *role ambiguity*.

In our context, the nurse knows that he/she has to interview patients. Yet, what are the consequences for the whole team given a specific performance level? What do the others expect from this role in terms of quality and quantity? How are things to be communicated so that they are easily understandable by the other members of the team?

In addition to that, the doctor and to a lower degree the lab tec face the additional challenge to put priorities on incoming demands. Especially in an ICT-mediated work arrangement, employees are constantly exposed to new requests demanding their attention. In real life they take the form of emails, messages, and other communicative events. These interruptions create ambiguity as they demand people to judge what request has the higher priority and what is the appropriate sequence of work. In the present scenario this situation seems to be worst for the doctor as messages are constantly send to him/her from both the lab tec and the nurse. Furthermore, they expect him/her to take care of the overall output of the team.

> *H3: Perceptions of role ambiguity will be higher for team members that are more embedded in ICT-mediated communication networks.*

Having a clear sense of what others expect has also been linked with levels of stress (Ayyagari et al., 2011). Generally speaking, the more a person understands what their job entails and what is expected when performing that job, the less likely they are to feel stress while performing that job (Moore, 2000). Role ambiguity is thought to lead to stress in an organizational or team context because one feels that one should be working on something important, but one does not understand exactly what that is. Thus, we hypothesize:

> *H4: Perceptions of stress will be linked to perceptions of role ambiguity for all members of teams that use ICT to communicate.*

Indispensability

In a team setting, and especially in the one presented here, the contribution of each role is crucial for the performance of the team. Without input from the nurse, neither the doctor nor the lab tec would be able to do anything. Furthermore, we already pointed out that both the doctor and lab tec await input from a team member in order to process it. Once the team is working we can imagine that any of the team members might pose a bottleneck which caps the overall performance of the team.

In the present scenario the doctor seems to be the most central figure as all communication has to pass through him/her. Once the nurse sends on the results of patient interviews, the nurse can expect that others need some time to process them. The lab tec relies on the doctor for new tasks to complete. The doctor relays the patient data from nurse to lab tec and consolidates what comes back from the lab tec to a full diagnosis. Thus, the doctor's performance would seem to be the most crucial for a successful team. The sense that one fills an important role in the team is termed *indispensability*. Feelings of indispensability arise when one feels that one's performance is critical to the performance of one's team. In contrast with social loafing, which leads to reduced individual performance, indispensability has been

linked with higher performance by individual team members (Kerr and Hertel, 2011), suggesting that it puts pressure on them to perform.

> *H5: Perceptions of indispensability will be higher for team members that are more embedded in ICT-mediated communication networks.*

We suggest that in roles where team members rely on ICT for communication and coordination activities, feelings of indispensability will be positively linked with stress. For members that are not as embedded in the ICT-mediated communication network, indispensability will impact their pace of work, but not their stress level directly. Thus, we hypothesize:

> *H6: Perceptions of stress will be more strongly linked to perceptions of indispensability for team members that are more embedded in ICT-mediated communication networks.*

Situational constraints

While ICT enables fast communication across the team, its features constrain users in how communication may unfold. For instance, the performance of the team may be hindered because the available tools do not support the transmission of meta-information necessary for an efficient handling of tasks. This may be due to limited length of messages. In addition, the technical artifact may provide awareness to the team members regarding the status of other members. Finally, the members of an ICT-mediated team have to agree on certain standards of communication: How do we communicate the outcomes of our work, so that the recipient can easily take up the task? The doctor, as the central person in the network, must negotiate communication practices with two other people. If those practices are inadequate, the performance of the doctor suffers most, and he/she would have to do the most work to compensate for the inadequacy. Thus, the embeddedness of a person in a communication network is related to the degree to which they must coordinate their work with others.

> *H7: Perceptions of situational constraints will be higher for team members that are more embedded in ICT-mediated communication networks.*

When ICT adequately supports the flow of information and/or is adequate in its support for his/her coordinating tasks, a person is unlikely to feel additional stress from the use of such technology. Similarly, a person that is only loosely tied to an ICT-mediated communication network, like the nurse, may not feel additional strain even if communication processes are inadequate and/or a particular ICT breaks down because little about the performance of his/her job depends on it. However, when technology breaks down or communication processes are inadequate for a person that is embedded in a communication network, their higher dependency on those technologies and processes is likely to lead to significantly more stress. Thus, we hypothesize:

> *H8: Perceptions of stress will be more strongly linked to perceptions of inadequate communication processes for team members that are more embedded in ICT-mediated communication networks.*

The hypotheses were tested via an experiment. In the following we relate how we transfered these different roles into an experimental setting to study their effects on stressors and strain in an ICT-enabled workflow.

Experimental Methods

Participants in the experiment were students enrolled in a general education information literacy course at a public U.S. university. A total of 144 students participated in the experiment and were included in this study. The experimental task was part of a class exercise on team collaboration. All interaction in the setting was via computer-mediated communication: team members communicated via chat or email using a browser-based application that was custom made for this study. Experimental sessions were conducted in a computer classroom in which each participant was seated in front of a computer. Participants entered their first names into the application at the beginning of the session, and all chat and email messages were labeled with these names.

Task

Each participant in the experiment was a member of a simulated emergency medical response team. Participants filled the role of a nurse, doctor, or laboratory technician. The medical setting was chosen because, having been patients themselves, the participants were at least peripherally aware of how patients are processed. Each role was performed using a job-specific expert system that approximated the domain knowledge that a person performing that job would have. The teams were free to decide how to communicate with each other.

In all sessions, the administrator read the same, scripted instructions, which were also displayed on the participants' screens. Participants first received informed consent information and completed a demographic questionnaire. Next, the participants were assigned a job and read job-specific instructions. Finally, the participants were divided into teams and met in a chat room. The first chat session lasted for five minutes to give the participants time to get to know each other and to discuss how to complete a task with which they were unfamiliar. Later chats were three minutes long. After chatting, the participants completed a post-chat questionnaire.

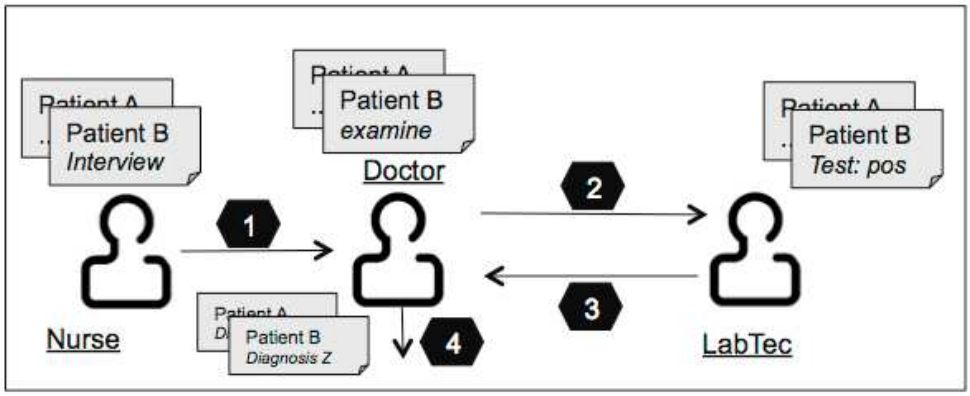

Figure 2: Experimental setup

During each diagnosing period, each team member was shown a list of the ten patients that needed to be diagnosed. The jobs were organized such that the final diagnosis could not be correctly made without a laboratory test (performed by the laboratory technician), patient examination (performed by the doctor), and patient interview (performed by the nurse). Furthermore, the patient examination requested information from the patient interview, and a specific laboratory test would be called for after the patient examination was finished. Thus, a four-step process was encouraged (Figure 2). First, the nurse would conduct a patient interview and pass that information to the doctor. Second, the doctor would enter the results of the patient interview and conduct the patient examination and request the required test from the laboratory technician. Third, the laboratory technician would perform the laboratory test requested by the doctor and send the results back to the doctor. Finally, the doctor would determine the final diagnosis for the patient by entering the results of the laboratory test. The diagnosis period lasted five minutes. After diagnosing, the participants completed a post-task questionnaire.

After the first and second diagnosing periods the participants in the session were divided into new teams and chatted with their new team about how they would diagnose patients. This re-division was done so that team members that were experienced with how to accomplish their own task would be placed in a new team, where there might be members that one has worked with before, and there is the chance that one will work with the same members again. This enables the teams to experience "swift trust" (Meyerson et al., 1996), and be more environmentally valid than the typical single shot teams used in most collaboration research (Pinsonneault and Heppel, 1997). Participants in the experiment diagnosed patients with three different teams. Only the results for the last team were used in the analysis for this study. Because of their experience in the first two rounds, the task as well as their role were quite clear by the third round. In addition, collaborative practices had evolved. As such, the situation more closely

approximated feelings in a real-life work arrangement: members of the teams have a good idea about how to perform their roles and their tasks, and they have worked in teams before and know how collaboration can be organized.

The design of the task was such that any patient could be interviewed, examined, or tested in any order. Thus, it was possible for the team members to behave rather chaotically, picking patients to process at random. However, there was a time penalty for performing an examination without knowing the results of the patient interview, and for choosing the wrong test to perform. This meant that teams had all stabilized on the four-step process by the second diagnosis round, and by the third round were accomplished at their task and their team's process.

Measures

The questionnaire items used for this study were gathered after the chat and task periods. The questions for the scales were intermingled and displayed in a different, random order for each participant. Unless otherwise noted, they were administered after the third diagnosing period. All questions were Likert-type and anchored *Strongly Disagree – Strongly Agree*.

Overload is the extent to which one feels that the assigned work exceeds one's capabilities or skill level (Ayyagari et al., 2011). The items were: (1) There were more requests or problems than I could comfortably handle, (2) I was busy the entire time I was working, (3) I needed to work every possible second while diagnosing patients, (4) I had to work at my highest speed.

Strain is defined as the "individual's psychological response to stressors" (Ayyagari et al. 2011, p. 834). The items were: (1) I feel drained from working with this team, (2) I feel tired from my work in this team, (3) Working with this team was a strain for me, (4) I feel burned out from working with this team.

Role ambiguity is defined as the degree of unpredictability of one's job performance and the extent to which one has the information one needs about how to perform one's job (Ayyagari et al., 2011). The items were based on the scale used by Moore (2000): (1) I feel certain about what my job is on this team, (2) I have clear, planned goals and objectives for doing my job, (3) I know what my responsibilities are, (4) I know exactly what is expected of me, and (5) I am clear about what has to be done. The role ambiguity items were gathered as part of the questionnaire that appeared after the third chat period.

Indispensability is defined as the feeling that the team outcome is strongly determined by one's own indidivual contribution (Kerr and Hertel, 2011). These items were developed for this study: (1) I believe that my contribution to the team's success was very important, (2) My team relied on me to give my best, (3) If I hadn't worked as hard, my team would not have done as well, and (4) A reduced effort from me would have held back the success of my team.

Situational Constraints is defined as the extent to which one feels that conditions in the work environment such as inadequate processes and tools hinder performance (Fritz and Sonnentag, 2009). The items were: (1) The communications practices in this team were effective, (2) Me and my communication partners received the information we needed on time, (3) Me and my communication partners shared information as quickly as possible, and (4) Members of this team knew exactly who should receive what information.

Experimental Treatments

This study was part of a larger study on computer-mediated communication. Participants were randomly assigned during the chat period to see either an attractive, dark blue background or an unattractive, greenish blue background. Teams were randomly assigned during the diagnosis period to either see what job each person had (e.g., next to a nurse's name it would say "interviews patients") or how many patients that the person had processed (e.g., next to the nurse's name it would say "3 patients interviewed"). All data is collapsed across treatments for purposes of this paper.

Participants in this study were assigned at the beginning of the experiment to one of the three possible roles: doctor, nurse, or lab tech[2]. The *nurse* was the first person in the information chain, and could process patients as quickly as he/she wanted. The nurse's processing of patients consisted of selecting a patient from their list, then clicking a button labeled "Interview Patient." After 15 seconds, the results of the interview were displayed in the list. The nurse then copied the patient name with the results of the interview into an email to the doctor.

The *doctor* was the pivotal person in the information chain. The doctor's processing of patients consisted of reading an email from the nurse, which had the name of a patient with their primary symptom and vital signs. Next, the doctor selected that patient from a drop-down list on their screen, selected the primary symptom and vital signs given by the nurse, and clicked a button labeled "Examine Patient." After 15 seconds, the results of the examination were displayed for that patient, along with which lab test was needed. The doctor would then send a request for that test to the laboratory technician. Depending on the coordination level of the team and skill of the doctor, the doctor could examine another patient or simply wait for an email from the lab tech with the results of the test. When the results came in, the doctor selected that patient from the drop down list and indicated what the results were. The computer would immediately respond with a diagnosis and whether it was correct (incorrect information for that patient would mean an incorrect diagnosis), and the process for that patient was complete.

The role of the *lab tec* was to respond to requests for lab tests from the doctor. The lab tec's processing of patients consisted of selecting a lab test for a patient on their list, then pressing a button labeled "Perform Test." After 15 seconds, the results of the test for that patient were displayed in the list. The lab tec then copied the patient name with the results of the lab test into an email to the doctor.

Results

As expected, a person's number of communication events varied according to their role in the team. On average, the nurse sent 9 messages and received 1, the doctor sent 3.4 and received 10.8, and the lab tec sent 3.8 and received 4.4 messages. We used analysis of variance to compare the levels of the study variables between participants in the doctor, nurse, and lab tec roles. Linear regression was used to examine how the influences on strain differed among the three roles. Table 2 presents the means, standard deviations, and reliability of the study scales. All of the scales exhibited adequate reliability.

An analysis of variance showed that significant differences between the roles were exhibited for Strain, Overload, and Indispensability. Post hoc analysis using a family-wise confidence interval showed that participants in the doctor role indicated more Strain than participants in the nurse ($p=.032$) and lab tec ($p=.014$) roles, supporting hypothesis 1a. Participants in the lab tec role indicated less Overload than participants in the doctor role ($p<.001$), which partially supports hypothesis 1b. Interestingly, participants in the lab tec role indicated lower levels of Indispensability than those in the nurse role ($p=.029$), which contradicts hypothesis 5. No significant differences by role were shown with respect to Role Ambiguity ($p=.825$) or Situational Constraints ($p=.082$), lending no support for hypotheses 3 and 7.

[2] The remaining participants were assigned to the role of specialist when the class size was not a multiple of three, meaning some teams had four members. Those teams are not included in our analysis.

Table 2: Overall Reliability and Means (Standard Deviations) of study variables by role				
	Alpha	Doctor	Nurse	Lab Tec
Overload	.75	20.56 (4.88)	18.04 (4.99)	15.75 (6.74)*
Strain	.92	15.40 (6.55)	11.88 (6.45)*	11.44 (7.33)*
Role Ambiguity (n.s.)	.97	29.54 (5.89)	29.33 (8.17)	30.21 (7.41)
Indispensability	.91	26.29 (5.67)	27.67 (6.31)	23.83 (9.31)†
Situational Constraints (n.s.)	.90	21.10 (6.23)	22.10 (5.44)	19.04 (8.32)
n.s. No statistically significant differences between roles, * Significantly different from Doctor (p<.05), † Lab Tec is significantly from Nurse (p<.05)				

To test hypotheses 2, 4, 6, and 8, separate linear regression models were run overall and for each of the three roles. Those results are presented in Table 3. Consistent with Hypothesis 2, Overload had a significant relationship with Strain overall and for all of the roles individually. Contrary to H4 and H6, Role Ambiguity and Indispensability were not a significant predictor of Strain overall or for any of the roles. Finally, consistent with H8, Situational Constraints were only an influence on Strain for the doctor and lab tec.

Table 3: Regression results for Strain overall and by role								
Variable	Overall (n=144)		Doctor (n=48)		Nurse (n=48)		Lab Tec (n=48)	
	b	t	b	t	b	t	b	t
Overload	.732	7.27***	.531	2.48*	.966	5.65***	.656	3.63***
Role Ambiguity	-.039	-0.53	-.193	-1.18	-.042	-0.43	.076	0.51
Indispensability	.029	.26	.174	0.85	-.307	-1.64	.100	0.49
Situational Constraints	-.402	-3.82***	-.490	-3.01**	-.123	-0.63	-.437	-2.13*
F	16.92***		3.72*		8.79***		4.32**	
Rsq	.328		.257		.450		.287	
***p<.001, **p<.01, *p<.05								

Discussion

Our experimental results reveal some additional insights about the causes of stress in workers that use communication technology. Overall, strain was highest for the doctor when compared with the other roles (p<.032), suggesting that being in a central, coordinating position as a knowledge worker is associated with more stress than those in an information production role (i.e., nurse) or information retrieval role (i.e., lab tec). Thus, we have support for our notion that technostress cannot be boiled down to simply being a function of increased workload due to faster processing. Although we did not examine technology breakdown as a factor in increasing workload and stress, we speculate that the stress that comes from breakdown would similarly come from role-specific factors and not simply from the increased workload.

Similarly, reported overload was not entirely dependent on the amount of work one had available to process. In our experiment, the nurse had the highest number of patients available to process, but reported less overload than the doctor (p=.074), whose amount of patients to process was less. The

obvious explanation for this is that the doctor had more communication and coordination work to do. However, the lab tec, who had the fewest number of patients to process, but both received and sent messages as part of their role, reported less overload than both the doctor ($p<.001$) and the nurse ($p=.114$).

Perceived indispensability did not differ for the nurse and the doctor, while the nurse was significantly higher than the lab tec ($p=.029$). This suggests that the additional strain felt by the doctor did not come from the feeling that one's effort had a direct impact on the performance of the team. Indeed, the regression results show that the stress levels of the members of the team that relied the most on communication to perform their tasks (i.e., the doctor and lab tec) were affected significantly by deficiencies in the communication practices (situational constraints in this context). The person that was least dependent on communication (i.e., the nurse) only felt strain to the extent that he/she felt overloaded.

The level of role ambiguity was not different between any of the roles, and was near the top of the scale on average, indicating that participants felt like they knew what was expected of them. Furthermore, role ambguity did not have a significant impact on strain for any of the roles. This likely occurred because the participants had performed in their role in two different teams already, and were using the same technology to communicate each time. We speculate that role ambiguity is only likely to be a stressor when a worker is new at their job and/or has experienced a disruption in their work processes or performance objectives. Workers in more stable situations are likely to feel little role ambiguity and it is unlikely to affect their perceived strain.

Limitations

As with any experiment, our participants were in a simulated context that may not reflect real world work practices. Furthermore, our roles may not exactly reflect the division of labor, communicative or otherwise, in real world teams. The roles as we analytically distinguished them are idealistic. Generally speaking, we would expect these idealized roles and tasks to co-exist within one worker and/or overlap across multiple workers in modern workplaces. However, our results suggest that the additional coordinative overhead associated with a central, embedded position in a, ICT-enabled communication network (i.e., the "doctor") can lead to a perceived overload and higher stress.

Ineffective communication practices would be another stressor for team members in an embedded and/or coordinating role. To an extent, our measure of situational constraints captured this in our context, but we recognize that such practices are a subject of explicit and very implicit negotation among team members. In our experiment, the chat sessions provided an opportunity to exchange best practices and opinions that might not occur in normal work situations. Finally, we note that despite the limitations set by the browser-based expert system, our participants showed a variety of ingenious communication practices that made their work more efficient – most prominently was the inclusion of all information in the subject line of an email rather than in the body. Thus, we suggest that active reflection and discussion on communication practices may be helpful to establish a sustainable work evironment.

Finally, even though all of our participants had two opportunities to refine their work processes, establishing effective communication practices proved cumbersome for some teams. Given the multiplicity of tools in the modern workplace, the sheer number of potential communication practices might be a source of stress in itself. Thus, we suggest that establishing shared and efficient communication practices is far from trivial.

Conclusion

Our study was motivated by the observation that despite the undoubted positive contribution ICT has brought to the modern workplace, employees are experiencing paradoxical consequences of their use of technology. Computer supported cooperative work is today, more than, ever a taken for granted reality in most organizations. Research on technostress cautions against embracing technology blindly by warning against unintended consequences to employees health.

While particular technology-related stressors have been established in other studies, we ventured to investigate how different roles in a work arrangement affect the perception of strain as well as stressors.

Our experiment simulated different roles and tasks with varying degree of embeddedness and associated coordinative responsibilities. Our results show that members in a coordinative role experience more workload and strain than others. This suggests that the perception of strain and stressors is heavily dependent on the social context and the evolved communication practices.

Unfortunately, modern workplaces are not characterized by the clear distinction of roles and tasks as enacted in our experiment. A real world knowledge worker might be expected to perform coordinative roles for some parts of their jobs, and responsive or productive in others. Furthermore, in an ICT supported knowledge workspace, a worker might find a multiplicity of different tools at their disposal. Thus, a given knowledge worker might be in a coordinative role for several different projects, in which requests come in via several channels and contexts that must be responded to in turn. In each context different communication practices might have evolved, meaning a medium or communication practice might be the appropriate one in one context while not in another. We theorize that employees face additional burden by juggling which kind of communication is the appropriate one for the various context they are in (Schellhammer et al., 2012). Our study suggests that this increased coordination leads to more strain, and calls for more research into how employees cope with the increasing speed and exposure to these demands in their daily work.

Finally, we observe that the results of our study indicate a more indirect influence of ICT to stress than normally assumed in the technostress-literature. The strain (or lack of it) in this context resulted from the emergence of effective communication practices and the demands placed by coordinative responsibilities, which were as much a result of social processes (i.e. practices negotiated during the chats) as the technology that enabled this team-based organization of work.

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