ORGANISATIE

Resilience and team communication processes

This research shows that studying team communication processes is important for understanding a team's resilience. Resilience is defined as the ability to manage trade-offs and to offer and accept support. Resilient team communication patterns are characterized by processes related to taking initiative, team members helping each other out (back-up behavior), and closed-loop communication structures. Human factors professionals can help in making teams more resilient by providing feedback on successful team communication patterns, helping teams train in these patterns, and assisting them in ways to reflect upon their own performance. It is important to study teams in their multi-level context and over longer periods of time.

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The world is becoming increasingly interconnected, forming complex interdependencies that can make it more susceptible to global disturbances (e.g., COVID-19). To ensure safety and effectiveness in closely intertwined systems and infrastructures, it is crucial to understand resilience, alongside how resilient behavior is generated and promoted. Teams play an important role in these systems and infrastructures, as work is increasingly organized in teams. We believe that studying communication processes in teams provides the key to understanding resilient team behavior.

Defining resilience

We define resilience as the continuously changing ability to manage trade-offs, and to use or provide comprehensive systems of support in contexts of adversity. This may seem like a very esoteric definition of resilience that has little to do with its original meaning of 'rebound from adversity' or 'ability to absorb disruptions' (Woods, 2015). Yet, these original meanings of the word resilience do not apply to complex sociotechnical systems that have the capacity not only to anticipate and learn (Hollnagel, 2011; OECD, 2018), but also to transform (Keck & Sakdapolrak, 2013) and manage trade-offs (Hoffman & Woods, 2011; Ungar, 2018), unlike physical or ecological systems. A society is not resilient in the face of adverse events when it chooses to always put the short term over the long term; neither is it resilient when it always does the reverse. Rather, it is resilient when it is able to manage trade-offs on a continuous basis, depending on the situational demands, and irrespective of outcomes (that cannot be predicted anyway at the time trade-offs need to be made). A company that doggedly chooses to always focus on one particular product is not particularly resilient in a world of changing and competing customer demands. It may survive for a long time, seemingly well-adapted, until a sudden transformation makes it obsolete (e.g., Kodak's inability to adapt to digital photography).

Managing trade-offs and providing systems of support in teams

Teams follow plans to achieve goals, while different goals have different requirements and are executed under constantly changing environments. Therefore, a necessary adaptive resource is the ability of a team to remain alert and constantly manage trade-offs in order to assess the tenability and correspondence of a certain plan to the requirements of the situation. For instance, Mrs. Elaine Bromiley was to undergo elective sinus surgery on 29 March 2005, a seemingly routine operation (Harmer, 2005). Prior to the operation, the anesthetists unsuccessfully tried to intubate her for a prolonged period of time. Despite this being a clear case of a "can't intubate – can't ventilate" emergency, the anesthetists lost track of time and continued to intubate. Suggestions by theatre nurses to perform a tracheostomy were ignored. In this case, the members of the anesthetist team did not properly manage the trade-offs 'securing access to airway' versus 'loss of oxygen saturation', and failed to recognize that their plan to secure Elaine's airway did not meet the requirements of the situation anymore, as oxygen saturation had dropped to a dangerously low level of 40%. Elaine Bromiley passed away 13 days later, having suffered irreversible hypoxic brain injury. Clearly, this team was not resilient to the adversity it was

confronted with. Not only did the team fail in its ability to manage trade-offs, it also neglected to use the support offered by the nurses in the form of a tracheostomy set.
Another example of a system of support that may strengthen the ability to manage trade-offs is the provision of real-time indicators on the system's various goals, which can be developed through cognitive analysis. For instance, weak resilience signals, defined as signals indicating a tendency towards system degradation in adaptability, may indicate that a certain plan no longer meets the requirements of the situation. Such signals must be presented to the agents involved early upon emergence so that they can then be discussed with the team; sharing perspectives is valuable and crucial to promote resilient behavior (Siegel & Schraagen, 2017a, b). Yet, an overemphasis on efficiency, cost savings, and other short term benefits can lead to negligence towards signals that underlie the management of trade-offs, thus depriving the system of the ability to develop true resilience.

Resilience in team communication patterns

Initiative and reciprocity are two essential characteristics of resilient teams (see figure 1). Initiative is needed when plans no longer match the situation. It takes willingness or even courage to adapt the plan to the changing environment, without waiting for permission from other members of the team or within the organization. Research on medical teams has shown that resilience is promoted by initiative from all team members, especially in difficult and unexpected situations (Barth & Schraagen, 2015; Schraagen, 2011). Reciprocity is necessary to distribute restrictions of attention, time, workload and energy among team members. A less stressed team member takes over tasks from an overburdened team member, in the hope and expectation that the overburdened team member will do the same in the future for the less stressed team member. Such backup behavior constitutes a support system that may be provided in contexts of adversity, and is therefore an example of resilient behavior. For example, we found (Schraagen, 2011) that the assistant surgeon took over the communication tasks of the first surgeon when the latter was so busy with the operation that he could no longer keep the rest of the team informed of the situation; the assistant surgeon took over and informed the rest of the team.
We recently applied Relational Event Analysis (Butts, 2008) to investigate the development of team communication patterns over time in critical and non-critical situations. We studied both a medical pediatric cardiac surgical team and the NASA Mission Control team during the Apollo 13 incident (for details, see Van den Oever and Schraagen, in press). Our findings indicate that more adaptation in communication takes place during highly critical situations, while less adaptation was observed during less critical ones. Further, we found that during highly critical situations, teams adapt their communication patterns, but will adhere to institutional roles and use closed-loop communication for as long as possible before doing so. Furthermore, teams can be expected to display closed-loop communication, an on-plan trained procedure, in both critical and non-critical situations (Davis et al., 2017), but may find it more difficult to maintain closed loops in critical situations due to more interruptions and changes of communication partners. Besides that, our findings suggest that teams display information seeking communication patterns in both critical and non-critical situations, which may be a way to deal with complexity (Manser et al., 2009).

Our study has provided valuable insights into the adaptation of communication patterns, but more research on the topic is warranted, particularly given the possibilities of providing real-time feedback on communication patterns to teams in training (e.g., Gorman et al., 2019; Grimm et al., 2017; Kiekel et al., 2002).

Capacity of adaptive resources

Adaptive resources can also be depleted. All resources are finite and can only handle a certain set of situations. This is the basic adaptive capacity or competence envelope of any system – that which the system can handle without the risk of saturation (Woods, 2018). As systems approach the boundaries of their competence envelope and basic resources become depleted, there is a risk of saturation. A unit in a system then has to ask for help from other units – other team members, other departments, other organizational units. Whether and how this help is requested, and how it can be stimulated, is a crucial question in resilience engineering. In certain situations, the saturation of resources can go so fast that the system can no longer expand itself and only reacts locally. In the cockpit of Air France Flight 447, this happened when the aircraft ended up in a 'high-level stall' (at the hands of one of the pilots) and the crew was no longer able to understand what was going on (partly because speed information was temporarily missing due to the freezing of so-called pitot tubes). The communication patterns that radiated reciprocity and initiative before the stall were then characterized by ad hoc responses to each other (David & Schraagen, 2018).

Methods for resilience engineering in team communications research

As a closing remark, we would like to point our readers to the methodological approaches that may foster the investigation of resilience as defined in the current article. As has been shown above, building and

Figure 1. Illustration of team resilience as the continuous management of trade-offs, regulated through communication patterns of initiative, reciprocity, and closed-loop communication structures, supported by comprehensive systems of support.

maintaining adaptive resources is a phenomenon that a) depends on trade-offs made by an organization or team and b) a process that takes place over time. This implies the following for research methods in the field of resilience:

a. Resources at an individual, team or organizational level are closely interrelated and are best studied from a multi-level perspective. They also depend on trade-offs that emphasize, for example, the short or the long term, or efficiency or thoroughness (Hoffman & Woods, 2011). An interdisciplinary approach that involves several levels at the same time seems indispensable in this field.
b. The "time" factor has long been ignored in psychology (Klonek et al., 2019). Recent developments of analysis techniques in the field make it possible to discover diverse communication patterns in time series of communication events, thus assisting in the investigation of how adaptive resources are built, maintained, or lost over time. For example, relational event analysis (Butts, 2008) enables the discovery of diverse communication patterns in a time series of communication events. It assumes that previous interactions influence current interactions, and is performed by modelling the sender and receiver(s) of information in a sequential order, in a system comprised by two, or (ideally) more agents. The robustness of the analysis is influenced by the number of events, with longer timescales yielding more stable patterns. Other analysis techniques, such as pattern analysis (Magnusson, 2018) can also help explore interaction as it evolves over time by modelling other pattern aspects, such as the content or type of communication data. In addition to traditional forms of assessing resilience, such as questionnaires (Van der Beek & Schraagen, 2015), longitudinal measures are therefore also useful and required to fully grasp the concept of resilience (Schraagen, 2013; Van den Oever & Schraagen, 2021).

Conclusions and practical implications

Studying team communication processes is important for understanding a team's resilience. The way team members communicate with each other can both help or hinder team resilience. Resilient team communication patterns are characterized by team members taking initiative, helping each other out (back-up behavior), and closed-loop communication. Teams need to be assisted in detecting early-warning signals, so they can

flexibly adjust their plans to the changing circumstances. Human factors professionals can help in making teams more resilient by providing feedback on successful team communication patterns, helping teams train in these patterns, and assisting teams in ways to reflect upon their own performance.

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