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# Toward a Model of Team Decision Making Under Stress

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TOWARD A MODEL OF
TEAM DECISION MAKING UNDER STRESS


by


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# ABSTRACT

Today's organizations are increasingly relying on teams, rather than individuals, to complete tasks in the workplace. For some teams, these tasks require them to make high stakes decisions under stressful conditions. In military, medical, and emergency response fields, for example, workers are regularly asked to make decisions under high time pressure, uncertainty, and risk. The purpose of this study is to summarize previous team decision-making perspectives and create a model for team decision-making under stress.

A literature review was conducted to examine the current state of team decision-making research. Several existing models of the team decision-making process were identified, representing multiple decision-making perspectives. Using this information, four primary characteristics of the team decision making process were identified. Team decision making appears to be multi-level, multi-phasic, dynamic, and cyclical process.

An additional search examined the effects of stress on performance. Using this information and the characteristics outlined from the team decision making literature, a model was designed to describe the effects of stress on team decision making. This model offers several propositions regarding the effects of stress on specific cognitive and team processes and their relationship team decision making

This study provides the theoretical basis for an empirical investigation of the relationship between stress and team decision making. This line of research has the potential to lead to practical solutions that may improve outcomes for workers in high stress occupations.

# DEDICATION

I dedicate this thesis to my family who supported and encouraged me throughout my education.

To my dad,
For making learning fun,
And because I'll never forget who the 11<sup>th</sup> president was.

To my mom,
For always supporting me,
And for helping me memorize all my 3<sup>rd</sup> grade spelling words.

To Katie,
For challenging me,
And for always coming in a close second in Jeopardy.

To Jenna,
For letting me teach you.
Where'd you learn to drive so well?

# ACKNOWLEGEMENTS

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# INTRODUCTION

In recent decades, organizations have placed an increasing focus on teams in the workplace. Global completion has changed the nature of work, and the skills required for many modern tasks have become too broad for a single individual (Salas, Dickinson, Converse, & Tannenbaum, 1992). For this reason, many organizations are shifting from a structure of primarily independent employees to a structure based on teams of interdependent workers (Salas, Cooke, & Rosen, 2008).

Within the workplace, there are many different types of teams, varying in size and structure (Keyton & Beck, 2008). They can be used for many different purposes, with possible tasks including managing and advising others, providing services, negotiating, physical work, and problem solving (Wildman et al., 2011). In all of these areas, teams must make decisions in order to complete their tasks. When teams fail to make well-informed, sound decisions, teams are susceptible to poor performance and negative outcomes (Zajac, Shuffler, Darling, & Salas, 2013).

Researchers have developed several models and frameworks to describe team decision making, however they have often failed to consider important aspects of the decision making processes (Burke, Priest, Salas, Sims, & Mayer, 2008). Some decision-making perspectives have inadvertently focused on individual decision making in a team context, rather than true team decision making. Others have overlooked the complex and dynamic nature of team work environments. Burke and colleagues (2008) have recently called for further investigation into the team decision making process.

Of particular concern is how the environment affects judgment and decision making. In

many organizations, teams are forced to make decisions under challenging conditions. Medical, military, and emergency response teams, for example, are regularly asked to complete tasks under high time pressure, uncertainty, and even personal threat. These environmental factors can act as stressors, demanding more from team members than they are prepared to handle (Cannon-Bowers & Salas, 1998). Because errors in team decision making can have catastrophic consequences, it is important to fully understand how stress affects the team decision-making process (Burke et al., 2008).

This paper will have two primary goals. The first will be to summarize the existing literature on team decision making. I will do this by reviewing two prominent decision making perspectives and examining existing models that fall within each perspective. The second is to use what is known about team decision making, to develop a model that applies to teams making decisions in stressful contexts. In doing so, I will also review the literature on stress, focusing specifically on the effects of stress that may impact team performance. The model will be supported by several testable propositions regarding stress and the team decision process. I will also discuss practical applications and directions for future research.

# TEAM DECISION MAKING

In order to understand how teams make decisions under stress, it is vital to understand how teams make decisions in general, before considering the effects of a stressful environment. In this section, I will aim to summarize the current state of the literature concerning team decision making.

In the past, there has been some discussion regarding the use of the terms *team* and *work group*. While some researchers have used the terms interchangeably (Kozlowski & Bell, 2003), in this paper I refer exclusively to teams. To borrow from Sonesh and colleagues, "compared to groups, team members have clearly defined roles and responsibilities and are reliant on each other with respect to task performance" (Sonesh, Rico & Salas, 2014, pp. 200). More specifically, a team can be defined as a set of two or more people who have individual roles, work interdependently, and share a common goal (Salas et al., 1992).

In the process of reaching any shared goal, decisions must be made within the team. Decision making refers to "the process by which people draw conclusions, reach evaluations, and make choices" (Highhouse, Dalal, & Salas, 2013, p. 1). When decisions are made in a team context, communication between members and the integration of relevant information is very important to a team's success. This can sometimes be difficult when people have differing points of view, preferences, and agendas (Sonesh et al., 2013).

Since the 1950's, there has been a substantial amount of research in the area of judgment and decision making in industrial-organizational psychology (Highhouse et al., 2013). However, over the same period of time, decision making has been studied in numerous other fields, including economics, cognitive psychology, philosophy, political science, computational science,

and biology. However, there has been very little crossover between the fields (Crowley &

Zentall, 2013). Different approaches, traditions, and jargon, have isolated researchers within their

own academic specializations (Palij, 2013).

As a result, a number of different decision making perspectives have emerged (Lipshitz,

Klein, Orasanu, & Salas, 2001). They generally seem to take one of two viewpoints. The first,

and historically most widespread, views decision making as a rational and analytic process. More

recently, a second point of view emerged which considers decision making in terms of heuristic

responses to the environment (Crowly & Zentall, 2013; Lipshitz et al., 2001; Burke et al., 2008).

While these perspectives have spawned many frameworks and models for individual decision

making, significantly less research has been produced on team decision making (Burke et al.,

2008).

Here, I will briefly review both decision making paradigms, and present existing models

and frameworks from each perspective. Models were excluded from review if they did not

specifically focus on the team (rather than individual) decision making process or if they did not

specifically focus on interdependent team members making decisions together (rather than

independent group members coming to consensus). The reviewed models are not meant to be an

exhaustive list of all team decision making models, but a good representation of how each

decision making perspective has generally applied their point of view in at the team level.

**Rational Decision Making**

The roots of rational decision making theories can be traced all the way back to Aristotle,

who considered decision making a rational and conscious process (Crowley & Zentall, 2013).

However, most modern work in the area of rational decision making was inspired by classical

decision making theory (Lipshitz et al., 2001). Developed in microeconomics, classical decision making theory was intended to describe how humans *should* behave, rather than how they *do* behave (Simon, 1959). Lipshitz and colleagues (2001) describe the theory in terms of four essential characteristics: (1) a choice among available options, (2) an input-output orientation that predicts which option will be chosen given a decision maker's preferences, (3) a comprehensive process that requires a deliberate and analytical information search, and (4) and abstract models that require no context.

However, because classical decision making is a normative in nature, describing ideal behaviors rather than observed behaviors, it has faced much criticism (Lipshitz et al., 2001). In the 1950's, Simon noted that while ideas of man as a rational, analytic decision maker may be adequate for simple and slow moving problems, that many real-world problems do not take place in this type of context (1959). This marked the beginning of a movement away from rational models, and an integration of more naturalist and context-bound ideas in decision making theories (Lipshitz et al., 2001). Because this shift began before the recent increase in team-related research, not many team decision-making frameworks have been based on this perspective. Two models have been identified that both examine decision making at a team level, and consider decision making to be a rational process.

**Multilevel theory of team decision making.** Developed by Ilgen and colleagues, the multilevel theory of team decision making addresses decision making in hierarchical teams with distributed expertise. Specifically, their model applies to teams where (1) there is an established leader, (2) the leader has the final say in the decision, and (3) each team member has unique knowledge and information (Hollenbeck et al., 1995). As the name suggests, the model breaks

decision making down into multiple levels: the decision level, the individual level, the dyadic level, and the team level. At each of the three lower decision-making levels, the theory identifies one critical variable that ultimately affects team decision-making accuracy (i.e., the degree to which the selected decision is representative of the best possible decision; Hollenbeck et al., 1995, 1998).

At the decision level, the critical variable is decision informity, defined as "the degree to which each team member has all the information necessary to perform his or her role in the decision-making process" (Hollenbeck et al., 1998, pp. 270). Decision informity can also be aggregated to the highest level of decision making, the team level, where it is known as team informity (Hollenbeck et al., 1995, 1998). The multilevel theory proposes that the better informed a team is about a decision, the more likely they are to make an accurate decision (Hollenbeck et al., 1995, 1998).

At the individual level lies individual validity, a construct that describes the degree to which an individual team member's recommendations are representative of the correct decision (Hollenbeck et al., 1998). Just as the construct from the decision level can be aggregated to team level, individual validity can be aggregated to team level, where it is referred to as staff validity (Hollenbeck et al., 1995, 1998). The theory suggests that when individual members are better able to predict the correct decision, the team will be more likely to make an accurate decision (Hollenbeck et al., 1995, 1998).

The third level included in the model, the dyadic level, is concerned with the relationship between an individual member and the team leader. Here the construct of interest is dyadic sensitivity, which "reflects the degree to which a team leader correctly weights each staff

member's recommendation to arrive at a team decision" (Hollenbeck et al., 1998, pp. 271). Dyadic sensitivity can be aggregated to form hierarchical sensitivity at the team level. The theory proposes that teams with higher levels of dyadic sensitivity will have higher decision making accuracy (Hollenbeck et al., 1995, 1998).

At the team level of Ilgen's model, is the team's decision-making accuracy, as well as aggregates of all the lower level constructs (Hollenbeck et al., 1995). The theory names the three major concepts at each of the three lower levels (i.e., decision informity, individual validity, and dyadic sensitivity) and their corresponding aggregates (i.e, team informity, staff validity, and hierarchical sensitivity) the core constructs. It predicts that the six core constructs of the theory mediate the relationship between all other potential variables and team decision-making accuracy (Hollenbeck et al., 1995). When tested, Hollenbeck and colleagues (1995, 1998) provided support for the model, finding in separate studies that the core constructs predicted 49%, 27%, and 63% of the variance in team decision-making accuracy.

**Information asymmetries model of group decision making.** The information asymmetries model (Brodbeck, Kerschreiter, Mojzisch, & Schultz-Hardt, 2007) also examines decision making in groups with distributed knowledge. Although the Brodbeck et al. (2007) refer specifically to groups rather than teams, the groups described have access to different sets of information, and are therefore dependent on one another. This meets the present paper's definition of a team, and I have considered it a model of team decision making for the purposes of this paper.

This model focuses primarily on the relationships between knowledge distribution before a decision is made, information processing during decision making, and the outcomes of the

decision making process (Brodbeck et al., 2007). Before the team considers and makes a decision, each team member has a set of knowledge. Some of this knowledge is shared amongst members, while some is unique to individual members. Further, it may be the case that an individual member's knowledge points to the best decision (i.e., manifest profile) or that it points to a suboptimal decision (i.e., hidden profile). In order for unshared information to be considered in the team decision making process, team members must share unique information with the group (Brodbeck et al., 2007).

During the decision making process, this model proposes that three types of biases impact decision making (Brodbeck et al., 2007). The first is a group-level negotiation focus, a tendency to exchange preferences so that the dominate position can be identified and settled on. The second, group-level discussion bias, includes the inclination to discuss shared (rather than unique) and preference-consistent information. Like discussion bias, the third bias, evaluation bias, concerns the preference for shared and preference consistent information, however it focuses on individual-level evaluations, rather than group discussion.

Brodbeck and colleagues (2007) propose that when individual team members' information indicates a decision other than the one that the combined information does (i.e., a hidden profile task), these biases can be damaging. More specifically, they predict that under these conditions each of the three biases negatively impact individual learning and group decision quality. Thus, to ensure maximum decision quality, teams should make efforts to share knowledge, so that all decisions are informed by the full range of relevant information. While the authors cite empirical and theoretical support for each bias present in the model, the overall model does not seem to have been tested for validity in predicting team performance.

**Naturalistic Decision Making**

After a gradual move away from rational perspectives on decision making, naturalistic decision making emerged as an attempt to understand how individuals make decisions in environments that are familiar and meaningful to them (Lipshitz et al., 2001; Zsambok, 1997). Naturalistic decision making is can be characterized by its own set of features: (1) a focus on the describing cognitive processes, rather than predicting outcomes, (2) a decision maker's tendency to match the current situation to past situations, (3) context specific decision making, (4) a focus on what decision makers actually do, not what they should do in theory (Lipshitz et al., 2001).

Naturalistic decision theories have been well supported in decision making literature in the last two decades, perhaps because of their focus on field research in occupational settings (Highhouse et al., 2013). However, naturalistic decision making has not gone without criticism, specifically concerning the methods used by researchers in this domain (Zsambok, 1997). Because these theories emphasize real-world decision making, most research in this area makes use of field studies (Lipshitz et al., 2001). While this is beneficial in terms of capturing the context decisions are made in, field studies often lack the large sample sizes, random assignment of subjects, and control of extraneous variables afforded by laboratory research (Lipshitz et al., 2001). Further, researchers from other perspectives have criticized naturalistic decision making as being narrowly focused and difficult to replicate (Yates, 2001). Despite these claims, naturalistic decision making theories have brought a renewed focus to the study of decision making at a team level (Lipshitz et al., 2001). As a result, the naturalistic perspective has successfully produced several models of the team decision making process.

**Advanced team decision making 1.0.** Klein and colleagues have produced two separate

models of the team decision making process. Because the models have substantial design differences, I will address them separately. The first version of the advanced team decision making model (ATDM 1.0; Zsambok, 1994; Zsambok, Klein, Kyne, & Klinger, 1992) focuses on the three key components of team decision making: team identity, team conceptual level, and team self-monitoring. According to the model, the processes and behaviors that are critical to good team decision making can be organized into those three components.

The first component, team identity, can be defined as "the extent to which members conceive of the team as an interdependent unit, and then operate from that perspective while engaged in their task" (Zsambok et al., 1992, pp.6). They propose that without a strong identity, team members will be forced to rely on individuals skills, rather than taking advantage of the team's shared expertise. There are four ways to improve team identity, by (1) clearly defining each team member's role and function, (2) encouraging engagement and participation from all team members, (3) encouraging members to compensate for teammates' performance when problems arise, and (4) avoiding micromanagement within the team.

The team conceptual level, a second key concept in this model, describes the degree to which a team has the shared intelligence necessary to make decisions and solve problems (Zsambok et al., 1992). This is important, because teams with low conceptual levels are more likely to produce poor, disjointed, or un-implementable plans. To avoid these issues, teams should (1) clearly understand all goals and plans, (2) focus plans on an appropriate breadth of considerations and span of time, (3) recognize any ambiguous or missing information, and (4) seek divergent viewpoints in order to assess the situation most accurately.

A final concept, team self-monitoring, captures a team's ability to monitor and adapt

behavior while performing job tasks (Zsambok et al., 1992). While team identity and team conceptual level are considered emergent team states, Zsambok and colleagues consider team self-monitoring to be a team process. In fact, team self-monitoring serves to regulate the processes and behaviors found within team identity and team conceptual level. They describe team self-monitoring as a function of two types of abilities, (1) the ability to adjust behaviors during performance and (2) the ability to effectively set and meet deadlines.

This original version of the advanced team decision making model was developed for the Industrial College of Armed Forces. The authors found that with training based on the ATDM 1.0, teams learn to discriminate between good and bad team performance based on the model (Zsambok, 1994). Additionally, they have used the model to develop interventions for a nuclear power plant's emergency response organization (Klinger & Klein, 1999), and it is reported to have been successfully applied to strategic geopolitical, military operational logistics, and emergency operations teams (Thordsen, Kyne, & Klein, 2002).

**Advanced team decision making 2.0.** The second version of the Advanced Team Decision Making (ADTM 2.0; Kyne, Thordesn, & Kaempf, 2002; Thordsen et al., 2002) model was modified significantly. While its predecessor examines team decision making in a broad sense, the ADTM 2.0 model aims to be both a general and a field-specific model of teamwork. To this end, the newer model consists of four tiers, with the upper two addressing the general factors affecting team performance and the lower two addressing decision making in specific fields and environments.

The top two tiers are similar to the ADTM 1.0 model. The uppermost tier consists of four team components: team resources, team identity, team cognition, and team metacognition

(Thordsen et al., 2002). The theory behind ADTM 1.0's original three components is still present, although the second model has adapted these components somewhat, identifying team conceptual level as team cognition and team self-monitoring as team metacognition. In addition, a team resources component was also added to capture a team's ability to recognize and utilize available resources.

Also like the original model, each top tier component in the ADTM 2.0 model is supported by a tier of behavioral dimensions, or behavioral factors on which the team components vary (Thordsen et al., 2002). For the three components present in the original model, team identity, team cognition, and team metacognition, these behavioral dimensions are largely unchanged. For the team resources component, these include the utilization of (1) individual member resources, (2) team leader resources, and (3) basic team procedures.

While the components and their behavioral dimensions are common across all areas and types of teams, Thordsen and colleagues describe two lower tiers that are tailored to specific domains (2002). The third tier consists of specific behaviors that lead to good team performance, and the bottom tier represents corresponding behavioral dimensions for each specific behavior. The third and fourth tiers mirror the first and second structurally, in the sense that the upper tier is measured by the dimensions of the lower tier.

While it would be virtually impossible to map the specific behaviors and behavioral dimensions for every type of team in every domain, the authors did test the process by investigating specific factors relevant to the firefighting field (Kyne et al., 2002). By observing teams and interviewing team leaders as part of a pilot study, they were able to develop a measure of specific behavioral markers for firefighting teams. They achieved an average agreement rate

of 83% among researchers and 71% among both researchers and fire battalion chiefs. Kyne et al. concluded that the ATDM 2.0 model had "considerable promise for assessing and diagnosing the dynamic processes of team performance in operational environments" (2002, pp. 18).

**Team decision making in a naturalistic setting.** A recent chapter by Sonesh (2013) and colleagues has synthesized literature in the area of naturalistic decision making, and proposed a new framework for team decision making. Like other naturalistic decision theories, this model considers decision making in a dynamic setting where teams must work within the confines of the environment. This model maps the relationships between inputs and outputs through the entirety of the decision making process.

The first inputs into the team decision are the processing objectives that motivate the team (Sonesh et al., 2013). These are the broad end goals that will drive the team decision throughout the duration of their task. Sonesh et al. (2013) proposes that these objectives contribute indirectly to the team decision quality by focusing attention on the most relevant attributes of the environment. Further, they suggest that process objectives also affect the engagement of necessary team competencies and team processes.

Team competencies are the knowledge, skills, and attitudes team members possess, while team processes are the interactions among members that contribute to a team's success. The model proposes that team competencies and team processes become input's themselves, impacting a team's ability to process information and to develop a shared understanding of the experience (i.e., team situation model; Sonesh et al., 2013). The authors describe the relationship between information processing and shared understanding as cyclical; as the members processes more information, they develop a better understanding of the situation, and as they develop a

better understanding, they are better able to gather additional information.

Information processing ability and shared team understanding continue on to affect a team's shared cognition (i.e., team mental models) or illusory shared cognition. While shared cognitions are mental representations of the environment shared amongst team members, illusory shared cognition occur when the team falsely believes that they possess shared cognitions. The authors predict that shared cognitions positively affect team decision making quality, while illusory shared cognitions have a negative effect. The team decision making framework concludes with the quality of team performance serving as the final outcome (Sonesh et al., 2013).

While Sonesh and colleagues (2013) provide theoretical support for their model, it does not appear to have been tested yet. They express the desire to have their framework tested in the future and to utilize it in developing training applications for teams operating in naturalistic settings (Sonesh et al., 2013).

**Comparison of Decision Perspectives**

While rational and naturalistic team decision making models have substantial differences both within and between perspectives, they all seem to share the same primary goals: to describe the team decision making process and, ultimately, to improve decision making in real teams. However, the main difference between models from the two paradigms seems to be the way in which they view decision making. From the rational perspective, decision making is about selecting a single option from many choices. However, from the naturalistic perspective, team decision making is used almost interchangeably with team performance; team decisions are

embedded within the task, where they are not choices as much as they are reactions to the environment based on knowledge and past experience.

In reality, these differing views on decision making may both be relevant to organizations, just in different ways. For example, decisions regarding employee selection are certainly a situation where the final decision will be a choice among options, with an individual being selected from a pool of candidates. However, decisions made in action, like a police officer's decision to draw a weapon in an emergency, typically leave less time for thought and rely heavily on intuitive reactions. Because workplace decisions can vary greatly, it is important to take into account the full range of decisions when developing a team decision making model.

# TEAM DECISION MAKING CONCLUSIONS

By reviewing various models of the team decision making process, I was able to extract several features that seem to generally characterize team decision making. Team decision making appears to progress through multiple phases and levels in dynamic and cyclical way (see Appendix, Table 1).

## Multi-Phasic Process

Team decision making appears to occur in a series of phases or steps. In order to arrive at a team decision, teams must be able to first assess their surroundings and environment (Hollenbeck et al., 1995; Thordsen et al., 2002; Zsambok et al., 1992), then use their knowledge to analyze the situation (Sonesh et al., 2013), and to ultimately make a decision regarding the best course of action (Brodbeck et al., 2007; Hollenbeck et al., 1995). While the amount of time and care taken in each phase may vary widely by discipline, type of task, and individual team, most models seem to generally agree that team decision making is a process, which requires situation assessment and analysis in order to make a decision.

## Multi-Level Process

Team decision making appears to be multi-level in the sense that information flows across multiple levels during the decision making process. Information about the current situation starts at the environmental level (Hollenbeck et al., 1995). It is up to individual team members to observe the environment and assess the situation (Hollenbeck et al., 1995; Thordsen et al., 2002; Zsambok et al., 1992). In turn, individuals then relay information to the team or team leaders (Hollenbeck et al., 1995; Sonesh et al., 2013). Information that is shared at the team-level information will ultimately inform the team decision.

**Dynamic Process**

While team decision making generally seems to progress in phases and build toward team-level knowledge, these movements do not appear to be strictly linear (Sonesh et al., 2013; Zsambok et al., 1992). As teams analyze the information they have gathered, they may realize that their information is incomplete or ambiguous and return to gather more rather than making an ill-informed decision. In the same way, as members share information to build a body of team-level knowledge, they are likely to adopt information presented by other team members into their own individual knowledge base. While these types of movements may seem to back away from a final decision, they could be important in refining and organizing knowledge. However, in order to reach a team decision, the team level and decision stage must be reached.

**Cyclical Process**

Although the theoretical end of the decision making process may occur when a decision is made, this is not the end for many teams. Most tasks require multiple decisions, and many teams regularly complete tasks together. Even when a team disbands, members hold onto their team decision making experiences. It appears that this individual knowledge builds expertise and can be useful when making future decisions by allowing team members to better gather and interpret information (Sonesh et al., 2013).

# DISCUSSION OF TEAM DECISION MAKING

As work teams become more widely used in organizations, teams are taking on new and different tasks in a variety of settings. In order to ensure teams make the best decisions possible, it is important to understand how teams make good decisions and where they might go wrong. By summarizing the current lines of research and outlining what is known about team decision making, I have endeavored to provide valuable information to future researchers. Ideally this information will facilitate future investigation into the intricacies of the team decision making process. Further, I hope that this line of research will lead to practical solutions for teams aiming to make higher quality decisions.

**Research Directions**

Fortunately, as the use of teams has become increasingly more common, research focusing on teams and teamwork has also increased (Kozlowski & Bell, 2003; Salas et al., 2008; Van Hootegem, Benders, Delarue, & Procter, 2005). However, as science progresses, it is important to continue building the base of knowledge regarding how and why teams perform at the level of quality they do. Specifically concerning team decision making, researchers have developed several important lines of research. Both the rational and naturalistic perspectives have provided models that contribute valuable insights into how teams make decisions. However, there is still much to be learned in this area.

One point of concern is the lack of integration between the two points of view. The two decision making perspectives seem to address very different types of decisions. Rational decision making focuses on decisions made after a great deal of thought, while naturalistic decision making focuses on decisions made rapidly and in action. While both perspectives have enjoyed

support with their respective types of decisions, future investigation is needed to more clearly determine how rational and naturalistic processes are related. While this paper has highlighted the characteristics that they have in common, there are many more characteristics on which they differ. In order to more clearly understand how and why teams use specific decision making styles, the function of these differences should be more thoroughly examined.

Some researchers have begun this process by investigating different team decision making strategies. Burke and colleagues (2008) propose that a team's context affects the process through which they make decisions. Specifically, they cite stress as a contextual factor that prevents teams from being able to use a rational decision process. When stress is present, they suggest that teams must resort to naturalistic decision making (Burke et al., 2008). This proposed relationship between the environment and team decision making warrants additional investigation. The remaining chapters of this paper will focus on continuing this line of research by examining the effects of stress on team decision making.

As future research attempts to answer these questions, the characteristics outlined in Figure 1 may serve as theoretical guide. The characteristics were designed to be general in nature, representing of all types of team decision making. For this reason, they may inform research studying decision making in a broad sense. Even in non-specific, ambiguous, or varied contexts, it appears that team decision making can be described as multi-level, multi-phasic, dynamic, and cyclical. Additionally, these broad characteristics can be adapted by researchers studying decision making in any particular context or by researchers comparing decision making between contexts.

**Practical Application**

The outlined characteristics not only serve as a theoretical basis for future research, but also for the development of practical solutions within organizations. As the use of teams increases in the workplace, there is an increasing need for informed methods of team member selection and composition (Bell, 2007), as well as training (Driskell, Lazzara, Salas, King, & Battles, 2012). Unfortunately, developing good methods for selecting and training team members has been no easy task (Bell, 2007; Salas, Guthrie, and Burke, 2007). One recommendation Salas and colleagues (2007) give for developing good team decision making training programs is to ensure that they have a solid theoretical basis. Without an understanding of how teams make decisions, there is no way to see where teams are going wrong. However, they noted a lack of good team decision making theories, and a need for better theories to be produced in the future (Salas et al., 2007). The current framework provides additional theoretical basis for team composition and training interventions, and I hope it serves as a step toward substantial improvement in the way teams make decisions in everyday contexts.

# TEAM DECISION MAKING AND STRESS

In the real world, decisions are made constantly by people in every type of context. Often, this includes "complex, dynamic environments where stress (and stressors) are ever present" (Burke et al., 2008, p. 188). Workers in our society are asked to perform jobs more complex than at any other time in human history (Salas, Driskell, & Hughes, 1996). Tasks such as performing a surgery, flying an airplane, or navigating an ambulance require enormous skill and exceptional attention. Unfortunately, many of these tasks are also associate with high risk outcomes, including potential fatalities. As demands on an individual increase, they may begin to feel stressed.

This is particularly concerning considering the relationship between stress and performance. Stress has been associated with a variety of different outcomes, including physiological reactions, cognitive effects, emotional reactions, social behavior, and performance outcomes (Salas et al., 1996). Further, stress has been shown to alter the way individuals make decisions (Starcke & Brand, 2012). Some have proposed that stress also has implications for decisions made by teams, affecting the way team members gather, weigh, and exchange information (Burke et al., 2008).

The purpose of this chapter is to review the literature on stress, specifically focusing on its effects on human performance. I will discuss ways in which stress affects individual- and team-level processes with the goal of uncovering the ways in which stress may affect team decision making. Ultimately, the reviewed research will serve to inform a proposed model of team decision making under stress.

**The Definition and Conceptualization of Stress**

Beginning in the 1930's, Hans Selye pioneered the field of stress research (Le Fevre, Matheny, & Kolt, 2003; Starcke & Brand, 2012). However, in the decades that have followed, there has been significant confusion regarding the exact definition of stress. This lack of clarity has penetrated both the scientific community and the general public (Jex, Beehr, & Roberts, 1992). Within organizations, team leaders have developed a wide range of opinions regarding stress; some believe it facilitates performance, some believe it leads to errors, and still others believe its beneficial only in small quantities (Le Fevre et al., 2003; Salas et al., 1996). Put simply, it is "obvious that stress means many things to many people" (Salas et al., 1996, p. 1).

Selye was the first to define many of the stress-related terms found in the literature today (Le Fevre et al., 2003). He originally defined stress as a bodily reaction to an external force acting on an individual. In addition, he named the unspecified external force a *stressor* (Selye, 1956). According to Selye, stress was not limited to either positive or negative responses, but included both. He differentiated the positive and negative effects by terming helpful stress *eustress* and harmful stress *distress* (Selye, 1987).

Since these terms were originally defined by Style, research in this area has continued to grow, promoting much discussion regarding stress-related terms, concepts, and theories (Levi, 1998). Though Selye was a physician, stress has been studied in several fields, including medicine, psychology, management, and sociology (Cummings and Cooper, 1998). Because each field has distinct perspectives and methodologies for studying stress, many different conceptualizations of stress have emerged (Le Fevre et al., 2003). Unfortunately, this has led to substantial inconsistency in usage of stress-related terms (Jex et al., 1992; Motowidlo, Packard,

& Manning, 1986; Ridner, 2004). Across the literature, *stress* has been referred to as a stimulus (i.e. Selye's stressor), a physical response, psychological interpretation, and/or behavioral reaction (i.e. Selye's stress), or the entire stimulus-response relationship (Jex et al., 1992; Le Fevre et al., 2003).

This lack of clarity has been intensified by the discrepancy between common usages of stress related terms and scientific usages. Specifically, there is some confusion regarding Selye's *stress*, *distress*, and *eustress* terms. While Selye's definition of stress is neither positive nor negative (1956), the Oxford Dictionary defines stress as "a mental or emotional strain or tension resulting from adverse or very demanding circumstances" ("Stress", 2014). This definition has clear negative connotations, further shown by its listed synonyms: "strain, pressure, (nervous) tension, worry, anxiety, trouble, and difficulty." It should be noted that this is only one of twelve definitions and sub-definitions listed for the word *stress*. Some others definitions stem from physics, linguistics, and computer science, and both noun and verb forms of the word are listed ("Stress", 2014).

To compare, the same dictionary defines distress as "extreme anxiety, sorry, or pain" ("Distress", 2014). While this definition seems to have more extreme connotations, like stress, it reflects negative undertones. Much like stress, it also has multiple definitions and sub-definitions (seven in total), including both noun and verb forms, and stemming from multiple fields (e.g., medicine, law; "Distress", 2014). Given the similarities between the two words, it is not surprising that stress and distress are often used interchangeably in casual speech.

Perhaps adding to the confusion, researchers have also coined a number of other terms that fall within the category of stress. Some concern the duration of the stress response, such as

the term *chronic stress,* which has been used to describe the effects of stressors that are persistent over time (McGonagle & Kessler, 1990; Salas et al., 1996). These might include stress stemming from ongoing job or family demands. In contrast, *acute stress* is concerned with intense stress in relatively short durations (McGonagle & Kessler, 1990; Salas et al., 1996). It may include point-in-time events, such as emergency or emotionally traumatic situations. Additional terms may be named after the type of stressor, such as *occupational* or *job stress* (LaRocco, House, & French, 1980), *stressful life events, or daily hassles* (Salas et al., 1996).

Diverging from Selye's original definition, a popular perspective in recent decades has focused on cognitive appraisal (Starcke & Brand, 2012). This theory, developed by Lazarus and colleagues (Lazarus, 1993), emphasizes the relationship between the environment and the individual response (Salas et al., 1996). The theory names cognitive appraisal as the processes through which a person decides if the environment is relevant to his or her wellbeing (Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1984). This is also referred to as the cognitive mediation approach, because cognitive appraisal is said to mediate the relationship between the environment and the stress reaction. This appraisal process allows individuals to determine harmful situations from those that are benign (Lazarus, 1993). When an individual perceives a task or situation to be too demanding to be completed with the limited resources they have, they experience stress (Lazarus, 1993; Salas et al., 1996).

According to this conceptualization, stress only spawns from situations where perceived demands exceed the perceived ability to perform a task. Because it is negative in nature, it is significantly more limited than Selye's definition. Lazarus clarified the purpose of these differences by emphasizing the difference between psychological and physiological stress

(1993). He noted that the factors that cause psychological harm are very different that the factors that can cause physiological harm. For this reason, he focused specifically on causes of psychological stress (1993).

Despite Lazarus's claim that psychological and physiological stress are not necessarily related, some have suggested that the relationship is both intuitively and neurologically plausible (Oldehinkel et al., 2011). Aided by technological advancement, there has been substantial investigation into this potential relationship between physiological and perceived stress over the last few decades. In a two studies by Schlotz and colleagues (2008), participants were either given a widely used psychological stressor, The Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993), or were given physical stressors, the application external and intravenous hormones. Both stressors produced similar responses in participants, specifically hypothalamic-pituitary-adrenal axis activation. These results are supported by additional studies indicating that perceived stress, autonomic, and endocrine system stress responses covary together (Oldehinkel et al., 2011; Schlotz, et al., 2008; Schommer, Hellhammer, Kirschbaum, 2003). These results provide convincing evidence that physiological and psychological stress are highly related are representative of the same theoretical stress concept.

Like the hormones used in Scholotz's study (2008), there are some stressors that can elicit a bodily response before any cognitive appraisal has taken place (Everyly & Lating, 2013). These are referred to as *biogenic stressors,* as they seem to inherently prompt physiological stress. While varying in severity, they include caffeine, nicotine, and amphetamines (Everyly & Lating, 2013; Kowalski, 2000). Biogenic stressors appear to cause a more direct reaction than appraisal-based stressors by directly adding stress related chemicals into the body. This

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interrupts the normal relationship between cognitive appraisal and the endocrine system mechanisms that produces the stress response (Kowalski, 2000).

While perceived stressors are often embedded in team tasks and performance environments (e.g., ambiguity, workload, threat), biogenic stressors usually are not. Although the use of biogenetic stressors may be common (e.g., drinking coffee, smoking cigarettes), they are not usually a significant concern to stress response systems unless used at extreme or chronic levels (Everly & Lating, 2013). Because of their relevance during team performance events, I will focus primarily on perceived stressors for the purposes of this paper. Additionally, I will adopt a definition of stress consistent with Lazarus's conceptualization; stress occurs when an individual perceives a situation to be too demanding to be completed with the available resources (Salas et al., 1996). In accordance with this definition, I will focus only on stress that occurs when an individual has a negative situational expectation. However, I will modify Lazarus's original view to encompass both psychological and physiological stress reactions. For clarity, all future uses of the term stress will refer to the overall (i.e., psychological and physiological) stress reaction, which is commonly caused by a negative appraisal, although it may be directly induced through chemical means.

**Stressors and Individual Differences**

Part of the difficulty in studying stress involves determining what qualifies as a stressor. Because stress is evoked by one's appraisal of the situation (Lazarus, 1993; Salas et al., 1996), what is or is not a stressor depends on an individual's perception. Even if two individuals with the same skills and abilities were completing the same job, it is entirely possible that that they could have unique perceptions of the situational demands and unique perceptions regarding their

resources. It is the individual's ratio of perceived demands to perceived resources that determines how whether or not they will experience stress (Lazarus, 1993; Salas et al., 1996).

Because stress appraisal is an individual process, it is affected by differences in cognitive and motivational variables (Lazarus, 1993). When individuals are put under what researchers consider to be stressful conditions, perhaps high time pressure, workload, or ambiguity, the results aren't necessarily a stressed participant (Lazarus, 1993). However, researchers note that some conditions may be more likely to elicit a stress response from most people than others (Brief & George, 1995). Likely stressors may include time pressure, high workload, ambiguity, adverse physical conditions, and threat (Cannon-Bowers & Salas, 1998).

Some researchers have further broken down stressors into two categories: those that are ambient and those that are task-related (Matthews & Campbell, 2009; Salas et al., 1996). Ambient stressors, or those external to the task being performed, may include environmental (e.g., noise), social (e.g., conflict with team members), or organizational climate stressors. Task-related stressors are internal to the task, and may include high workload, ambiguity, or monotony (Matthews & Campbell, 2009; Salas et al., 1996). This categorization highlights the reason that stressors are so problematic; many are deeply embedded within a team's job or work environment.

In order to study stress, researchers can conduct laboratory or field studies where simulated or natural stressors are present. For laboratory experiments, this is often done through manipulated stressors that are physically challenging, cognitively demanding, and/or socially threatening (Starcke & Brand, 2012). Physical challenges may involve fatigue, extreme temperature, or exercise, while cognitive demands usually focus on complex reasoning, mental

arithmetic, or timed reactions. Social/evaluative threats are most often associated with public speaking tasks. Though each of these potential stressors has a good record of eliciting stress, there is no guarantee that any individual participant will feel stressed by any particular task. For this reason, it is important to check experimental manipulations to ensure that the stressor actually resulted in perceived stress (Starke & Brand, 2012).

**Effects of Stress**

Researchers have proposed a variety of relationships between stress and performance, including negative linear, positive linear, and inverted-U shaped relationships (Kavanagh, 2005). Given the lack of clarity surrounding the term stress (Jex et al., 1992), it is not surprising that researchers assert divergent views on stress and performance. Selye (1975) suggested an inverted-U relationship between stress and performance, a view that would be consistent with stress defined as his unspecific force acting on individuals. This inverted-U shaped relationship is based on the work of Yerkes and Dodson (1908) which detailed the relationship between a conditioning stimuli and habit formation. Since then, type of relationship has been more generally stated as a relationship between arousal and performance, such that there is a level of arousal that will produce optimal performance, and over- or under-arousal reduces performance (Cohen, 2011).

When considering stress as the result of a negative appraisal rather than a general force, the theoretical basis for an inverted-U relationship must be revisited. It may be the case that the point where demands are first perceived as exceeding resources occurs before, at, or after the optimal level of arousal. Investigation into the relationship between stress and aspects of performance may provide additional theoretical insight and a foundation for developing

propositions regarding the team decision making process under stress.

Salas and colleagues (1996) reported that stress is related to a number of undesirable consequences, including negative physiological, psychological, behavioral, and social outcomes. Further, others have concluded that stress has the ability to alter the way individuals make judgments and decisions (Kavanagh, 2005; Starke & Brand, 2012). Additionally, stress has been proposed to affect the way teams are able to make decisions on the job (Burke et al., 2008). In an effort to understand how and why stress affects the team decision making process, I will further investigate this relationship by reviewing the ways stress affects human performance. I will do so by breaking down the effects of stress into four broad, yet interrelated categories: the physiological, emotional, cognitive, and social effects of stress.

**Physiological foundations of stress.** Stress has often been used as an umbrella term meant to capture a wide range of physiological reactions (Oldehinkel et al., 2011). However, there has been some confusion regarding the bodily responses associated with stress, and their relationship to the bodily responses associated with arousal (King, Burrows, & Stanley, 1983). Physiological arousal is generally associated with the activation of the central nervous system, while physiological stress is associated with the activation of the hypothalamic-pituitary-adrenal axis (Pfaff, Martin & Ribeiro, 2007; Oldehinkel et al., 2010). To clarify, Pfaff and colleagues (2007) state that arousal can and does occur in the absence of stress. However, stress is not possible without the arousal. They say that the relation between the two "does not highlight a clear separation within them; it is an inclusion relationship in which stress includes arousal but arousal does not necessarily include stress" (Pfaff et al., 2007, p. 318).

Immediately after individual perceives a situation to be stressful (or is exposed to a

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biogenetic stressor; Kowalski, 2000), the human stress response is triggered (Kowalski, 2000; Starcke & Brand, 2012). In the first stage of this response, the hypothalamus secretes two hormones: corticotropin-releasing hormone and arginine-vassopressin (Randall, 2010). In laboratory studies, these hormones can be administered to participants in order to provoke a stress response in lieu of an environmental stressor (Schlotz et al., 2008; Starke & Brand, 2012). Together these hormones activate the hypothalamic-pituitary-adrenal axis, a system of feedback interactions between the hypothalamus, pituitary gland, and adrenal gland that regulates the physiological stress response (Randall, 2010). From the pituitary gland, adrenocorticotrophic hormones are released, which in turn regulate the release of cortisol from the adrenal cortex (Pariante & Lightman, 2008). Cortisol is the primary hormone responsible for the human stress response (Randall, 2010).

Despite the fact that stress can be triggered by a wide range of potential stressors, once triggered, stress produces similar responses within the body (Kavanagh, 2005). Physiologically, it can be observed through a wide range of measurements including increased heart rate, dilated pupils, increased blood pressure, galvanic skin response (Selye, 1956), heart rate variability, electrocardiograph (EKG) and impedance cardiographic (ZKG) signals, pulse transit time, salivary immunoglobulin A levels, blood pressure, adrenaline and noradrenaline output, cortisol output, electromyography (EMG) levels, blood glucose level, muscle tension, eye blink duration, respiration rate (Salas et al., 1996). However, it is often difficult to measure and interpret physiological stress reactions (Salas et al., 1996). Some researchers recommend taking multiple physiological measurements, in order to gain a more complete idea of how the body is reacting to the stressor (King et al., 1983).

Activation of stress responses can have important implications for those experiencing stress. High stress levels have been linked to cognitive impairment, decreased thyroid functioning, prolonged healing times, and suppressed immune system functionality (Randall, 2010). While hormone and immune system functioning are certainly a concern for those regularly and chronically experience stress, cognitive impairments may be the most concerning in terms of effects on the decision making process, a primarily cognitive process. At the very least, these physiological responses may serve as a distraction during performance events (Salas et al., 1996). Attention and distraction will further be discussed in a later section, along with other cognitive effects.

**Emotional reactions to stress.** Many researchers also suggest a relationship between stress and emotional response. Lazarus (1999) emphasizes that the relationship between stress and emotion are inseparable, calling the degree of separation between stress-focused and emotion-focused scientists "an absurdity" (p. 35). Further, he has proposed that stress may manifest itself as a less differentiated form of negative emotion (1993). In fact, stress has often been associated with a number of different emotions including fear, annoyance, tension, frustration, and concern (Salas et al., 1996).

Because stress is so closely associated with negative emotions, subjective measures of stress tend to focus questions on the emotions associated with stress (Salas et al., 1996; Starcke & Brand, 2012). Most often, this is done though self-report questionnaires. Studies of acute stress may rely on measures of current affect, as opposed to studies of chronic stress that are more likely to rely on trait-focused measures (Salas et al., 1996; Starcke & Brand, 2012).

However, there has been some discussion regarding the directionality of the relationship

between stress and emotions. Some have hypothesized that perceptions of stress may lead to an increase in negative emotional responses (Driskell, Driskell, & Salas, 2013; Salas et al., 1996). Alternatively, others have suggested that the relationship works in the alternate direction. Individuals who are more emotionally stable may be more tolerant of stressors, and therefore experience less of a stress reaction than those who are more neurotic (Mount, Barrick, & Stewart, 1998). It may be the case that both propositions are relevant. Before a physiological stress response is triggered, emotionally stability may serve as a mediator between the environment and perceptions of stress. After a physiological stress response is activated, it may cause chemical and cognitive reactions that lead to new or exasperated emotional responses. Like physiological effects, these emotions may be related to cognitive functioning, as they may pose a distraction to individuals as they complete job tasks.

**Cognitive differences under stress.** The effects of stress on cognitive performance have been well documented over the last several decades (Driskell & Salas, 1991; Kavanagh, 2005; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; McEwen & Sapolsky, 1995; Salas et al., 1996). Stress from both acute, short-term stressors (Lieberman, Tharion, Shukitt-Hale, Speckman, & Tully, 2002) and chronic, long-term stressors (Lupien et al., 2007) has been shown to impact human cognition. Among these affects are changes in attention/distraction, memory, strategy use, adjustment/adaptation, feedback processing, reward/punishment sensitivity (Kavanagh, 2005; Lupien et al., 2007; Salas et al., 1996; Starcke & Brand, 2012).

*Attention.* Perhaps the most highly documented cognitive effect of stress concerns the relationship between stress and attention (Driskell et al., 2013; Salas et al., 1996). In 1959, Easterbrook proposed a model that contends that when under stress, individuals attend to fewer

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perceptual cues in their environment. In other words, their breadth of attention narrows, allowing them to pay more attention to immediate cues, but less attention to peripheral cues (Booth & Sharma, 2009; Kavenaugh, 2005; Salas et al., 1996). The utility of attentional narrowing likely depends on the task at hand. For a task where the important factors are relatively obvious, it may be beneficial to be able to ignore irrelevant information. However, in highly complex or ambiguous tasks, what is or is not relevant may not be immediately clear. In these situations, stress may cause an individual to ignore important cues, jeopardizing performance (Braunstein-Bercovitz, 2003; Salas et al., 1996).

One area where this has been shown involves the Stroop task (Stroop, 1935), which requires participants to ignore the meaning of a color word and to respond only with the color it is printed in. This task is relatively unambiguous in the sense that participants are aware of the goal and how to meet it. Difficulty usually arises from the inability to ignore word meaning. It has often been proposed that for this task, stress should increase performance (Booth & Sharma, 2009). This hypothesis has repeatedly been supported, showing that stress from bursts of noise (Chajut & Algom, 2003; O'Malley & Gallas, 1977) and a very difficult fake IQ test (Chajut & Algom, 2003) increase performance. Alternatively, in a separate study that utilized more complex selective and divided attention tasks, researchers found that performance on these tasks was impaired when participants had higher levels of perceived stress and salivary cortisol (Vedhara, Hyde, Gilchrist, Tytherleigh, & Plummer, 2000).

***Strategy use.*** Related to attention is strategy use, another cognitive factor that appears to be related to stress (Starke & Brand, 2012). In 1996, Klein proposed that narrowed attention leads to simpler decision making strategies that would involve less analytical strategies. A wide

range of evidence suggests that this is the case. Studies have shown individuals are more likely to scan fewer alternatives, to scan alternatives less systematically, to use heuristics or rules of thumb, and to make decisions without checking the consequences (Kavenaugh, 2005; Salas et al., 1996; Starcke & Brand, 2012).

A study by Keinan (1987) exposed participants to either controllable stress, uncontrollable stress, or no stress during a decision making task. This was done by telling participants either that they may be shocked for poor performance, that they may be shocked randomly, or nothing about any electrical shocks, respectively. The experiment found that participants in both stress conditions scanned alternatives less systematically and that they were more likely to make a decision without considering all the alternatives. These results were consistent with previous findings both inside the lab (Kelley et al., 1965) and in real-life situations involving stress (Quarantelli, 1954). Janis & Mann (1977) termed this pattern of non-systematic searching and premature closure hypervigilant decision making.

Similarly, research has also supported the idea that stress increases the use of heuristics in decision making. Heuristics are shortcuts or guidelines based on past experiences (Kavanagh, 2005). A study by Shaham, Singer, and Schaeffer (1992) showed that participants who were exposed to noise during an analytical test before taking a survey were more likely to use heuristics than those who weren't. Klein (1996) suggests that this may allow individuals to perform more quickly, often an advantage in stressful situations (Kavanagh, 2005).

Also related, Dorner (1990) found that under stress, people were more likely to make decisions without considering the consequences of their actions. He termed this phenomenon "ballistic decision making." He hypothesized that this type of behavior allows participants to see

the consequences of their decisions more easily than they would if they were forced to think about them purely hypothetically. Although ballistic decision making is certainly bad for the decision at hand, it may help to make better decisions in the future.

All of these strategy modifications seem to have a few things in common. In a world without stressors, all of these modifications would be hurt performance. However, they all seem to facilitate rapid decision making. In situations where stressors are common, it may be advantageous to make decisions more quickly and with less thought than would normally be considered ideal. This may be particularly true for situations that are high threat and high risk, where the cost of making an error is very high.

*Memory.* There has also been a substantial amount of research examining the relationship between stress and memory. In addition to his proposition regarding attention and decision making, Klein also suggested a relationship between memory and decision making (1996). He theorized that stress may affect with the memory by causing interference and distraction. As a result working memory may be reduced, affecting mental assessments of the situation (Klein, 1996).

Two experiments by Kirschbaum and colleagues (Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996) partially support Klein's proposition about memory. In the first, participants completed the "Trier Social Stress Test," a task designed to elicit a stress response via a public speaking and mental arithmetic task performed in front of a group of an audience. After completing the task, they then participated in a declarative memory (i.e., memory for facts) task that included memorizing and recalling a list of nouns. The results demonstrated that the stressor clearly induced a physiological stress response measured by saliva cortisol levels. Further, there

was a significant negative correlation between amount of cortisol (an indicator of the stress response) present and declarative memory functioning. In the second study, stress was triggered by a dose of cortisol delivered orally. In this version of the experiment, the measures included both a declarative and procedural (i.e., memory for skills and processes) memory test. As compared to participants who did not receive cortisol, participants who received cortisol performed significantly worse on the declarative memory task. There was no difference in procedural memory functioning (Kirschbaum et al., 1996).

In addition to experiments where information was encoded and recalled under stress, Kuhlman, Piel, and Wolf (2005) investigated how information learned before the stressor was present. On the first day of the study, participants were given two minutes to learn a list of words and then immediately recalled them. On the second day, some participants were given the Trier Social Stress Test and others were given a control condition, before being asked to recall the word list from the previous day. Participants in the stress condition remembered significantly more words than those in the control condition.

Even further, a recent meta-analysis of twenty-eight studies revealed that stress was associated with both cortisol secretion and declarative memory deficits (Sauro, Jorgensen, & Pedlow, 2003). In fact, the amounts of cortisol present was negatively related to declarative memory functioning. This suggest that as stress increases, the memory functioning becomes increasingly impaired. However, the study found no effects for procedural memory, consistent with Kirschbaum et al.'s results (1996).

**Changes in social behavior under stress.** For team tasks, social behavior may be very important to overall performance. To build a shared knowledge and understanding within the

team, members need to be able to communicate with one another. However, Driskell, Salas, and Johnston (1999) proposed that attentional narrowing cause by stress may extend to the social interactions between team members. They hypothesized that under stress team members may shift from a focus on teamwork to a focus on their individual subtasks. This claim was informed by Cohen's research on attentional narrowing. Cohen suggested that attentional narrowing may cause a neglect of social cues and decreased sensitivity to others (1980).

Several studies have supported these notions. A study Baumeister (1984) provided evidence to suggest that when under pressure to perform well, individuals tend to pay more attention to their own performance. Driskell and colleages (1999) also experimented with these concepts, examining the relationship between stress and team perspective. Team perspective is a combination of collective representations of the group (i.e. a common team identity) and a collective representation of the task (i.e. shared mental models or common perspectives on goals, resources, and performance strategies; Driskell et al., 1999). Ultimately, they found that teams performing under high stress conditions had significantly reduced team perspective.

In addition to a more individualist focus, research has found that stress has negative effects on team communication. One study found tested the differences between teams performing in either high or low time pressure and high or low risk to team performance (Gladstein & Reilly, 1985). The authors found that under high time pressure, teams communicated less and used fewer channels of stress. Under increased risk of performance loss, teams also communicated less, and they thought that they shared too little information with one another. In a separate study by Serfaty and colleagues (Serfaty, Entin, & Volpe, 1993), researchers also found that teams communicated significantly less under stress. However, they

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also found a relationship between stress and increased implicit coordination, or the ability to anticipate each other's needs without overt communication (Serfaty et al., 1993). For teams that are able to coordinate without communication, a decrease in communication may have less severe effects on performance (Entin & Serfaty, 1999).

**Overall effects on performance.** Driskell and Salas wrote "the deleterious effects of stress on human performance are well documented and have been a focus of research in the social and behavioral sciences for a number of years" (1991, p. 473). With few exceptions, the empirical studies cited in the sections on cognitive and social reactions to stress also revealed performance decrements. When this was not the case (Chajut & Algom, 2003; O'Malley & Gallas, 1977), the task at hand was a Stroop Task, which is relatively simple and includes no elements of ambiguity, threat, or risk. This is in contrast to most team performance tasks, which are often complex and dynamic in nature (Burke et al., 2008).

Concerning the cognitive effects of stress, studies generally show a negative relationship with performance outcomes for both laboratory and natural stress (Starke & Brand, 2012). This may be attributed to changes in specific cognitive processes, such as attention, memory, and strategy use. The current literature suggests that stress narrows attention, impairs declarative memory, and results in the use of dysfunctional decision strategies. Distraction stemming from attention paid to physiological or emotional symptoms of stress may also damage performance.

Concerning the social effects of stress, research also shows a negative relationship with performance (Driskell et al., 1999). Among the contributing factors may be increased attention focused on oneself, rather than on teammates, and a decline in team communication. It is likely that these effects stem from the cognitive decrements associated with stress (Salas et al., 1996).

Whatever their origins, impaired communication and coordination of operations will inevitably

result in diminished performance outcomes.

# A MODEL OF TEAM DECISION MAKING UNDER STRESS

Using what is known about the team decision making process and the effects of stress on performance, a model of team decision making under stress has been developed (see Appendix, Figure 1). To support this model, I offer several propositions based to the current understanding of stress and team decision making.

**The Effects of Stress on Cognitive and Teamwork Processes**

The effects of stress on a number of cognitive processes have been well documented in the literature on individual performance (Salas et al., 1996; Starke & Brand, 2012) Among these effects are attentional narrowing, declarative memory deficits, and increasing dysfunctional strategy use. Following previous research findings, I believe that stress will negatively affect these cognitive processes.

> Proposition 1: Stress is related negatively related to breadth of attention and declarative memory functioning; stress is positively related to dysfunctional strategy use.

In addition to the cognitive effects, stress also appears to have a negative effect on social behavior (Salas et al., 1996). Team processes, the interactions among team members that contribute to successes (Sonesh et al., 2013), include the essential processes of team communication and coordination. Under stress, these processes are compromised by an increased focus on the individual, at the expense of a team focus. For this reason, I believe that stress negatively affects the teamwork processes of communication and coordination.

Proposition 2: Stress is related negatively related to team communication and team coordination.

**The Team Decision Making Process**

To reiterate the conclusions of first portion of this paper, team decision making appears to be multi-phasic, multi-level, dynamic, and cyclical. The model of team decision making under stress has been developed in conjunction with these characteristics, to best represent how teams make decisions on the job. It contains four phases: perception of the situation, development of individual mental models, development of shared mental models, and the team decision.

The first phase, perception of the situation, represents how individual team members take in and interpret the environment and task at hand (Efron, 1969). How team members perceive the situation will inevitably affect their mental models (i.e., their working mental representations) regarding the situation, environment, and task (Johnson-Laird, 1980). This is shown in the second phase of the decision process. In the third stage, individual mental models are shared and accepted among team members, building a system of shared mental models (Mathieu, Heffner, Goodwin, Salas, & Cannon-Bowers, 2000). In the final stage, shared mental models inform team decisions. I suggest that how accurately teams have perceived, mentally represented, and integrated these representations will affect the quality of their decision (i.e. how similar the team's decision is to the ideal decision or the ones with the best outcomes).

In line with earlier conclusions, this model of decision making is also cyclical. As teams make decisions and learn from decisions outcomes, this may inform how they perceive future information, incorporate it into their mental models, and share mental representations. Moreover,

the decision making process is also dynamic, in the sense that it is not necessarily linear. As teams perform, they are continually receiving information from the environment to be incorporated into member's individual mental models and shared with the team. Teams may move back and forth in the decision process many times taking in new information as they go, before making any decisions. This model is also representative of a multi-level process, as some stages are purely individual (i.e., perception and individual mental model building), while others occur at the team-level (i.e., shared mental model building and team decision making).

Proposition 3: The accuracy of team member situational perceptions affects the accuracy of team member models.

Proposition 4: The accuracy of team member mental models affects the accuracy of team shared mental models.

Proposition 5: The accuracy of team shared mental models affect the quality of team decisions.

Propositions 6: The outcomes of team decisions will affect future team member perceptions.

**The Relationship Between Cognitive and Teamwork Processes and Team Decision Making**

Team decision making appears to necessitate the use both individual cognitive processes

and team processes. However, in order to make decisions as an integrated unit, teams need to be able to think and process information at a team level. In the words of Cooke and colleagues, "team cognition is more than the sum of the cognition of the individual team members. Instead, team cognition emerges from the interplay of the individual cognition of each team member and team process behaviors" (Cooke, Salas, Kiekel & Bell, 2004, p.4). In line with this reasoning, I propose that as teams make decisions, individual cognition is shared with the team through team processing.

Proposition 7: The individual cognitive processes that are involved in team decision making (i.e., attention, memory, and strategy use) are positively related to the team processes involved in team decision making (i.e., communication and coordination).

Team decision making, as a form of team cognition, is affected by cognitive and team processing (Cooke et al., 2004). Therefore, I suggest that these processes may act as coordinating mechanisms facilitating movements through the decision making process. In practice, this translates to a mediation relationship between these processes and accuracy/quality at each stage of the decision process.

Proposition 8: Team member cognitive processes (i.e., attention, memory, and strategy use) mediate all relationships involving the accuracy/quality of individual-level phases of team decision making (i.e., team member situational perception and team member mental models).

Proposition 9: Team processes (i.e., communication and coordination) mediate all

relationships involving the accuracy/quality team-level phases of team decision making

(i.e., team shared mental models and team decisions).

# DISCUSSION OF TEAM DECISION MAKING UNDER STRESS

Teams make decisions in a variety of contexts and environments. Unfortunately, many of these contexts involve common stressors, including time pressure, ambiguity, and personal threat. This is concerning given the high risks often associated with very stressful contexts. When the team in question is preforming a surgery, flying a plane, or rescuing those in eminent danger, they must be able to make good decisions. Using what research has found regarding stress and performance and the team decision making framework, I have developed a model of team decision making under stress. The model proposes relationships between perceived stress, cognitive and team processes, and the team decision making process.

**Research Directions**

A critical first step in future research will be to test the propositions associated with the model of team decision making under stress. Moreover, additional empirical research should be done to further analyze the relationships between the constructs discussed as part of the model. While the current model names a few specific processes that have been particularly well researched, there are many more that may affect team decision making. Future studies may aim to investigate these processes, and their respective relationships with stress and decision making. Additionally, it may be the case that some of the processes mentioned in this model (i.e., attention, memory, strategy use, team communication, and team coordination) are affected by stress more or less than the others. Further, different processes may impact the decision making process more or less severely.

An additional concern is the differences in decision making between teams with different tasks and goals. While this model was intended to apply broadly to all teams experiencing stress,

it may be the case that the decision process varies between types of teams and types of tasks. The cognitive and team processes that are important to decision making in one context may be very different than the processes that are important in another context. Further investigation into this line of research will be central to answering these questions.

**Practical Application**

The model for team decision making under stress may help to inform selection and training programs in fields where stressful conditions are common. Because stress can negatively impact decision making at both the individual (Brand & Starcke, 2012) and team level (Burke et al., 2008), it is important to do everything possible to combat these decrements. Both team selection (Bell, 2007) and training (Salas et al., 2007) recommend considering the environment in which teams perform. If a team is regularly tasked with performing in stressful environments, selection and training methods should ideally be tailored to this environment in order to make it as relevant and applicable as possible. The team decision making under stress model can help to identify where decision making goes awry. It could be that the biggest losses in decision making quality are occurring at the individual level or at the team level, either by affecting the processes through which team members acquire and assess information, by affecting their perception of the situation, their mental representations of the situation, or their ability to convert accurate representations to good decisions. When these problem areas are identified, training and new member selection can be targeted to impact them most efficiently.

**Conclusion**

As teams become more relevant in the workplace, it is important to understand how they work together to make decisions. I have taken an important step forward by reviewing the

literature on team decision making. Additionally, the information summarized in this review was used to guide the development of a team decision making model that applies to teams under stress. This research has aimed to promote and inform future investigation into the team decision making process as a whole, as well as in the area of team decision making under stress.

# APPENDIX A: TABLES

*Table 1. The characteristics that describe the team decision making process*

| Characteristic | Explanation | Supporting Models |
|---|---|---|
| Multi-level | Occurs in a series of phases or steps that include situational assessment and analysis before reaching a decision | Brodbeck et al., 2007; Hollenbeck et al., 1995; Sonesh et al., 2013; Thordsen et al., 2002; Zsambok et al., 1992 |
| Multi-phasic | Information must flow from the environment to individual to the team in order to inform a team decision | Hollenbeck et al., 1995; Sonesh et al., 2013; Thordsen et al., 2002; Zsambok et al., 1992 |
| Dynamic | Does not need to move linearly, can move back and forth across levels and phases | Sonesh et al., 2013; Zsambok et al., 1992 |
| Cyclical | As teams make decisions, they gain experience that can inform and aid future decision making | Sonesh et al., 2013 |

**APPENDIX B: FIGURES**

*Figure 1. The proposed model of team decision making under stress*
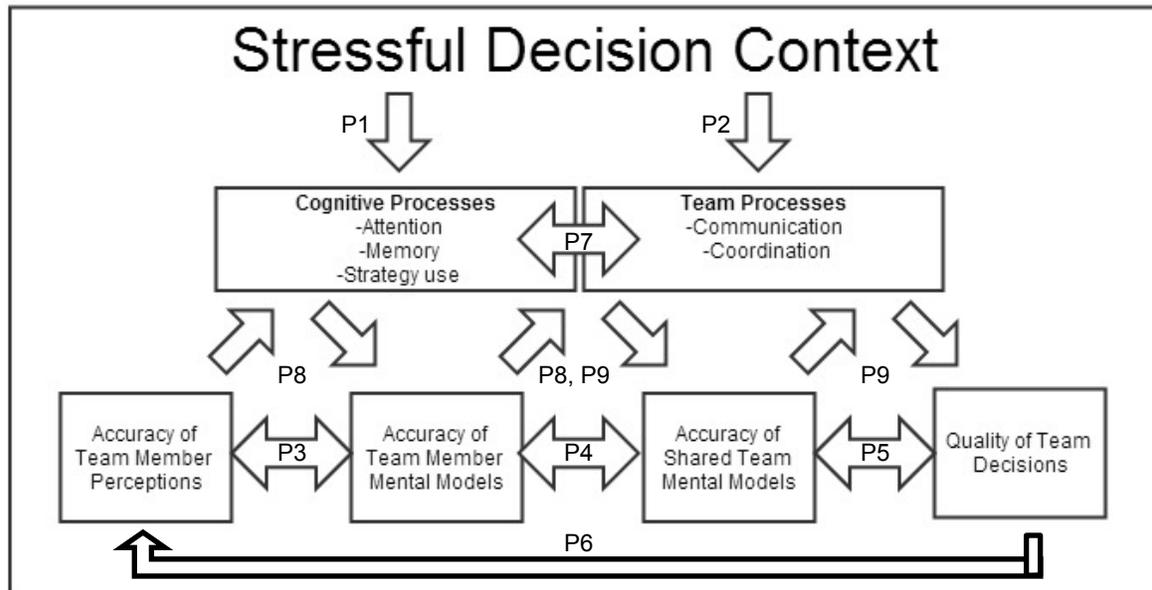
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