12-2021

Utilizing the RADSM Process: Developing an Unobtrusive Measure of Cohesion

Zachary Lee Rahner

Utilizing the RADSM Process:

Developing an Unobtrusive Measure of Cohesion

by

Zachary Lee Rahner

A thesis submitted to the School of Psychology at
Florida Institute of Technology
in partial fulfillment of the requirements
for the degree of

Master of Science
in
Industrial/Organizational Psychology

Melbourne, Florida
December, 2021

We the undersigned committee hereby approve the attached thesis,
"Utilizing the RADSM Process:
Developing an Unobtrusive Measure of Cohesion"
by
Zachary Lee Rahner

_____

Amanda L. Thayer, Ph.D.
Assistant Professor
School of Psychology
Major Advisor

_____

Jessica L. Wildman, Ph.D.
Associate Professor
School of Psychology

_____

Meredith Carroll, Ph.D.
Professor
College of Aeronautics

_____

Robert A. Taylor, Ph.D.
Professor and Interim Dean
College of Psychology and Liberal Arts

Abstract

Title:
Utilizing the RADSM Process:
Developing an Unobtrusive Measure of Cohesion

Author:
Zachary Lee Rahner

Major Advisor:
Amanda L. Thayer, Ph.D.

In this study, verbal indicators produced following the RADSM process were used to code transcript data collected from 62 three-person teams playing a cooperative bridge crew simulator. A training dataset, consisting of 88 mission transcripts, and a testing dataset, consisting of 39 mission transcripts, were created from the data. Multilevel modeling was employed to develop a linear-regression algorithm to predict/measure team task and social cohesion. The findings revealed that task cohesion perceptions are linked to the proportion of speech dedicated to information requests and instructions, whereas social cohesion perceptions are associated with the proportion of speech dedicated to amusing and humoring others. Although the regression equations did not demonstrate convergent validity, these findings provide a foundation for future iterations.

Keywords: cohesion, groups, unobtrusive, non-obtrusive, RADSM, measurement, development, validation, assessment, teams, teamwork, cohesiveness

Table of Contents

List of Figures

List of Tables

Acknowledgment

Foremost, I would like to express my sincere gratitude to Erica Medrano for her contribution developing the indicators and coding behavioral transcripts. Without her countless hours of contribution, this study would not have been possible. I am also grateful for my supervisor, Dr. Amanda Thayer, for her much-needed guidance and support. Special thanks go to Dr. John Mathieu for providing access to the data.

The research described herein was sponsored by NASA (Grant No. NNX11AR22G) and the U.S. Army Research Institute for the Behavioral and Social Sciences, Department of the Army (Cooperative Agreement No. W911NF-19-2-0173). The views, opinions, and/or findings contained in this paper are those of the author and should not be construed as an official Department of the Army, DOD, NASA, or U.S. Government position, policy, or decision, unless so designated by other documents.

Chapter 1: Introduction

Military leaders have long recognized the importance of cohesion for unit effectiveness and efficient operations both within and outside of active combat. As SME Glen Morrell observed, "what we have learned and relearned in our Army is that unit cohesion and teamwork are what give individual soldiers the confidence to use initiative, to be resourceful, and to be all they can be." As evidenced by decades of research into organizational cohesion, this lesson is as true for combat units as it is for all other groups and teams in organizations.

In recent decades, organizations have undergone profound changes to maintain their competitive edge in response to newly emerging markets, technological development, and rapid political and ideological transformation. One such change has been a significant shift towards increasingly collaborative work processes (Kozlowski et al., 2018; Lawler et al., 2001). Such collaborative social systems, perceived to be entities by members and non-members, are rapidly replacing traditional bureaucratic forms of organizing (Hackman, 2012).

Group-oriented workplace structuring offers many benefits to individuals, groups, and organizations as a whole (Severt & Estrada, 2015). The

realization of such benefits, however, depends upon environmental factors, design factors, group processes, and group psychosocial traits (Cohen & Bailey, 1997). Deficiencies in any of these can lead to process loss and, in extreme cases, the dissolution of the group as a whole (Carron & Chelladurai, 1981). Through research into these critical characteristics, psychologists may improve our understanding of groups and teams, allowing us to more effectively influence group formation, socialization, and development to produce maximally effective collaborative work systems.

Numerous authors have described cohesion as the most important small group variable (e.g., Golembiewski, 1962; Lott & Lott, 1965), and it is one of many critical variables that, when absent, impairs team functioning. Accordingly, cohesion is one of the most readily researched constructs associated with group performance and effectiveness (Rosh et al., 2012). This is in large part due to the well-established meta-analytic findings suggesting that team cohesion is a critical antecedent to a variety of outcomes such as group performance (Beal et al., 2003), team motivation and effort (Greene, 1989), individual well-being (Bliese & Halverson, 1996), group member satisfaction, and willingness to continue working together in the future (Severt & Estrada, 2015).

Although cohesion has been one of the oldest studied team constructs, and remains one of the most widely researched concepts in contemporary

organizational literature, we still know little about its development, antecedents, stability, and dynamic interactions with other team processes and critical outcomes (Grossman, 2014; Santoro et al., 2015). The lack of understanding is due, in part, to historical misspecification, measurement limitations, and researchers' reluctance to adopt more advanced statistical techniques (Griffith, 1988; Santoro et al., 2015). Despite the fact that available research indicates that cohesion is a multidimensional construct that emerges over time, researchers continue to rely on rather simplistic unidimensional and bidimensional self-report measures that fail to capture the construct's complexity and temporal dynamics. Flexible continuous assessment tools are needed to understand how cohesion emerges and changes over time, what factors influence the emergence and change, and how cohesive teams operate differently from less cohesive teams.

Furthermore, these traditional self-report methods are considered obtrusive, meaning that they interrupt ongoing processes and require the participants' cooperation. It is possible that these interruptions may influence the phenomenon of interest and even change its nature (McClurg et al., 2017). Moreover, in some team environments, interrupting ongoing processes is not feasible, such as in the case of extreme teams.

Extreme teams are characterized by atypical operational environments, including factors such as extreme time pressure, danger, or isolation (Bell et al.,

2018). In extreme teams, the consequences of teamwork or judgment errors are likely to be catastrophic (Bell et al., 2018). For example, surgical teams operate in high-intensity environments in which performance cannot be interrupted, and teamwork errors have the potential to lead to loss of life. In this example, it is practically impossible to halt team processes and administer a self-report measure. Other examples of extreme teams include aviation teams, space teams, and military teams (Santoro et al., 2015). As long as research into cohesion remains dominated by cross-sectional research designs and traditional obtrusive self-report measures, researchers will continue to miss many of the processes and dynamics that inform our understanding of, and our ability to influence, cohesion.

Over 50 years have passed since Webb, Campbell, Schwartz, and Sechrest (1966) wrote their book "Unobtrusive Measures: Nonreactive Research in the Social Sciences." This work laments social scientists' over-reliance on a narrow range of methodologies. Like many authors before them, they highlight the many limitations of traditional methods. Their primary critique is not that researchers should use one measurement method over another, but that they must develop supplementary measures to complement the use of interviews and questionnaires. The overreliance on any one measure inherently fails to capture all the knowledge of interest and consequently, diminishes the strength of arguments made from such research (Campbell &

Fiske, 1959). Although numerous researchers recognize the need to use an assortment of methods, as long as they lack exposure to such methods, they will continue to use the approaches that they are most comfortable with and which they see as most prevalent in the field (Webb & Weick, 1979; Hill et al., 2014).

In the 54 years since the publication of their book, several technological advances have made their suggestions more feasible than ever before. Advances and innovations relating to digital recording equipment, computing power, and statistical techniques allow researchers to capture and analyze data not readily attainable using conventional tools. Nevertheless, researchers continue to use the narrow range of methods with which they are most familiar. Despite strengths in traditional psychometric scale development, the field lacks a readily accepted standardized development and validation process for unobtrusive measures, or measures that do not require respondent participation. Consequently, there is a lack of notable exemplar papers detailing the step-by-step development and validation of unobtrusive measures for a prevalent construct.

The following thesis serves as an attempt to address both factors. Thus, the aims of this study are two-fold. First, the study intends to demonstrate the effectiveness of the RADSM process as a method for developing unobtrusive measures. By utilizing the RADSM process, researchers and practitioners can relinquish their reliance on purely data-driven approaches and incorporate

theory and contextual expertise more fully in the measurement development process. Second, the study aims to lay the groundwork and provide direction for future multimodal unobtrusive measures of cohesion through the development and validation of verbal indicators of cohesion. If able to effectively demonstrate the value of using semantic content analytic techniques, this study has the potential to persuade future researchers to use a similar top-down approach to developing semantic indicators of other group constructs.

In the following chapters, I introduce the theoretical foundations of one of the most critical characteristics associated with group effectiveness, cohesion. I then review the specific methods that have previously been used to conduct cohesion research and analysis. Following this review, I provide an overview of current approaches to unobtrusively measuring psychological constructs and how they may be especially effective for cohesion research.

After providing the necessary context, I move on to describe the systematic procedure that will be utilized to develop my own unobtrusive measure of cohesion. I provide a step-by-step breakdown of the process that will be followed in development of this measure, highlighting some of the critical decisions to be made throughout this process. The paper concludes with a summary of the anticipated findings, as well as a discussion of their potential implications.

Chapter 2: Theoretical Background

Group Cohesion

Our understanding of cohesion in the field of psychology can be accredited to the early theories of Kurt Lewin and his students (Lewin, 1935). In the mid-1930s, Kurt Lewin proposed that individuals in groups endure "forces," or psychological factors, that influence their adherence to others within the group (Lewin, 1935). Lewin argued that it was these forces that govern a group's willingness to remain united in pursuit of their goals. One of Lewin's students, Leon Festinger, and his colleagues (1950), expanded upon Lewin's original psychological adhesion principle. They proposed that group cohesion refers to the "total field of forces," including both attraction and repulsion forces, which act on members to remain in the group (Festinger et al., 1950, p. 37).

This "field of forces" definition of cohesion pioneered the notion that cohesion is a multidimensional construct (Dion, 2000). These authors concluded that the "forces" acting on members fall into one of two classes (Festinger, 1950). The first class includes forces relating to the attractiveness of the group. The second class refers to the extent to which the group mediates goals for its members, referred to as "means control." These two classifications

have closely resembled many of the bi-dimensional models of cohesion that have since been proposed (Dion, 2000).

Cohesion, according to most prominent cohesion models, is composed of both attraction to the task (task cohesion) and attraction to the social bonds that membership provides (social cohesion) (Severt & Estrada, 2015). This early bidimensional differentiation most often credited to the work of Mikalachki (1969) has received a great deal of empirical support (e.g , Carron et al., 1985; Mikalachki, 1969; Siebold, 2006; Zaccaro & Lowe, 1988). Along with the widely accepted dimensions of social and task cohesion, prominent cohesion theorists have proposed a third dimension termed group pride (Beal et al., 2003; Festinger et al., 1950). This group pride dimension references the extent to which members of a team agree with, or identify with, the ideologies that the group represents (Beal et al., 2003). It's this dimension that allows a team to persist as a recognizable entity despite member turnover (Salas et al., 2015).

Our modern understanding of cohesion has developed considerably since Lewin's early formulation of the concept. Severt and Estrada (2015) synthesized prominent early theories of cohesion, addressed modern criticisms (e.g. level misalignment, precarious factor structures, and a lack of theoretically relevant dimensions), and incorporated proposed improvements into their integrative framework. This framework allows for the differentiation of

cohesion into eight conceptually separate classifications, and can be further distinguished according to the relatedness (group members, group as a whole, boundary spanner) of the interacting parties. Figures 1 and 2 provide visual representations of this framework.

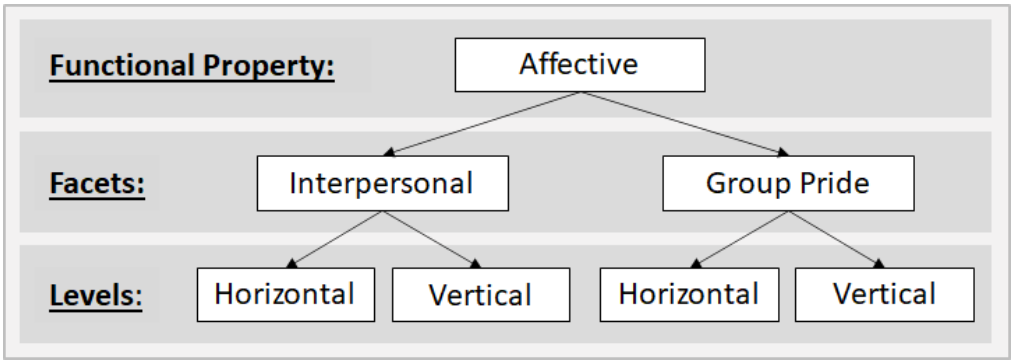

Figure 1. Affective Function of Severt and Estrada's integrative framework of cohesion (adapted from Severt & Estrada, 2015)

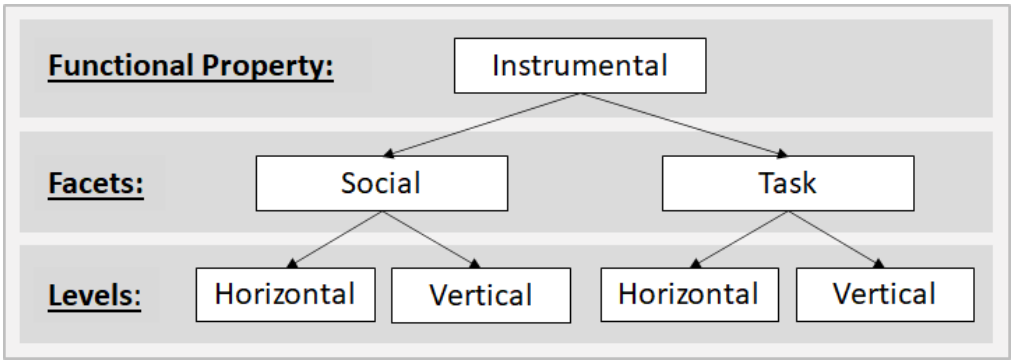

Figure 2. Instrumental Function of Severt and Estrada's integrative framework of cohesion (adapted from Severt & Estrada, 2015)

First, Severt and Estrada (2015) propose that cohesion can be differentiated into two classes depending upon its function for individuals and teams. Cohesion has two main functions: an instrumental function and an affective function (Severt & Estrada, 2015). The instrumental function refers to aspects of cohesion that propel the group to achieve its goals. Through this function, groups are kept intact, and members are motivated to accomplish their tasks. Much of what we know about cohesion comes from our understanding of cohesion's instrumental function, as modern research has prioritized the exploration of this function since it relates most directly to tangible outcomes, and the benefits of promoting task accomplishment are self-evident.

In addition to facilitating task completion, cohesion serves an affective function for individuals within the group. The affective function refers to the aspects of cohesion related to the emotional experiences that result from being a member of the group. These emotional experiences originate at the individual level and extend to influence the group as a whole. Empirical evidence has supported this notion that groups provide emotional benefits to their members (Ahronson & Cameron, 2007; Baumeister & Leary, 1995). Theorized to be among these many benefits is the satisfaction of our fundamental need to belong (Baumeister & Leary, 1995).

Each of these functions are further differentiated into two separate facets. For the instrumental function, these facets are task cohesion and social

cohesion (Severt & Estrada, 2015). Task cohesion refers to group members mutual commitment to perform the group's tasks to the best of their abilities (Brawley, Carron, & Widmeyer, 1993), and social cohesion refers to the social bonds that develop between group members that are "bound by the group's working relationship" (Severt & Estrada, 2015, p. 11). Considerable empirical research supports this differentiation, and differential group outcomes are associated with each (e.g., Carron et al., 1985; Griffith, 1988; Mullen & Copper, 1994; Siebold & Kelly, 1988; Zaccaro & McCoy, 1988).

A group with a high level of task cohesion would be characterized as having a shared understanding of the processes needed to complete the task, trust among members that they will perform their duties, and confidence that others can execute their roles effectively. On the other hand, social cohesion would be characterized by team members sharing feelings of liking, attraction, and trust. As group members interact, they develop feelings towards other members of the group. The nature and quality of these emotional bonds ultimately influence members' likelihood of developing and maintaining constructive working relationships. For example, suppose members develop feelings of animosity, repulsion, and distrust. In this case, team members will be less motivated to engage in many of the prosocial behaviors that enable groups to perform optimally (Salas et al., 2015).

In addition to the instrumental function, cohesion also serves an affective function. This function can be split into two facets, a group pride facet, and an interpersonal facet. Group pride refers to the "extent to which group members exhibit liking for the status of the ideologies that the group supports or represents, or the shared importance of being a member of the group" (Beal et al., 2003, p.995). This component allows groups to endure as a distinct entity despite member turnover (Severt & Estrada, 2015). Although the group pride dimension is readily accepted and has received considerable support (Salas et al., 2015), it is infrequently assessed in cohesion research. This is likely attributable to its inconsistent relationship to group performance (Salas et al., 2015).

The second facet of the affective function includes the interpersonal facet. This facet refers to the friendship bonds that develop among group members and satisfy members' fundamental need to belong (Severt & Estrada, 2015). As group members interact, they develop feelings for one another. If these feelings are positive and result in friendship bonds, members will be more willing to continue interacting in the future (Severt & Estrada, 2015). Moreover, these feelings of friendship encourage informal, and sometimes personal, communication (Severt & Estrada, 2015). On occasion, they may even motivate members to interact socially outside of the group context (Chowdhury, 2005).

Each facet of cohesion can be further divided along what Griffith (1988) labeled the "directions of cohesion." Griffith (1988) identified two directions of cohesion: horizontal cohesion and vertical cohesion. Horizontal cohesion refers to cohesion among group members at equal levels of authority. In contrast, vertical cohesion refers to cohesion among members at differing levels of authority, such as cohesion between a superior and a subordinate. The recognition that cohesion exists among different levels in a hierarchy highlights the multilevel nature of cohesion (Severt & Estrada, 2015). For an even more precise description of cohesion, cohesion may be described as occurring between group members, the group as a whole, or group boundary spanners (Severt & Estrada, 2015).

Cohesion as an Emergent Phenomenon

In early research, cohesion was identified and operationalized strictly as a process (Severt & Estrada, 2015). Team process constructs constitute behavioral mechanisms. They occur at the micro level, at identifiable points in time, and they are more visible than team emergent states, which are considered latent psychological phenomena (Carter et al., 2018). However, our modern understanding of cohesion instead presents cohesion as an emergent state (Severt & Estrada, 2015). As is the case with many team emergent states, researchers must avoid misalignment between the theoretical level at which

cohesion is conceptualized, the level of measurement, and the level of analysis (Kozlowski & Klein, 2000).

Emergence, and thereby cohesion, is characterized by three main features (Santoro et al., 2015). Each has implications for cohesion's development and measurement within groups (Kozlowski & Chao, 2012). First, and addressed above, constructs that emerge are multilevel phenomena. Second, emergence is characterized by process mechanisms. And third, emergent phenomena necessitate interaction among team members over time before manifesting as recognizable team properties (Carter et al., 2015).

Influenced by the static IPO model, cohesion has historically been explored from a contextual, top-down perspective (Kozlowski, 2015). This static model of correlational relationships has failed to capture the complex dynamics and the bottom-up emergence that characterize cohesion (Grossman et al., 2015). Cohesion originates at the individual level within team members' cognition/affect, and is influenced by context. As team members interact over time, perceptions converge, and cohesion is formed at the team level as a unified construct (Kozlowski & Klein, 2000; Santoro et al., 2015).

Process mechanisms constitute the "rules" that drive interactions and exchanges among group members (Santoro et al., 2015). As individuals interact, their behaviors are informed by the group's norms and principles (Dion, 2000), which, in turn, influence member interaction (Zhang et al., 2018).

By observing process behaviors and identifying process mechanisms, researchers may infer team states and better understand the factors that drive the emergence of constructs like cohesion (Kozlowski et al., 2018).

The notion that cohesion emerges over time has significant implications for its development and measurement. Cohesion, like all emergent states, is dynamic. Its intensity can vary over time. Just as cohesion can emerge, it can also "demerge" (Santoro et al., 2015). For researchers to accurately capture these complex dynamics, they must take temporal considerations into account, and longitudinal measurement is essential.

Through temporal specificity, researchers can forecast growth trajectories, map fluctuations over time, and identify reciprocal linkages between cohesion and other important emerged properties (Kozlowski, 2015). Traditional measurement methods are inadequate for addressing these complex measurement issues. Rather, researchers must embrace new analytic techniques that allow for the measurement of these complex phenomena over time.

Measuring Cohesion

According to Grossman et al. (2015), "To date, the literature lacks a consistent conceptualization of cohesion, and in turn, a clear, agreed upon approach to measuring it" (p. 148). Despite the wealth of literature and studies examining cohesion, extant research has used measurement methods that fail to

capture the previously identified complex dynamics. This lack of quality measurement methods may be partly attributed to the lack of consensus on the "who (what level of measurement is best?), what (what dimensions should be assessed?), when (when, and how often should cohesion be assessed?), where (what dimension is most important in various contexts?), and how (what's the best measurement method to maximize reliability and validity?)" of cohesion (Grossman et al., 2015; Siebold, 1999; Kozlowski & Klein, 2000). There are a variety of cohesion models, and no single model has gained widespread acceptance among a majority of researchers (Cota et al., 1995). Because cohesion has been conceptualized in various ways, our methods for measuring it, aggregating scores, and analyzing the data collected have, similarly, varied widely.

Building off Festinger's loose "total field of forces" definition, early cohesion research primarily assessed cohesion in terms of group attractiveness (Gross & Martin, 1952). In these early studies, participants were asked questions such as how much they liked one another and how much they valued being a member of the group (Gross & Martin, 1952). However, as the field developed, more complex conceptualizations of cohesion emerged.

E.F. Gross (1952) advanced one such conceptualization, arguing that the total field of forces definition did not align with its operationalization as attractiveness, and instead proposed that cohesion be conceptualized as a

group's resistance to disrupting forces. Rather than ask how attractive a group is to each of its members, Gross and Martin (1952) wanted to know how strong of a force would be required to cause group dissolution.

The Gross Cohesion Questionnaire, Developed by E.F. Gross (1957) in his unpublished thesis, dominated cohesion research for the next several decades. However, these early definitions and measures were of little use for modern organizations and functional teams because they were designed to assess cohesion within transient social groups rather than action teams embedded within larger, often hierarchically organized, organizations. Moreover, the measures lacked practical utility, because the obtained results were difficult to compare to quantifiable performance criteria (Siebold, 1999).

In the early 1980s, the conventional method of studying cohesion shifted as research began to focus on multilevel real-world groups with formal leaders, rather than the study of small interpersonal groups, as was popular in social psychology (Seibold, 1999). The applied researchers who were responsible for this shift in understanding and measurement were motivated by their curiosity about the influence of cohesion on tangible outcome criteria (Beal et al., 2003). The most significant advances made during this time period were led by two groups: military researchers and sports psychologists (Seibold, 1999).

Thought to be positively associated with combat effectiveness and survival in military situations, military researchers began investigating factors that predict and threaten cohesion (Griffith, 2012). Much of this research was carried out under the pretense of understanding unit morale, sometimes referred to as "esprit de corps" (Gal, 1986). Unit morale is defined as "a group's collective enthusiasm or its persistence in pursuing common goals under adverse conditions" (Gal, 1986)

Although early research on the concept of morale sought to understand morale from a unitary perspective, the notion of morale was identified as a multidimensional construct upon recommendation by Ingraham and Manning (1981). The concepts of cohesion, individual morale, and esprit were differentiated by these researchers as referring to similar concepts at different levels of analysis. This distinction generated renewed interest in military research on cohesion, particularly as it relates to personnel manning policies. In these studies, cohesion was defined at the group level as "feelings of belonging, of solidarity with a specific set of others who constitute "we" as opposed to "them" (Ingraham and Manning, 1981, p. 6).

Reuven Gal expanded on Ingraham and Manning's (1981) multidimensional perspective by developing the Combat Readiness Morale Questionnaire (CRMQ) for use in the Israeli Military (Gal, 1986). Gal factor analyzed the CRMQ to examine its underlying structure and evaluate its

validity. He ultimately concluded that the CRMQ comprises eight components, one of which is unit cohesion and morale. His findings showed that unit cohesion is a significant determinant of unit morale, and they provided empirical support for Ingraham and Manning's (1981) multidimensional differentiation.

The United States Army is another major producer of military cohesion research. Much of this research is concerned with how to build and sustain unit cohesion. Cohesion was defined in many of these studies as "the degree to which mechanisms of social control operant in a unit maintain a structured pattern of social relationships between unit members, individually and collectively, necessary to achieve the unit's purpose" (Seibold, 1987, p. 5). In contrast to the other measures, this definition defines cohesion at the group level rather than the individual level. The most popular military cohesion questionnaire, the 79-item Combat Platoon Questionnaire, is based on this definition. The Platoon Cohesion Index is a 20-item condensed version of this metric. Each has demonstrated significant promise and has been used by a number of western militaries (Bury, 2018).

The modern understanding and measurement of cohesion in sports psychology, and later other domains, was greatly influenced by Albert Carron (1982, 1985). Carron (1985) employed a conceptual approach to understand cohesion and proposed that cohesion was a multidimensional construct made up

of two broad higher-level dimensions, "task-social" and "individual-group." These dimensions emphasize that, while individuals may be attracted to a group through social bonds and relationships, they may also, sometimes more importantly, be attracted to the group's goals.

Furthermore, Carron identified four major limitations of treating cohesion solely as attraction to the group (Carron, 1982). First, cohesion as attraction ignores the other forces that influence group appeal; group goals. Members are frequently drawn to a team because they want to achieve higher levels of performance, as is the case with sports teams. Second, operationalizing cohesion as attraction "fails to explain cohesiveness in situations characterized by negative affect" (Carron, 1982, p.126). He observed that many sports teams can remain united even when there is little mutual attraction, and there is social tension among members. Third, many groups are not formed based on attraction, but because of a desire to accomplish a particular goal. Finally, he noted that the operationalization of cohesion as attraction failed to garner significant empirical support, and that the evidence appeared to suggest instead, that cohesion is a non-unitary construct.

In response to these criticisms, Carron proposed a new definition of cohesion, which has remained prominent to this day. According to this definition, cohesion is "a dynamic process that is reflected in the tendency for a group to stick together and remain united in the pursuit of its goals and

objectives" (p. 124). By shifting the focus away from just the social dimension, Carron greatly broadened the scope of cohesion research.

This new definition was used to develop the Group Environment Questionnaire (GEQ), an 18-item group cohesion questionnaire (Carron et al., 1985; Seibold 1999). Confirmatory factor analysis of the original GEQ support Carrons proposed four dimensions of team cohesion: personal factors, team factors, leadership factors, and environmental factors. Since then, it has been successfully adapted for use in a variety of non-sport domains, including the workplace (Carless & De Paola, 2000) and the military (Ahronson & Cameron, 2007). However, empirical evidence suggests that the GEQ factor structure varies for groups other than sports groups (Dion, 2000). For example, Carless and DePaola (2000), the authors of the GEQ adapted for work teams, discovered greater support for a three-factor model of cohesion (task cohesion, social cohesion, group attraction) as opposed to Carron's original four-factor model (Carless & De Paola, 2000). Appendix A contains a sample list of classic cohesion measures and their items.

Introduction to Unobtrusive Measurement

Despite the fact that cohesion has been one of the oldest studied team emergent states, we still know very little regarding its antecedents, pattern of development, and dynamic interactions with other team processes and outcomes (Santoro et al., 2015). This is largely due to the limitations of

traditional measurement methods (McClurg et al., 2017). In nearly all cases, cohesion has been measured using either questionnaires or interviews (Siebold, 1999). These classical measures are based solely on individuals' recollection and interpretations of their cognitive, motivational, affective, and behavioral reactions to a particular event (Kozlowski, 2015). Although these measures tend to provide valuable insight into participants' cognition, they still have considerable limitations (Kozlowski, 2015).

Traditional survey approaches are vulnerable to measurement error (not accurately measuring what a survey is supposed to measure), non-response error (when respondents' characteristics differ from those of nonrespondents), and more (Visser et al., 2000; Reiter, 2017; Kozlowski et al., 2018). There is considerable variation in what information individuals attend to and how they process, encode, and integrate information with their existing knowledge. This variation affects social perception, judgment, and behavior. Consequently, when confronted with complex judgment tasks, such as questionnaires or interviews, individuals' responses are unlikely to be perfectly reliable or accurate (Morgeson & Campion, 1997).

Measurement error can result from several sources (Reiter, 2017). First, individuals may interpret words and questions differently than initially intended by the measure developer. Second, individuals may intentionally distort their responses because they fear that they may reflect negatively upon them. Lastly,

individuals may not respond to a particular item accurately because they lack the necessary information or understanding to do so. While in some cases, this may simply refer to a lack of knowledge, in others, this may involve information processing errors. For example, even when attempting to represent their cognitive processes accurately, individuals tend to base decisions on information that is readily available in their memory, which is influenced by factors such as vividness and recency (Tversky & Kahneman, 1974).

Additionally, missing data is a ubiquitous part of using traditional measurement methods. Although there are retroactive strategies for handling missing responses, such as modifying survey weights and imputation, these strategies are imperfect solutions (SIOP, 2018). In worst-case scenarios, the characteristics of the respondents may differ systematically from those of the non-respondents. In this instance, non-response error is likely, and the inferences made from the sample data are potentially biased (Reiter, 2017).

When considering emergent team phenomena, the phenomena's pattern or intensity is expected to vary over time (Santoro et al., 2015). Capturing this variation using traditional methods requires longitudinal assessment. Researchers must select a sampling frequency that maximizes research value and minimizes effort or expense. If researchers choose a sampling frequency that is too low, the measure may fail to capture some of the nuance and important variation in the phenomena. However, if the sampling rate is too

high, the measurement method will be inefficient and is more likely to lead to fatigue and response patterns among participants.

Although the need for an alternative mode of unobtrusive measurement is evident in the case of extreme teams, unobtrusive measures could also help address the previously mentioned limitations of traditional measurement methods (Hill et al., 2014). Indeed, unobtrusive measures have several strengths above traditional methods (Hill et al., 2014). The first primary advantage of using unobtrusive measures is that such measures are more likely to capture participants' natural behaviors as opposed to contrived behavior in response to demand characteristics. In comparison to conventional obtrusive methods, participants are less likely to infer the study's intent and the precise behaviors being assessed, thereby making it more difficult for subjects to alter their behaviors in self-serving and atypical ways (Kazdin, 1979).

The use of obtrusive measures may increase the likelihood that individuals will selectively withhold or share information depending on the perceived intent of the investigation. When participants perceive that accurate responses may threaten their own self-image or others' impressions of themselves, they are likely to selectively alter their responses to account (Day et al., 2002). This is especially problematic when individuals are not willing participants, as is sometimes the case in organizational settings (Hausdorf et al., 2014).

The second advantage of using unobtrusive measures is that it alleviates one of the most persistent psychological research concerns: common method bias (Hill et al., 2014). Common method bias occurs when the instrument used to capture responses induces variation in responses itself, rather than reflecting respondents' actual standing on the construct that the instrument seeks to assess (Podsakoff et al., 2003). And therefore, the commonly employed approach of using multiple measures with the same method/source creates problems because when all data is collected from the same respondents using the same method, any observed correlations between variables may be due to common method variance, rather than reflect a true relationship between the constructs. As all traditional self-report methods require participant self-reflection, which can be biased, the influence of common method variance is particularly concerning for traditional obtrusive survey methods (Spector, 2006).

Third, unobtrusive measures allow researchers to study phenomena in settings where traditional obtrusive measurement is impractical. In some cases, unobtrusive analysis may be less expensive, more efficient, and less disruptive than obtrusive analysis. Pausing ongoing activities to collect respondent feedback in many settings may be prohibitively costly in both monetary (pausing production), and non-monetary terms (health and safety of respondents or stakeholders, such as soldiers in combat or patients in operating rooms). As unobtrusive data collection tools become less expensive, and

unobtrusive data becomes more widely available, researchers are becoming increasingly able to evaluate psychological constructs in previously inaccessible settings.

The fourth advantage of unobtrusive measures over traditional measures relates to their perceived face validity (Johannes et al., 2015). When research success depends upon participant support, face validity is a critical concern. In situations where participants expect the assessment results to affect them, they may be less trusting of traditional items and measures. Participants are likely to regard unobtrusive measures as more objective than those that require subjective reflection, as such measures are often perceived as less prone to judgment errors or rating biases (i.e. leniency, halo, etc.).

Following Hill et al., 2014, I classify unobtrusive measures into two broad categories based on their information source: behavior-based measures and language-based measures. Behavior-based measures are measures that assess constructs using nonverbal behavioral indicators. Language-based measures, on the other hand, are measures employed to assess constructs using written or spoken words (Hill et al., 2014).

Behavior-based measures. Behavior-based measures may be used to assess individuals' and groups' standing on a particular construct (Hill et al., 2014). For individuals, they are based on the assumption that individuals' behaviors provide insight into the psychological factors that motivate action.

For groups, it's based on the belief that collective-level behavior is partially indicative of the individual members' psychological processes and can be used to infer group-level constructs. Common behavioral-based measures include external observation, social network analysis, and physiological indicators, while more modern techniques employ "big data," machine learning, and automated video content analysis (Salas et al., 2015; Hill et al., 2014).

Some of the earliest unobtrusive behavioral research is based simply on manual external observation. It is well established that individuals can observe behavioral patterns, identify rules that govern those patterns, and use those rules to anticipate and interpret others' behaviors (Terada & Yamada, 2017). When observers are knowledgeable about a team and its members, they can often accurately estimate the team's standing on a particular construct without needing to assess each team member's individual perceptions (Grossman et al., 2015). Additionally, external observers may be used to code pre-recorded group interactions, and the resulting data may be analyzed to infer team processes and states.

Manual external observation is popular due to its relative ease. Audio and video recording and coding can be used to produce large amounts of data with little interruption to ongoing processes, it can be used in a wide variety of structured and unstructured situations, and it's cost-efficient (Kozlowski, 2015). However, manual observation also has its limitations. Without effective

scenario design, coding system design, and effective coder training and monitoring, observation is unlikely to be effective (Santoro et al., 2015). Additionally, the coding of pre-recorded material has high labor costs; the number of observers depends on the number of observed subjects, the number of events, and the duration of observations (Kozlowski et al., 2018). When there are many participants and many events, researchers may lack the resources necessary to code all observations.

In the case of specific non-verbal behaviors like location, gaze, posture, and head and body movements, manual coding is time-consuming and subjective (Bhattacharya, 2018). Researchers have recently begun to employ supervised learning algorithms and advanced techniques such as convolutional neural networks and gesture and locomotion tracking software to automatically classify and code non-verbal behavior (Bhattacharya, 2018; Frauendorfer et al., 2014). As these techniques become more popular, researchers will have access to large amounts of novel data, which may be used to predict various psychological states.

With our modern ability to gather and store large amounts of communication metadata and the introduction of affordable wearable social sensing platforms, social network analysis is becoming an increasingly common method to assess constructs in groups and teams (Zhang et al., 2018). Sociometric electronic tags and communication data allow researchers to track

team member temporal proximity, interaction duration, and interaction frequency (Eys & Brawley, 2018; Olguin et al., 2009; Olguin & Pentland, 2010). This data, in combination with machine learning algorithms show significant promise in our ability to identify emergent constructs (Coultas et al., 2014; Matusik et al., 2019).

Psychophysiological indices are another set of increasingly common behavioral indicators (DeCostanza et al., 2018). These measures use technology to directly or indirectly measure the properties and functions of biological systems' such as heart rate, blood pressure, galvanic skin response, hormone levels, and cortical activity (DeCostanza et al., 2018). Their use is based on the fundamental assumption that psychological states can be understood through changes in biological systems (Allen, 2017). Taken together, each of the tools and techniques previously discussed can be used on their own, or in combination with other modes of measurement to assess psychological states and processes from observable behavior.

Language-based measures. The second class of unobtrusive measures includes language-based measures, which rely on the analysis of verbal and textual communication (Hill et al., 2014). Language data gathered from audio recordings and electronic distributed group communication can be analyzed in two ways. Both methods are based on the assumption that an individual's linguistic style is indicative of their psychological processes (Hill et al., 2014).

The first technique includes the analysis of low-level features of communication, such as vocal activity, intensity, duration, and interruptions. The second includes more thorough analysis, using semantic content analytic techniques. However, use of this second method is less frequent, as words may have different meanings based on context, and therefore, requires expert understanding of the construct under investigation (Santoro et al., 2015).

Modern approaches. It has long been established that cohesion can be effectively estimated using external observers familiar with the team (Salas et al., 2015). Using supervised machine learning, researchers, primarily data scientists, have identified behavioral and language-based features that relate to the cohesiveness of groups (Maman et al., 2020). In recent years, researchers have begun to employ more novel unobtrusive methods and statistical techniques.

Recent approaches for estimating team cohesiveness include automated examination of big data, assessment of interaction patterns, automated behavioral analysis, and both low-level and content analytic language analysis techniques (Brzozowski, 2009; Ghosh et al., 2018; Hung & Gatica-Perez, 2010; Nanninga et al., 2017; Salas et al., 2015; Zhu et al., 2019). As this research has relied primarily on a bottom-up approach, it lacks much of the critical validity analyses typically employed when developing measures using a rational top-down approach (Orvis et al., 2013). For example, many of the measures using

these techniques lack construct validity. In order to establish construct validity, theory must be incorporated into the unobtrusive measurement development process, and convergent and discriminant validity must be demonstrated (DeCostanza et al., 2018).

As video and image content analytic software becomes more efficient and accessible, researchers have begun to use these automated tools to quantify behavior. Some cohesion researchers have used these tools to annotate observed behaviors, producing data that may be used in traditional quantitative analysis (e.g. Hung & Gatica-Perez, 2010; Bhattacharya, 2018). For example, Hung and Gatica-Perez (2010) used automated analysis to quantify participants' raw visual activity (physical movement) and used it as a predictor in a cohesion estimation model. Others employ more opaque methods, utilizing convolutional neural networks, and supervised learning algorithms, which both produce results based on machine learning "judgments" that are difficult to quantify and interpret (e.g. Ghosh et al., 2018, Kennedy & McComb, 2014). In one notable example, Ghosh and colleagues (2018) used a multi-task convolutional neural network to analyze group images, extract facial features, and predict perceived cohesiveness. Impressively, this model predicted teams' perceived cohesiveness nearly as effectively as human raters (Ghosh et al., 2018).

Researchers have also successfully used interaction pattern analysis to approximate group cohesiveness (Zhang et al., 2018). As it becomes

increasingly easy to access and store interaction data and wearable social sensors become more affordable, an increasing number of researchers are exploring how interaction patterns can be used to provide insights into team states. In one notable example, Zhang et al. (2018) collected social interaction data of six group members as they interacted throughout a four-month simulated space exploration mission. Using machine learning, the researchers successfully trained a binary classification model (negative or positive) to accurately classify cohesion 80% of the time.

Historically, research exploring small groups' behavioral cues has yielded better cohesion predictions than those that use language-based measures (Maman, 2020; Zhang et al., 2018). However, language-based features still contribute to the accuracy of prediction models (Hung & Gatica-Perez, 2010). In cohesion research, low-level features have been the most often assessed language-based measures. Features such as word count, pauses during communication, turn length, overlapping speech, and prosody (e.g. intonation, stress, and rhythm) have all been found to contribute to model accuracy (Hung & Gatica-Perez, 2010; Nanninga et al., 2017).

A few researchers have employed content analytic techniques in cohesion research (e.g., Castro-Hernández, 2016; Gonzales et al., 2010). These techniques commonly employ Linguistic Inquiry and Word Count (LIWC) dictionaries to assess cohesion. LIWC dictionaries are collections of words or

phrases chosen by researchers theorized to be related to a particular construct (Tausczik & Pennebaker, 2010). Researchers then use the frequency of words or phrases contained within the LIWC dictionary as a variable in their analysis.

Dictionaries may contain only words from a single category, such as first-person pronouns, which has been found to be negatively related to team cohesiveness, or they may be made up of more complex word sets, which may provide insight with additional computation, as in the use of linguistic style matching algorithms. In linguistic style matching algorithms, the LIWC dictionary comprises nine types of function words: "auxiliary verbs (e.g., to be, to have), articles (e.g., an, the), common adverbs (e.g., hardly, often), personal pronouns (e.g., I, they, we), indefinite pronouns (e.g., it, those), prepositions (e.g., for, after, with), negations (e.g., not, never), conjunctions (e.g., and, but), quantifiers (e.g., many, few)" (Gonzales et al, 2010, p. 5). By calculating mimicry based on the shared use of these function words, researchers may infer approximately 17% of the variation in group cohesiveness (Gonzales et al., 2010).

As demonstrated above, numerous psychologists, frequently in collaboration with data scientists, have explored the subject of predicting emergent states using unobtrusive methods. However, most studies in this field rely solely on a data-driven approach, which fails to provide insight into the reasons for the observed relationships. These bottom-up approaches consider

data availability but largely ignore theory, hypothesis testing, and context (Orvis et al., 2013). Though this research has identified many possible predictors of group cohesion, further research is needed to understand why the relationships exist and how we can use this knowledge to foster and maintain group cohesion in practice.

Chapter 3: Measure Development

Moving Forward: The RADSM Process

In an attempt to integrate subject matter expertise, theory, and validation into this approach, Orvis and colleagues (2013) proposed the Rational Approach to Developing Systems-based Measures (RADSM). Their overall strategy is to incorporate theory, data availability, and a range of multi-disciplinary data analysis methods to develop measures using a combination of top-down and bottom-up approaches. The Top-down approach refers to the process of identifying observable behaviors and attributes that are theoretically relevant to the construct of interest and specific to the environment. The bottom-up approach refers to the process of identifying available systems-based data that relate to the subject of interest and the analysis methods that would enable the researcher to analyze or infer meaning from the system's data. Despite its limited application, the RADSM process has shown great promise. In one case, it was used to successfully develop a valid measure of coordination in a military context (McCormack et al., 2017).

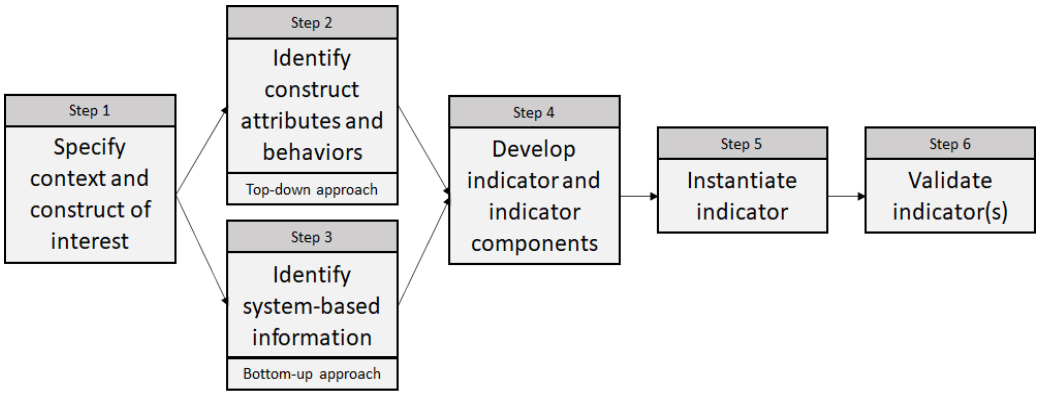

Figure 3. The Rational Approach to Developing Systems-based Measures (adapted from DeCostanza et al., 2018)

The RADSM process is divided into six discrete steps (Figure 3). The first involves the identification of the context and construct of interest. One must have a thorough understanding of what they intend to measure, understand how the construct relates to the context in which it will be observed, and distinguish between the construct of interest from other related constructs.

The second step of the RADSM process incorporates the top-down approach. This entails compiling a list of construct attributes and behaviors that are specific to the context under investigation. It is necessary to seek expert advice during this stage. Subject matter feedback is required to ensure that the construct is fully captured and that contextual nuance is taken into account.

The third step of the RADSM process incorporates the bottom-up approach. This step aims to determine which systems-based information is

available within the specified context. Researchers should then use this information to create a list of all possible types of available data and general analysis methods that could be used to analyze the identified data streams.

The fourth step of the RADSM process integrates the information gathered during steps two and three. In this step, the attributes identified in step two are paired with the data and analyses identified in step three. This process closely resembles the development of survey-based measures, though it differs slightly, as it deals with systems-based items rather than survey items. For each systems-based item, a decision must be made regarding how to aggregate the items into a coherent measure. For example, items may be normalized and averaged together, or they may be combined in a weighted compensatory algorithm. The method of aggregation should also be determined in this step.

The fifth step involves the instantiation of the systems-based metrics. The purpose of this step is to extract all of the available data identified in step four, prep it for final analysis, and store it in a format suitable for use in validation analyses. Instantiation includes data aggregation and preparatory analysis methods such as behavioral coding, content analysis, and social network analysis.

The final step of the RADSM process mirrors the final step of all measurement development processes, that is, the researcher must provide evidence of measure validity. Validity broadly refers to the quality of the

judgements, decisions, and interpretations derived from the use of a measurement (AERA et al., 2014). Although validity is a unitary concept, evidence of validity can be differentiated into three general categories: content validity, criterion-related validity, and construct validity (Binning & Barrett, 1989).

Step 1: Specifying Context and Construct of Interest

Context Specification. The data used for the current study had already been collected by another researcher as part of a NASA-funded study to explore team processes over time. The participants included 247 undergraduate and graduate students (117 male, 128 female, average age M = 19.98 years, SD = 2.64) from a large Southeastern university. Each participant received compensation in the form of monetary remuneration or course credit.

Participants were randomly assigned to 3-person teams (N = 73 teams). Each team played a multiplayer co-operative spaceship simulation game: "Artemis: Spaceship Bridge Simulator" (Robertson, 2010). In this computer-based simulation game, participants were tasked with working as a "flight crew" to control the operation of a "spaceship." The experimental activity was divided into three phases. In the first phase, the team was tasked with navigating the spaceship from point "A" to point "B" while engaging with enemies and avoiding hazardous mines. In the second phase, teams were tasked with following and providing support to a second ally ship while avoiding

mines. In the third and final phase, teams traveled from point “B” back to point “A” through a mine-filled nebula that impaired ship capabilities.

When participants arrived at the experimental site, they were given training for their individually assigned roles and taught how to communicate with other team members. Each participant was instructed to communicate with the other participants only through their microphone-equipped headsets. Participants communicated with other team members by using keyboard commands to open specific "radio" channels. Communication delays ranging from 0 to 10 seconds were gradually implemented and removed over the course of the mission, with the largest delays occurring during phase two. All communication behaviors were documented and timestamped, and all audio was recorded. The audio and timestamps were transcribed and saved in text format.

In the experimental procedure, two design manipulations were used. First, teams were assigned to one of two “governance” conditions: “mission control-governance” or “self-governance.” In both cases, team members could communicate via radio with "mission control," which consisted of a confederate stationed in another room. Participants in the self-governance condition were told that mission control was a source of information, whereas participants in the mission control-governance condition were told that mission control was the leader. Mission control behaved identically, providing little information in

both scenarios. The second experimental manipulation was the presence of, or lack of, a debriefing session between the second and third phases of the simulation. Following the second mission phase, teams in the debrief condition participated in an automated, self-led debrief, while the control condition watched a video about Mars.

Prior to participating in the experimental activity, all participants completed a battery of pre-measures. These measures assessed individuals' knowledge, skills, abilities, other characteristics, and their previous experience with the simulation task. In addition, they were given a variety of individual attitudinal and trait-based measures. At the end of each simulation phase, participants completed another set of questionnaire measures. These questionnaires asked participants questions about various social psychological states, such as cohesion and perceived resiliency. In addition to self-report ratings of various constructs, observers were asked to rate individual team members, and the team as a whole on behavioral constructs such as Marks et al., (2001) transition, action, and interpersonal processes.

Construct Specification. As addressed in the previous section, this study aims to develop and validate an unobtrusive measure of cohesion. As is the case with all attempts at measurement development, the construct of interest must be clearly specified to justify measurement decisions and delineate it from other constructs. Researchers must choose measurement, aggregation, and

analysis methods that align with the stated definition. The first level of specification involves the definitional specification of cohesion.

Cohesion has a long history in psychological research, and many various definitions have been proposed. Although Severt and Estrada's framework of cohesion provides the most comprehensive and theoretically nuanced understanding of cohesion, for the purposes of this study, I will be using a simpler bi-dimensional model. More specifically, I adopt Carron and colleagues' (1985) definition of task cohesion and Shaw's (1981) definition of social cohesion. These definitions are reproduced in Table 1.

There are three reasons for this decision. First, the archival data available for this study is insufficient to evaluate Severt and Estrada's more complex theoretical framework. Within the available archival data, six items adapted from the Moos Group Environment Scale (Moos, 1980) are used to measure cohesion (Mathieu, 1991; Mathieu et al., 2015; Appendix B). Three of the selected items closely align with Carron & colleagues' (1985) definition of task cohesion (e.g., "My team members pull together to accomplish work") and three closely relate to Shaw's (1981) definition of social cohesion (e.g., "There is a feeling of unity and cohesion in my team"). Second, although Severt and Estrada's framework is intuitively appealing, it has received considerably less empirical attention. The bi-dimensional framework that I use instead has

broadly dominated cohesion research, and continuing to use this model, will allow for easier comparison of results across studies (Salas et al., 2015).

It is necessary to select a model that allows for easy comparison across studies, as demonstrating expected empirical relationships between cohesion and other related constructs is a critical component of construct validity. Last, because this is a preliminary attempt at developing an unobtrusive measure of cohesion, it is prudent to choose the most parsimonious model, as minimizing the number of components to be measured will increase statistical power. As future studies replicate and expand upon the current work, a more comprehensive model may be developed.

Table 1. Construct specification and definitions

Construct Specification	Level Specification
Task Cohesion: "An attraction or bonding between group members that is based on a shared commitment to achieving the group's goals and objectives" Carron, Widmeyer, & Brawley (1985)	Task cohesion originates in the perceptions of members at the individual level, as members interact, perceptions converge, and cohesion emerges at the group level. Hence, task cohesion resides at the group level.
Social Cohesion: "A closeness and attraction within the group that is based on social relationships within the group" Shaw (1981)	Social cohesion originates in the perceptions of members at the individual level, as members interact, perceptions converge, and cohesion emerges at the group level. Hence, social cohesion resides at the group level.

Step 2: Identifying Construct Attributes and Behaviors

The second step of the RADSM process involves compiling a list of construct attributes and behaviors. To accomplish this, seven popular cohesion measures were compiled. Upon reviewing each item, 38 attributes of cohesion consistent across items and relevant to the context were identified and classified as relating to either task or social cohesion. These attributes are listed in Table 2, along with a corresponding item from one of the seven cohesion measures.

Of the identified attributes, 16 were most closely related to the task dimension of cohesion. High task cohesion teams are likely to be effective under pressure, have effective processes for reevaluating team goals, and have established clear priorities and objectives. Members in teams with high task cohesion are more likely to have well-defined roles and know what is expected of them, be determined to succeed, desire to develop task knowledge and skills, put what is good for the team ahead of personal desires, believe that the team's goal is important, want to contribute to achieving the team's goals, cooperate efficiently, and be willing to share workloads to maximize team success. The members are also likely to share a focus on the task at hand, may more readily monitor others' behaviors, and may share more task-relevant information.

Of the identified attributes, 22 related most closely to the social dimension of cohesion. In teams with high social cohesion, team members are likely to feel valued and appreciated, feel socially close, feel a sense of

belonging, and feel a strong sense of loyalty to one another. Members of the team are likely to, care for, inspire, encourage, respect, trust, and like one another. They are also likely to derive enjoyment from team membership, pride from group membership, and desire to socialize outside of the task context. They are also expected to have few persistent interpersonal conflicts, provide others with personal and emotional support, take shared responsibility for team outcomes, take individual responsibility for their actions and decisions, be confident in each other's capabilities, be satisfied with their relationships, be open and honest with eachother, and be aware of the team rules and norms.

Table 2: List of cohesion construct attributes

Construct Attributes	**Example Item(s)**	**Relevant Dimension**
Feeling valued/appreciated	"How much do you feel your role or contribution to the team is valued by your teammates?"	Social
Sense of belongingness	"There is a strong feeling of belongingness among my team members."	Social
Feelings of social closeness	"Members of my team feel close to each other."	Social
Membership enjoyment	"How much do you enjoy playing with this particular team?"	Social
Desire for non-work socialization	"Our team would like to spend time together outside of work hours"	Social
Relationship satisfaction	"How satisfied are you with the friendships that you have developed within your team?"	Social
Liking	"Soldiers in this platoon like one another"	Social

Care	“First-termers in this platoon care about each other.”	Social
Group pride	“Soldiers here are proud to be in this platoon.”	Social
Persistent interpersonal conflict	“Conflict never seems to be resolved on our team (i.e. teammates argue a lot and have trouble getting along with one another).”	Social
Honesty and openness	“Being honest, open, and truthful.”	Social
Personal/emotional support	“First-termers in this platoon can get help from their leaders on personal problems.”	Social
Shared responsibility	“We all take responsibility for any loss or poor performance by our team.”	Social
Inspiration	“Do the soldiers in your platoon make each other feel like doing a good job?”	Social
Encouragement	“To what extent do members of your platoon encourage each other to succeed when in the field or at competitions?”	Social
Respect	“First-termers in this platoon really respect one another.”	Social
Loyalty	“Rate the degree of loyalty you have to your team.”	Social
Confidence	“In general, how much confidence do you have in your teammates' capabilities?”	Social
Trust	“Soldiers here can trust one another.”	Social
Individual responsibility	“Taking responsibility for their actions and decisions.”	Social
Clear rules/norms	“In this platoon the behaviors that will get you in trouble are well known.”	Social
Clear roles/expectations	“Rate the degree to which your team has well-defined roles in that each person knows what is expected of them.”	Task
Shared goal importance	“First-term soldiers feel this platoon's wartime mission is very important.”	Task
Desire to contribute	“I'm not happy with the amount of playing time I get”	Task

Effectiveness under pressure	“In general, our team seems to fall apart easily, and lose its intensity in crucial situations (i.e. when the going gets tough).”	Task
Coordination	“To what extent do the members of your platoon pull together and share the load while in the field?”	Task
Desire to improve	“Dedication to learning their job and doing it well.”	Task
Willingness to take charge	“To what extent does someone on your team take charge when things are going bad, which in turn, gets the rest of the team to work together in a coordinated manner.”	Task
Teamwork and cooperation	“There is a very high degree of teamwork and cooperation among first-term soldiers In this platoon.”	Task
Task focus	“Members of my team share a focus on our work.”	Task
Monitoring others	“Leaders keep themselves informed about the progress soldiers are making in their training.”	Task
Information sharing	“The leaders keep their soldiers well informed about what is going on.”	Task
Priority clarity	“The priorities in this platoon are clear.”	Task
Goal clarity	“Do you feel your teammates have a clear understanding of the goals the team is striving to achieve?”	Task
Processes for goal evaluation	“Do you feel your team has an effective method by which to re-evaluate the goals and objectives the team is working toward”	Task
Selflessness	“Putting what is good for their fellow soldiers and mission accomplishment ahead of personal desires.”	Task
Will to win	“How high is the determination or "will" to win in combat in your platoon?”	Task

Step 3: Identifying Systems-based Information

The third step of the RADSM process involves compiling a comprehensive list of all available data, as well as a list of the information that could be extracted from it. Text-based transcripts were the only unobtrusive data available for this study. These transcripts included information regarding who was talking to whom, when they started talking, and what was said.

Step 4: Developing Indicators and Indicator Components

The initial list of indicators was developed in the fourth step by pairing the construct attributes compiled in step two with the available data identified in step three. The experimental task was highly structured, time-bound, and necessitated a high degree of interdependence. These task characteristics constrained behaviors such that participants engaged in very little non-task-related communication. Because the majority of the construct attributes identified in step two refer to perceptions, the lack of subjective perceptual communication hampered the development of precise verbal indicators. Rather than selecting specific statements as indicators, more general verbal behaviors theorized to be associated with the construct attributes, common enough to be present in multiple teams, and sufficiently variable across teams were chosen.

In total, 18 indicators were developed. Nine related to task cohesion and nine to social cohesion. All but one of the indicators, speaker equality, are derived from interpreting the semantic content of speech. Coders were needed

to classify each statement in the transcript as belonging to one of the indicator categories. By calculating the proportion of statements falling into each indicator category, a meaningful team level attribute was derived. Table 3 provides the compiled list of construct indicators, along with their definitions and example items.

Individual Instruction. The task cohesion indicator individual instruction refers to any statements made with the intention of directing or ordering another to behave in a particular way. This includes statements directly ordering individuals to act, such as "lower the shields." As well as statements phrased as requests with the intention of directing another to act, such as "could you lower the shields?" The indicator was expected to most closely relate to the construct attributes "willingness to take charge," "monitoring others," and "clear roles/expectations."

Group Instruction. The task cohesion indicator group instruction refers to any statements made with the intention of directing or ordering the group to behave in a particular way. This included statements such as "okay everybody, let's just keep a follow on the Intrepid" and "someone help me out." This indicator was expected to relate to task construct attributes such as "willingness to take charge," "teamwork and cooperation," "goal clarity," and "priority clarity."

Coordination Offer. The task cohesion indicator coordination offer refers to any statement made with the intention of obtaining permission/approval to act, such as "should I decrease warp?". The indicator also includes statements made with the intention of offering support and assistance, such as "do you need power to anything?". The indicator is expected to relate to the construct attributes "clear roles/expectations," "desire to contribute," "coordination," teamwork and cooperation," "monitoring others," and "selflessness."

Behavior Sharing. The task cohesion indicator behavior sharing refers to any statement made with the intention of communicating one's past, present, or future behaviors. Example statements include "I'm going to raise the shields," "I'm raising the shields," and "I raised the shields." All behavior sharing statements are self-referent. Describing the actions of another team member would not be classified as behavior sharing. The indicator is thought to relate to the construct attributes "coordination," "information sharing," and "teamwork and cooperation."

Information Sharing. The task cohesion indicator information sharing refers to any statement made with the intention of sharing task-relevant ideas, information, or suggestions. It includes factual statements such as "the impulse is at 50," subjective statements such as "he's moving so fast," explanations following instructions or behavior sharing statements such as "… to save

energy," and suggestions such as "maybe that's what we have to destroy." The indicator is thought to relate to the construct attributes "coordination," "teamwork and cooperation," "task focus," and "information sharing."

Information Request. The task cohesion indicator information request refers to any statement made with the intention of soliciting task relevant ideas, information, and suggestions. It includes a wide variety of statements such as "what's our goal for this round?" "I'm in range to do what?" and "Can I leave the intrepid?" It is expected to be related to the construct attributes coordination, "desire to improve," "teamwork and cooperation," "task focus," and "processes for goal evaluation."

Acknowledgement. The task cohesion indicator acknowledgement refers to any statement made with the intention of informing another that knowledge/information conveyed has been received/understood. Example statements include "okay," "alright," and "got it." The indicator is assumed to relate to the construct attributes "teamwork and cooperation," "priority clarity," and "goal clarity."

Commitment. The task cohesion indicator commitment refers to any statement made with the intention of informing another that one intends to (+) or does not intend to (-) follow through on a suggested/requested behavior. An example of a positive commitment is "can do." An example of a negative commitment is "no can do." The commitment indicator was to be computed by

subtracting the frequency count of negative commitments from the frequency count of positive commitments and dividing the result by the total number of indicators. This indicator was expected to relate to construct attributes such as "coordination," "teamwork and cooperation," "priority clarity," and "goal clarity."

Task Satisfaction. The task cohesion indicator task satisfaction refers to any statement or expression that conveys a pleasurable/positive (+), or unpleasurable/negative (-) emotional state associated with task activities and outcomes. An example positive task satisfaction statement is "this is cool," and an example of a negative task satisfaction statement is "this sucks." The task satisfaction indicator was to be computed by subtracting the frequency count of negative task satisfaction statements from the frequency count of positive task satisfaction statements and dividing the result by the total number of indicators. This indicator was expected to relate to the construct attribute "will to win."

Care. The social cohesion indicator care refers to any statements made that convey attention to or consideration for another's well-being. It includes statements expressing sympathy or empathy for another's situation (e.g., "It looks frustrating"), statements intended to comfort other team members (e.g., responding to an apology with "no worries"), and statements intended to evaluate another team members wellbeing (e.g., "are you okay?"). This

indicator is thought to be related to the construct attributes "belonginess," "care," and "personal/emotional support."

Recognition. The social cohesion indicator recognition refers to any statements used to convey appreciation for or acknowledge another's contribution. It includes basic appreciation statements like "thank you," and acknowledgement statements like "great job." The indicator is believed to relate most closely to "feeling valued/appreciated" and "respect."

Politeness. The social cohesion indicator politeness refers to any words or phrases used along with individual instructions that show respect and consideration for another's autonomy (e.g., "can you…," "could you…," "would you…," "you can…," and "please"). It is expected to relate most closely to the construct attributes "care," "persistent interpersonal conflict," and "respect."

Humor. The social cohesion indicator humor refers to any statements or expressions made with the intent of eliciting or expressing laughter and amusement. This includes laughter itself (e.g., "haha"), sarcasm (e.g.," Great! An escort mission"), and noises ("Ka-plowy!") or statements meant to amuse (e.g., "hope he has space insurance"). The indicator is expected to be related to "honesty/openess," "social closeness," and "desire for non-work socialization."

Apology. The social cohesion indicator apology refers to any statements used to convey regretful acknowledgment of an offense or failure. This

included variations of “sorry” and “my apologies.” It is thought to be related most closely to “persistent interpersonal conflict,” “shared responsibility,” “respect,” “individual responsibility,” and “clear rules/norms.”

Honesty/Openness. The social cohesion indicator honesty/openess refers to any statements used to convey that one is speculating, has limited understanding, or has made an error of judgment. Statements like “I think,” “I don’t know,” “I don’t understand,” “I hope,” “Oh, never mind,” and “my bad,” all fit within this indicator. It is anticipated to relate most closely to the construct attributes “social closeness,” “honesty/openess,” and “trust.”

Trust/Confidence. The social cohesion indicator trust/confidence refers to any statements used to convey faith (+), or lack of faith (-) in the capabilities of the team or team members. Positive trust/confidence statements include statements such as “we can do this,” “you’ve got this,” and “I feel like we actually know what we’re doing for this one.” Negative trust/confidence statements include statements such as “we’re screwed,” “it’s not looking promising,” and “I think we suck at this game.” The indicator was to be computed by subtracting the frequency count of negative trust/confidence statements from the frequency count of positive trust/confidence statements and dividing the result by the total number of indicators. The indicator was expected to relate to the construct attributes “inspiration,” “encouragement,” “loyalty,” “confidence,” and “trust.”

Social Satisfaction. The social cohesion indicator social satisfaction refers to any statements used to convey satisfaction with team membership or social relationships. Example statements include “I like your style,” “It was good working with you,” and “Space party at my house!” It was anticipated to be most closely related to “sense of belongingness,” “social closeness,” “membership enjoyment,” “desire for non-work socialization,” “relationship satisfaction,” “liking,” “care,” “group pride,” “persistent interpersonal conflict,” and “loyalty.”

Speaker Equality. For the indicator speaker equality, a new team level variable was computed. Speaker equality was operationalized by calculating one minus the standard deviation of the proportion of exchanges initiated by each team member. This calculation yielded a value ranging from zero to one. The value one indicates that each member of the team initiated an equal number of exchanges. The value zero indicates that only one team member spoke. Although the construct is expected to relate to both task and social construct attributes, upon review with an SME, a decision was made to classify this as a social indicator. The construct indicator was anticipated to be related to “desire to contribute,” “shared goal importance,” “teamwork and cooperation,” “social closeness” and “shared responsibility.”

Table 3. Cohesion Indicator Definitions and Examples

Construct Indicator	Description	Relevant Dimen-sion	Example:
Individual Instruction	A statement made with the intention of directing or ordering another to behave in a particular way	Task	"Go ahead and shoot." "You can slow down and start definitely taking a right." "Put a shield on just in case." "Can you give a little power to warp?"
Group Instruction	A statement made with the intention of directing or ordering the group to behave in a particular way	Task	"Let's try it again" "Tell me when you guys want the shields up." "Okay everybody let's just keep a follow on the Intrepid." "Someone help me out."
Coordination Offer	A statement made with the intention of obtaining permission/approval to act; or a statement made with the intention of offering support/assistance	Task	"Would you like me to load one up?" "Should I move forward or wait for the damage to be fixed?" "How slow do you need to be going right now?"
Behavior Sharing	A statement made with the intention of communicating one's past, present, or future behaviors	Task	"Adjusting heading to 320." "I'll start heading over there now." "I just fired"
Information Sharing	A statement made with the intention of sharing task-relevant ideas, information, or suggestions	Task	"We might crash into it" "I can't move" "The ship is damaged somehow" "...so that we can get to the docking bay"
Information Request	A statement made with the intention of soliciting task relevant ideas, information, and suggestions	Task	"What are we looking for?" "Where are you going? "So, you're going to?" "Can I raise the power somehow?"

Acknowledg-ment	A statement made with the intention of informing another that knowledge/ information conveyed has been received/understood.	Task	"Sounds good" "Yeah, …" "Alright, ..." "Gotcha."
Commitment	A statement made with the intention of informing another that one intends to (+), or does not intend to (-) follow through on a suggested/requested behavior.	Task	"Will do." "Sounds like a plan." "Alright" "Gotcha"
Task Satisfaction	A statement or expression that conveys a pleasurable/positive (+), or unpleasurable/ negative (-) emotional state associated with task activities and outcomes.	Task	"Yes, thank goodness!" "Yay!" "yo, so much better than the last game" "Ugh!"
Care	Statements made that convey attention to or consideration for another's well-being.	Social	"No worries." "It looks frustrating" "It's alright." "Don't worry"
Recognition	Statements used that convey appreciation for or acknowledge another's contribution.	Social	"GG team." "Thank you" "Good idea" "Brilliant shot weapons"
Politeness	Statements used during instruction that show respect and consideration for another's autonomy.	Social	"You can…" "Can you..." "Please" "Would you"
Humor	Statement or expressions made with the intent of eliciting or expressing laughter and amusement.	Social	"[Laughing]" "Pue pue pue" "Hope he has space insurance." "It's having a seizure, guys."

Apology	Statements used to convey regretful acknowledgment of an offense or failure.	Social	"Sorry guys" "Sorry about that" "I apologize" "I'm sorry"
Honesty/ Openness	Statements used to convey that one is speculating, has limited understanding, or has made an error of judgment.	Social	"I think…" "I'm not sure." "I hope" "My bad"
Trust/ Confidence	Statements used to convey faith (+), or lack of faith (-) in the capabilities of the team or team members.	Social	"You got this." "We can do this." "I feel like we actually know what we're doing for this one" "We are so dead"
Social Satisfaction	Statements used to convey satisfaction with team membership or social relationships.	Social	"Space party at my house!" "It was good working with ya" "I like your style"
Speaker Equality	A measure of speaker dominance. Ranges from 0 (only one team member spoke) to 1 (all team members spoke equally)	Social	N/A

Step 5: Instantiating Indicators

In the fifth step, the transcripts from the second and third (of three) experimental missions were coded based upon the indicators identified in step four. Two coders coded each of the transcripts independently. Together they reviewed each of the statements in which there were disagreements. Only once the coders reached an agreement on any differentially coded items were the codes considered final.

Speech that did not fit into any of the specified indicator categories was coded non-applicable and was not included in the total indicator count. This category accounted for less than 1% of total speech. Example statements include "we'll see what happens" and "hello." Text statements that lacked sufficient context to make a decision were also coded as non-applicable. This included statements such as "oh my god," "yes," "no," and "alright" with no apparent context. Non-fluencies like "uh" and "um" were also excluded. Finally, non-task communication with experimenters was also excluded. Two examples include "can you hear me clearly, Mission Control?" and "testing my earphones."

Following transcript coding, the data was cleaned. Transcripts were discarded from analysis if there were fewer than ten total exchanges between team members. As a result, the total number of transcripts was reduced from 147 to 128. In addition, one transcript, which contained speech from only one

of the three team members, was removed. In total, 127 transcripts were preserved for final analysis. Table 4 displays descriptive statistics for each of the coded indicators.

Table 4: Indicator Descriptive Statistics

	Total Count	Mission Mean	Mission SD	Mission Minimum	Mission Maximum
Individual Instruction	755	5.95	4.99	0	25
Group Instruction	117	0.92	1.67	0	10
Coordination Offer	299	2.35	2.68	0	13
Behavior Sharing	2222	17.50	12.93	0	55
Information Sharing	4809	37.87	29.75	2	184
Information Request	1483	11.68	9.35	0	46
Acknowledgement	1241	9.77	10.16	0	50
Commitment Positive	370	2.91	3.07	0	14
Commitment Negative	4	0.03	0.18	0	1
Task Satisfaction Positive	125	0.98	1.74	0	8
Task Satisfaction Negative	95	0.75	1.82	0	16
Care	20	0.16	.426	0	2
Recognition	336	2.65	3.95	0	24
Politeness	399	3.14	3.49	0	15
Humor	511	4.02	5.62	0	29
Apology	81	0.64	1.12	0	6
Honesty/Openess	1104	8.69	8.12	0	41
Trust/Confidence Positive	18	0.14	0.39	0	2
Trust/Confidence Negative	18	0.14	0.61	0	5
Social Satisfaction Positive	12	0.09	0.34	0	2
Social Satisfaction Negative	7	0.06	0.48	0	5

Once the data were cleaned, each coded behavioral indicator was evaluated based on coder confidence and frequency of occurrence. When a regression model contains too many predictors for the available number of observations, the developed regression equation is unlikely to generalize. Instead of reflecting the overall population, the model becomes overly sensitive to the characteristics of the specific sample. Because of the relatively small sample size available for this study and the importance of having at least 10-15 observations for each independent variable included in regression analyses to avoid overfitting and ensure sufficient statistical power, judgments had to be made to select the highest quality indicators from the total list (Harrel, 2001). Upon reviewing the coded data, two task indicators were merged, three task indicators were discarded, and three social indicators were discarded prior to analysis.

Because coders found it challenging to consistently distinguish group instructions from individual instructions, these indicators were merged to form a single "instruction" indicator. Rather than addressing a single person, most statements were delivered via the group "radio" channel. When the target of the speech was not explicitly defined, it was often unclear whether instruction statements were directed at an individual or the group as a whole.

Due to coders' lack of confidence in differentiating acknowledgement from commitment, and difficulty distinguishing acknowledgement from speech

disfluencies, these indicators were dropped prior to analysis. Words like “okay” and “alright” were frequently used to break silence instead of acknowledge another’s statement, and differentiating the two using only text-based transcripts was problematic.

Before conducting analyses, task satisfaction was also removed. There are two primary reasons for doing so. First, there were few direct statements of task satisfaction. It was challenging to interpret indirect task satisfaction statements, and they were not coded consistently. Second, interpreting task satisfaction statements without tonal cues is extremely difficult. Consider the expression “this is fun.” While a coder reading this statement on paper might assume that something exciting is happening on the player’s screen, it’s also possible that nothing is happening, and the speaker is remarking sarcastically on how tedious the activity is.

Three of the proposed social cohesion indicators, with very low rates of occurrence and low confidence by coders, were dropped prior to analysis (trust/confidence, care, social satisfaction). In a total of 10,390 team member exchanges, only 36 exchanges included a trust/confidence component, only 20 exchanges included a care component, and only 19 statements included a social satisfaction component. In addition to their low rate of occurrence, coders had frequent disagreements regarding the appropriateness of classifying these statements into their respective categories. When the coders worked

independently, approximately half of the statements in these categories were differentially coded. The remaining 11 indicators, five of which were task-related and six of which were social-related, were deemed sufficient to include in the regression models developed in the following step. Table five shows the correlations between each of the finalized indicators and participants' self-reported cohesion ratings.

Table 5: Indicator Correlations

Variable		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Task Cohesion	Pearson's r	—												
	p-value	—												
2. Social Cohesion	Pearson's r	0.665 **	—											
	p-value	< .001	—											
3. Instruction	Pearson's r	0.327 **	0.330 **	—										
	p-value	< .001	< .001	—										
4. Coordination Offer	Pearson's r	0.025	0.087	-0.046	—									
	p-value	0.783	0.329	0.605	—									
5. Behavior Sharing	Pearson's r	0.078	-0.196 *	-0.264 **	-0.226 *	—								
	p-value	0.380	0.027	0.003	0.011	—								
6. Information Sharing	Pearson's r	-0.150	0.125	0.011	0.024	-0.375 **	—							
	p-value	0.093	0.161	0.904	0.792	< .001	—							
7. Information Request	Pearson's r	-0.290 **	-0.005	-0.076	0.162	-0.576 **	0.128	—						
	p-value	< .001	0.954	0.396	0.068	< .001	0.152	—						
8. Recognition	Pearson's r	0.216 *	-0.043	0.030	0.075	0.050	-0.397 **	-0.126	—					
	p-value	0.015	0.633	0.734	0.404	0.579	< .001	0.159	—					
9. Politeness	Pearson's r	0.111	-0.124	0.329 **	-0.044	0.108	-0.445 **	-0.218 *	0.181 *	—				
	p-value	0.216	0.166	< .001	0.622	0.227	< .001	0.014	0.041	—				
10. Humor	Pearson's r	0.100	0.281 **	0.077	-0.018	-0.308 **	-0.122	0.205 *	-0.099	-0.127	—			
	p-value	0.264	0.001	0.389	0.843	< .001	0.171	0.021	0.269	0.155	—			
11. Apology	Pearson's r	0.012	0.022	0.048	-0.130	-0.017	-0.131	0.012	0.143	0.025	0.031	—		
	p-value	0.896	0.806	0.589	0.144	0.846	0.141	0.894	0.108	0.784	0.727	—		
12. Honesty/Openess	Pearson's r	-0.191 *	0.051	-0.082	-0.031	-0.541 **	0.298 **	0.396 **	-0.283 **	-0.362 **	0.084	0.002	—	
	p-value	0.031	0.572	0.362	0.729	< .001	< .001	< .001	0.001	< .001	0.348	0.982	—	
13. Speaker Equality	Pearson's r	0.086	0.166	0.159	0.079	-0.447 **	0.067	0.201 *	-0.029	0.094	0.058	0.088	0.208 *	—
	p-value	0.338	0.062	0.074	0.379	< .001	0.454	0.023	0.743	0.293	0.518	0.328	0.019	—

* p < .05, ** p < .01

Step 6: Validating Indicators

Model building and validation analyses were carried out in the sixth and final step. Before beginning any analyses, the data was divided into two subsets. The first subset, the "training" dataset, comprised data from a random 70% of missions (n = 88). This dataset was used to develop the regression equations used to predict/measure teams' task and social cohesion. The second dataset, or "testing" dataset, contained data from the remaining 30% of missions (n =39). This dataset was used to demonstrate the predictive accuracy of the computed regression equations.

Multilevel modeling was used to account for data nesting. In the regression models, each indicator identified in the previous step of the RADSM process was treated as an independent variable. The dependent variable was the mean self-reported task or social cohesion scores for each team. Following multilevel modeling best practices, each indicator was group-mean centered by phase (Enders & Tofighi, 2007). To control for the effect of the debrief manipulation, a dummy coded variable denoting the presence or absence of the debrief activity was included in the model.

To obtain cohesion ratings, each team member completed six items adapted from the Moos Group Environment Scale (Moos, 1980 Mathieu, 1991; Mathieu et al., 2015; Appendix B). Three of these items related to task cohesion (M = 4.30, SD = 0.40), while the remaining three related to social cohesion (M

= 3.83, *SD* = 0.61). Responses were given on a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). By averaging cohesion scores across individuals within a team, meaningful team-level cohesion scores were produced. For task cohesion, ICC(1) = .22, ICC(2) = .45, F(125, 248) = 1.83, p < .001, justifying aggregation to the team level. For task cohesion, ICC(1) = .17, ICC(2) = .37, F(125, 248) = 1.59, p = .001, justifying aggregation to the team level. The average $r_{wg(j)}$ coefficient was .91 for task cohesion, and .79 for social cohesion, demonstrating within-group agreement.

Table six displays the results of the task cohesion regression analysis. By examining the obtained regression coefficients, it's possible to estimate how important each indicator is in determining the teams' cohesion ratings. This output shows that instruction is a significant predictor of task cohesion (t = 2.22, $p < 0.05$), and that as the proportion of instruction statements increases by one standard deviation above the mean, task cohesion increases by .10 points. Similarly, information request is also significant (t = -2.66, $p < 0.05$), and that as the proportion of instruction statements increases by one standard deviation above the mean, task cohesion decreases by .15 points. None of the other indicators relate significantly to task cohesion.

The social cohesion regression output is shown in table seven. From this output, we can see that humor is a significant predictor of social cohesion (t = 2.21, $p = 0.04$), and that as the proportion of humor indicators increases by one

standard deviation above the norm, social cohesion increases .13 points. None of the remaining indicators were identified as significant. Phase was also determined to be a significant predictor of social cohesion ($t = 3.67$, $p = .002$). It accounted for a .28-point difference in teams' social cohesion scores.

Table 6: Task Cohesion Regression Model

	Task Cohesion		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	4.25	4.10 – 4.40	**<0.001**
Phase	0.09	-0.05 – 0.22	0.190
Debrief	0.02	-0.16 – 0.21	0.798
Information Request	-0.15	-0.26 – -0.03	**0.015**
Instruction	0.10	0.01 – 0.19	**0.038**
Coordination Offer	0.05	-0.04 – 0.14	0.272
Information Sharing	-0.05	-0.14 – 0.04	0.263
Behavior Sharing	-0.01	-0.14 – 0.13	0.928
Random Effects			
σ^2	0.07		
$\tau_{00\ TeamID}$	0.07		
ICC	0.50		
$N_{\ TeamID}$	62		
Observations	88		
Marginal R^2 / Conditional R^2	0.198 / 0.602		

Table 7: Social Cohesion Regression Model

	Social Cohesion		
Predictors	*Estimates*	*CI*	*p*
(Intercept)	2.94	1.94 – 3.94	**<0.001**
Phase	0.28	0.12 – 0.44	**0.002**
Debrief	0.02	-0.27 – 0.30	0.915
Humor	0.13	0.01 – 0.26	**0.040**
Politeness	-0.07	-0.19 – 0.06	0.276
Speaker Equality	0.94	-0.35 – 2.23	0.143
Recognition	0.07	-0.09 – 0.22	0.371
Honesty/Openess	0.01	-0.11 – 0.14	0.823
Apology	0.03	-0.11 – 0.17	0.656
Random Effects			
σ^2	0.09		
$\tau_{00\ TeamID}$	0.23		
ICC	0.73		
N_{TeamID}	62		
Observations	88		
Marginal R^2 / Conditional R^2	0.142 / 0.765		

The generated regression equations must meet established convergent and discriminant validity thresholds to be considered valid instruments for assessing cohesion. If the predicted scores are relatively highly correlated with scores on other measures of the same construct, there is evidence of convergent validity. As previously stated, team members completed six items adapted from the Moos Group Environment Scale (Moos, 1980), and thus their self-reported cohesion scores were known (Mathieu, 1991; Mathieu et al., 2015). The relationship between predicted task cohesion scores and self-reported task cohesion scores was moderate and positive, $r(37) = .41$, $p = .01$. Likewise, the correlation between predicted and self-reported social cohesion scores was also moderate and positive, $r(37) = .41$, $p = .01$. Because these are only moderate, significant correlations, convergent validity is not shown (Bagozzi et al., 1991).

Similarly, discriminant validity is demonstrated when there is a low correlation between predicted cohesion scores and scores on a theoretically unrelated construct. To establish discriminant validity, the predicted team cohesion values were compared to team members' average ratings of Computer-game-specific Self Efficacy, as measured using a modified version of the Generalized Self-Efficacy Scale (Schwarzer & Jerusalem, 1995; Appendix C). In this measure, participants rate the degree to which they agree with statements regarding their confidence in their capabilities to mobilize the courses of action needed to meet video game situational demands on a four-

point Likert scale from one (not at all true) to four (exactly true) (M = 2.90, SD = 0.49). Sample items include “I am confident that I could deal efficiently with unexpected events in a videogame” and “I can always manage to solve difficult problems within a videogame if I try hard enough.” The correlation coefficient between the predicted task cohesion scores and the self-reported video game self-efficacy scores was calculated as weak and negative, $r(37) = -.04$, $p = .782$. The correlation between the predicted social cohesion scores and the self-reported video game self-efficacy scores was calculated to be moderately weak and negative, $r(37) = -.24$, $p = .141$. Because these correlations are relatively small and not statistically significant, evidence for discriminant validity is shown (Bagozzi et al., 1991).

Chapter 4: Discussion

What is known about the development and maintenance of cohesion comes primarily from evidence obtained from individual small-scale studies using traditional measures. To further our understanding of how team phenomena emerge, and to learn how to promote such states, we must explore the mechanisms and process dynamics that drive them rather than simply examining their resulting covariances (Kozlowski et al., 2018). This requires repeated assessment over time in a variety of samples, which, through continued research, can likely be achieved through the implementation of unobtrusive measurement methods.

Although the findings suggest that the developed regression equation, in its current state, does not represent a viable mechanism for unobtrusively measuring cohesion, the study does provide meaningful insight into the specific communication behaviors that influence team cohesion perceptions. This constitutes a step in the right direction. The process of developing unobtrusive measures is iterative, and by analyzing and theorizing about the observed findings, and incorporating these lessons into future research, future iterations may be more successful.

Task Cohesion

Although convergent validity was not demonstrated, a significant positive correlation ($r = .41$, $p = .01$) was found between the values predicted using the computed regression equation and teams' self-reported task cohesion scores. This moderate correlation is insufficient to establish convergent validity, but it indicates that teams' perceptions of cohesion were associated with the developed regression equations. The non-significant correlation between the predicted cohesion scores and scores on the Computer-game Self-efficacy Scale ($r = -.05$, $p = .782$) suggests that the observed correlation is due to captured task cohesion variance rather than other factors.

The results show that a higher proportion of statements directing other team members to act is associated with greater task cohesion. Instructing others to perform an action tacitly communicates one's commitment to the team task and desire to achieve the team's goals. By instructing other team members to act, the speaker may be influencing each team member's sense of responsibility for the team's performance. This sense of shared responsibility and commitment to the team goal is a crucial component of the task cohesion construct.

Similarly, when a greater proportion of statements are dedicated to requesting information, perceptions of task cohesion are lower. Although the exact cause of this relationship is unknown, a higher proportion of information

requesting statements may indicate a lack of engagement. Engaged team members may be more focused on the task at hand and thus gather the necessary information implicitly, avoiding the need to ask others for information directly.

The findings also revealed that the proportion of total coordination offers was not a significant indicator of task cohesion. Throughout the activity, participants generally made two types of coordination offers. The first were offers requesting permission to act. For instance, a participant might inquire, "Should I back up?" The second type of coordination offers were statements made by team members offering support and assistance, such as "do you need me to do anything for you?" Although these two types of behaviors were clustered together and treated as a single indicator, future research should look at them separately, as they may differentially reflect task cohesion.

It was also assumed that sharing information would promote shared understanding and task familiarity, which are necessary for task cohesion. Contrary to expectations, information sharing showed a non-significant relationship with task cohesion perceptions. The precise reason for this observation is unclear. However, there may be several contributing factors. First, the information sharing indicator was broad in scope. It included factual information (e.g., "the dock is outside of the nebula"), justifications (e.g., "…so that we can go faster"), and subjective information (e.g., "That was strange").

Separating these types of information in future research may provide novel insights. Second, the novelty of the information was not considered. While novel information sharing is likely indicative of task cohesion, non-novel information sharing may indicate the opposite.

Finally, the relationship between behavior sharing and task cohesion was found to be non-significant. The content of this indicator, like that of information sharing, was quite broad. This indicator included statements about past, present, and future behavior. This is important for two reasons. First, like information requests, sharing past behaviors may indicate low task cohesion, as the information would not need to be explicitly shared if team members were attentive to the actions of others. Second, sharing past and present behavior is likely to serve a different purpose than does sharing future behavior. While sharing past and present behavior simply informs others of past and occurring actions, the purpose of sharing future behavior is likely to serve a variety of purposes. A team member who shares future behavior may be seeking feedback on their proposed course of action or attempting to prompt others to engage in preparatory behaviors. Regardless, future research should examine the sharing of future behaviors separately from past and current behaviors.

Social Cohesion

Like task cohesion, a significant positive correlation ($r = .41$, $p = .01$) was found between teams' self-reported social cohesion scores and predicted

team cohesion scores. Although the correlation does not establish convergent validity, this positive relationship and the corresponding non-significant relationship (r = -.24, p = .141) between predicted cohesion scores and Computer-game self-efficacy imply that the proposed regression equations capture variability attributable to social cohesion. By retaining relevant indicators in future iterations, a valid unobtrusive measure of social cohesion may eventually be developed.

When it comes to meaningful predictors of social cohesion, the most statistically significant component in the regression equation was humor. In group activities, humor is often used to reduce tension, enhance social feelings, and build social identity (Gelkopf & Kreitler, 1996; Gilson et al., 2015). In the current study, team members' humor was seldom made at the expense of another team member, and future research should consider that, depending on the content and target of humor, the relationship between humor and social cohesion may not always be positive. Further research is needed to explore this possibility.

All other indicators of social cohesion were found to be non-significant. Remarkably, the politeness of instruction statements did not affect social cohesion perceptions. Instructions were identified as polite if they were phrased as a request. These included instructions with phrasing such as "can you," "could you," and "would you," but also instructions that included the word

“please.” Although together they have no relationship to cohesion, future research should examine request instructions (e.g., “could you raise the shields”) separately from direct instructions that include the word “please” (e.g., “please raise the shields”).

It is also possible that the influence of politeness is only meaningful for established teams. The current sample consisted of newly formed teams with no prior experience with the task activity. This may impact the politeness-cohesion relationship in two ways. First, politeness statements may be less meaningful in newly formed teams attempting to establish rapport and relationships than in teams with already established rapport. When politeness is employed later in a team’s life cycle, it may more accurately reflect team states. Second, none of the participants were familiar with the task. They may have chosen to phrase their instructions as requests rather than demands because they are less confident in their requests.

The proportion of statements in the honesty/openness indicator category failed to relate meaningfully to perceptions of social cohesion. Participants may have used these statements to communicate their lack of confidence due to unfamiliarity with the task. For well-established teams that are already familiar with the task, this may not be the case. Furthermore, speculative "I think" statements can vary greatly whether a participant refers to information or behaviors. Sharing speculative task-relevant information, such as "I think those

are asteroids," differs considerably from saying, "I think we should avoid those asteroids." Future research should differentiate between speculating about information and speculating about potential courses of action.

Contrary to expectations, speaker equality was not a significant predictor of social cohesion. Almost all communication was task-focused, and tasks were highly interdependent. It is possible that task demands, rather than relational factors, were the primary driver of speaker equality. It is worth noting that the obtained speaker equality regression coefficient was the largest, affirming the indicator's potential relatedness to social cohesion. Rather than removing this indicator from inclusion in future research, it may be more apt to consider its inclusion in light of the context. When communication patterns are less task-imposed, this indicator may be more meaningful.

Recognition was another non-significant indicator. Although it was expected that recognizing others for their contributions would be associated with feelings of closeness, this was not the case. The nascency of teams in this sample may be one possible explanation for this relationship. Because team members are still establishing rapport, recognition behaviors may not necessarily reflect feelings of closeness. Once politeness norms and expectations are established, variability in recognition behavior may be more reliably associated with social cohesion.

Lastly, there was no significant relationship between apology and social cohesion in the regression model. It was anticipated that expressing regret for an action, accepting responsibility for it, and acknowledging that it constituted an offense would simultaneously demonstrate respect and strengthen social cohesion. As with the other non-significant indicators, this might partially be explained by member unfamiliarity. While team members are becoming acquainted, apologies may be extended as a show of politeness rather than genuine remorse.

The findings also revealed that only perceptions of social cohesion were significantly influenced by mission phase. Between the second and third phases, perceptions of social cohesion increased on average. These findings are consistent with previous research indicating that social cohesion increases over time (Carron, 1982). The more time team members spend together, the more likely they are to develop feelings of liking for one another (Bell & Brown, 2015).

Limitations

The findings described above should be viewed in light of the study's numerous limitations. The most obvious shortcoming of the work described here is the sample's characteristics. The sample consisted of newly formed teams rather than established teams working together for an extended period. Measuring cohesion in newly formed teams is challenging because teams do

not always display an observable level of team cohesiveness at the early stages of development. Furthermore, team members' perceptions drive team cohesiveness, which is more variable when individuals are unfamiliar with one another and lack a historical foundation against which to compare current behaviors. Future research attempting to develop unobtrusive measures for emergent states should craft their samples using teams with established working relationships.

Additionally, the results may not generalize to different contexts. The indicators were developed with the experimental activity in mind. Any replication of this process would have to take the context into account. However, given the structured nature of the task, and the specific task type under consideration, the effects observed in this study may be generalizable to other activities with similar task characteristics.

The study was also greatly limited by the available data in two ways. First, only text-based transcripts were available for analysis. As a result, other important behavioral features, such as tonal and nonverbal cues, could not be included. Future research should build on this work by taking a multimodal approach. Other possible data sources include video, audio, location, and psychophysiological data. By using an assortment of different methods, researchers may make greater progress towards unpacking the infamous "black box" of team processes.

Second, the only measure of cohesion available in the archival data was derived from participant self-perceptions. Unobtrusive measurement is based upon the assumption that individuals' behavior reflects their psychological processes and states. However, behaviors only reveal a fraction of what goes on inside the mind. By definition, any unobtrusive method will fail to capture variance attributable to cognitive processes with no observable correlates. When developing unobtrusive measures, observer ratings of psychological states may be preferable to participant ratings because observer ratings may capture a greater proportion of observable variance. Future research attempting to employ this methodology should investigate this proposition.

Future Research

Although the regression equations do not produce cohesion predictions that meet convergent validity thresholds, the obtained results justify further development of unobtrusive methods for the assessment of team states. Because the full potential of the approach has yet to be demonstrated, there are several ways in which the current work can be extended and improved. First, in future attempts, the identified non-significant indicators should be refined or removed. Only indicators that consistently improve the predictive validity of the equation should be retained to reduce irrelevant error. Second, the model can be refined further by incorporating newly developed indicators. In addition to adding more indicators derived from the semantic content of speech, including indicators

derived from alternative modes of measurement may significantly improve the measure's reliability and validity.

The RADSM approach presented in this paper is sufficiently general to be applied to the development of measures of other constructs in alternative samples. The method provides a compromise between the purely top-down and bottom-up approaches typically employed in the development of unobtrusive methods. By applying this method to a diverse range of teams and task types, we can gain meaningful insight into the cohesion construct, and apply these findings to real-world team settings.

For the methods presented here to be practical, it is necessary to improve the efficiency of the coding process. This method is time intensive and relies upon subjective judgments made by human coders. Future research should compare the accuracy and reliability of automatically generated codes using text classification algorithms to those made by human coders. If the coding process can be reliably automated, the designed equations may enable practical functionality above what is possible with traditional obtrusive methods. A real-time measure of team states can, in addition to providing theoretical insights, enable the development of real-time feedback systems to promote optimal team outcomes.

Conclusion

In two ways, the current study is unique. It is one of the first studies to show the potential of the RADSM approach for developing valid unobtrusive measures of team emergent states, and it also emphasizes the relative importance of specific indicators. By identifying specific behavioral indicators, researchers can begin to distinguish the relative importance of various individual and team behaviors in the formation of team cohesion. Such information can be used to extend current theories of teamwork and cohesion, provide a deeper understanding of team dynamics, and provide knowledge that can be used to design successful interventions that improve processes related to the development of cohesion.

Overall, the results of this study suggest two general conclusions: 1) the RADSM approach is a promising technique for developing valid unobtrusive measures, and 2) communication-based unobtrusive measurement methods can, once refined, likely be used as an effective means to supplement more traditional measurement methods. Taken together, the study's findings have implications for understanding the mechanisms and process dynamics that drive team cohesion, and may help inform future attempts at unobtrusively assessing such processes.

References

Ahronson, A., & Cameron, J. E. (2007). The Nature and Consequences of Group Cohesion in a Military Sample. *Military Psychology*, *19*(1), 9–25. https://doi.org/10.1080/08995600701323277

Allen, M. (2017). *The SAGE Encyclopedia of Communication Research Methods.* doi:10.4135/9781483381411

Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, *117*(3), 497–529. https://doi.org/10.1037/0033-2909.117.3.497

Beal, D. J., Cohen, R. R., Burke, M. J., & McLendon, C. L. (2003). Cohesion and Performance in Groups: A Meta-Analytic Clarification of Construct Relations. *Journal of Applied Psychology*, *88*(6), 989–1004. https://doi.org/10.1037/0021-9010.88.6.989

Bell, S. T., Fisher, D. M., Brown, S. G., & Mann, K. E. (2018). An Approach for Conducting Actionable Research With Extreme Teams. *Journal of Management*, *44*(7), 2740–2765. https://doi.org/10.1177/0149206316653805

Bhattacharya, I. (2018). Unobtrusive Analysis of Group Interactions without Cameras. *Proceedings of the 2018 on International Conference on Multimodal Interaction - ICMI '18*, 501–505. https://doi.org/10.1145/3242969.3264973

Binning, J. F., & Barrett, G. V. (1989). Validity of personnel decisions: A conceptual analysis of the inferential and evidential bases. *Journal of Applied Psychology*, *74*(3), 478–494. http://dx.doi.org.portal.lib.fit.edu/10.1037/0021-9010.74.3.478

Bliese, P. D., & Halverson, R. R. (1996). Individual and Nomothetic Models of Job Stress: An Examination of Work Hours, Cohesion, and Well-Being1. *Journal of Applied Social Psychology*, *26*(13), 1171–1189. https://doi.org/10.1111/j.1559-1816.1996.tb02291.x

Brawley, L. R., Carron, A. V., & Widmeyer, W. N. (1987). Assessing the cohesion of teams: Validity of the Group Environment Questionnaire. *Journal of Sport and Exercise Psychology, 9*(3), 275-294.

Brawley, L. R., Carron, A. V., & Widmeyer, W. N. (1993). The Influence of the Group and Its Cohesiveness on Perceptions of Group Goal-Related Variables. *Journal of Sport and Exercise Psychology*, *15*(3), 245–260. https://doi.org/10.1123/jsep.15.3.245

Brzozowski, M. J. (2009). WaterCooler: Exploring an organization through enterprise social media. *Proceedinfs of the ACM 2009 International Conference on Supporting Group Work - GROUP '09*, 219. https://doi.org/10.1145/1531674.1531706

Bury, P. (2018). Future Reserves 2020: Perceptions of cohesion, readiness and transformation in the British Army Reserve. *Defence Studies*, *18*(4), 411–432. https://doi.org/10.1080/14702436.2018.1511373

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological Bulletin*, *56*(2), 81–105. https://doi.org/10.1037/h0046016

Carless, S. A., & De Paola, C. (2000). The Measurement of Cohesion in Work Teams. *Small Group Research*, *31*(1), 71–88. https://doi.org/10.1177/104649640003100104

Carron, A. V. (1982). Cohesiveness in Sport Groups: Interpretations ani Considerations. *Journal of Sport Psychology*, *4*(2), 123–138. https://doi.org/10.1123/jsp.4.2.123

Carron, A. V., & Chelladurai, P. (1981). Cohesiveness as a Factor in Sport Performance. *International Review of Sport Sociology*, *16*(2), 21–43. https://doi.org/10.1177/101269028101600202

Carron, A. V., Widmeyer, W. N., & Brawley, L. R. (1985). The Development of an Instrument to Assess Cohesion in Sport Teams: The Group Environment Questionnaire. *Journal of Sport Psychology*, *7*(3), 244–266. https://doi.org/10.1123/jsp.7.3.244

Carter, D. R., Asencio, R., Wax, A., DeChurch, L. A., & Contractor, N. S. (2015). Little Teams, Big Data: Big Data Provides New Opportunities for Teams *Theory*. *Industrial and Organizational Psychology*, *8*(4), 550–555. https://doi.org/10.1017/iop.2015.82

Carter, N. T., Carter, D. R., & DeChurch, L. A. (2018). Implications of Observability for the Theory and Measurement of Emergent Team Phenomena. *Journal of Management*, *44*(4), 1398–1425. https://doi.org/10.1177/0149206315609402

Castro-Hernández, A. (2016). Content and Temporal Analysis of Communications to Predict Task Cohesion in Software Development Global Teams. *2016 IEEE 11th International Conference on Global Software Engineering Workshops (ICGSEW)*, 65–68. https://doi.org/10.1109/ICGSEW.2016.24

Chowdhury, S. (2005). The Role of Affect- and Cognition-based Trust in Complex Knowledge Sharing. *Journal of Managerial Issues*, *17*(3), 310–326.

Cohen, S. G., & Bailey, D. E. (1997). What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite. *Journal of Management*, *23*(3), 239–290. https://doi.org/10.1177/014920639702300303

Cota, A. A., Evans, C. R., Dion, K. L., Kilik, L., & Longman, R. S. (1995). The Structure of Group Cohesion. *Personality and Social Psychology Bulletin*, *21*(6), 572–580. https://doi.org/10.1177/0146167295216003

Coultas, C. W., Driskell, T., Burke, C. S., & Salas, E. (2014). A Conceptual Review of Emergent State Measurement: Current Problems, Future Solutions. *Small Group Research*, *45*(6), 671–703. https://doi.org/10.1177/1046496414552285

Day, D. V., Shleicher, D. J., Unckless, A. L., & Hiller, N. J. (2002). Self-monitoring personality at work: A meta-analytic investigation of construct validity. *Journal of Applied Psychology*, *87*(2), 390–401. https://doi.org/10.1037/0021-9010.87.2.390

DeCostanza, A. H., Gamble, K. R., Estrada, A. X., & Orvis, K. L. (2018). Team Measurement: Unobtrusive Strategies for Intelligent Tutoring Systems. In J. Johnston, R. Sottilare, A. M. Sinatra, & C. Shawn Burke (Eds.), *Research on Managing Groups and Teams* (Vol. 19, pp. 101–130). Emerald Publishing Limited. https://doi.org/10.1108/S1534-085620180000019009

Dion, K. L. (2000). Group cohesion: From “field of forces” to multidimensional construct. *Group Dynamics: Theory, Research, and Practice*, *4*(1), 7–26. https://doi.org/10.1037/1089-2699.4.1.7

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. Psychological Methods, 12(2), 121–138. https://doi.org/10.1037/1082-989X.12.2.121

Eys, M. A., & Brawley, L. R. (2018). Reflections on cohesion research with sport and exercise groups. *Social and Personality Psychology Compass*, *12*(4), e12379. https://doi.org/10.1111/spc3.12379

Festinger, L., Schachter, S., & Back, K. (1950). *Social pressures in informal groups; a study of human factors in housing* (pp. x, 240). Harper.

Frauendorfer, D., Schmid Mast, M., Nguyen, L., & Gatica-Perez, D. (2014). Nonverbal Social Sensing in Action: Unobtrusive Recording and Extracting of Nonverbal Behavior in Social Interactions Illustrated with a Research Example. *Journal of Nonverbal Behavior*, *38*(2), 231–245. https://doi.org/10.1007/s10919-014-0173-5

Gal, R. (1986). Unit Morale: From a Theoretical Puzzle to an Empirical Illustration—An Israeli Example1. *Journal of Applied Social Psychology*, *16*(6), 549–564. https://doi.org/10.1111/j.1559-1816.1986.tb01158.x

Ghosh, S., Dhall, A., Sebe, N., & Gedeon, T. (2018). *Predicting Group Cohesiveness in Images*. http://arxiv.org/abs/1812.11771v4

Gofembiewski, R. (1962). *The small group*. Chicago: University of Chicago Press.

Gonzales, A. L., Hancock, J. T., & Pennebaker, J. W. (2010). Language Style Matching as a Predictor of Social Dynamics in Small Groups. *Communication Research*, *37*(1), 3–19. https://doi.org/10.1177/0093650209351468

Greene, C. N. (1989). Cohesion and Productivity in Work Groups. *Small Group Behavior*, *20*(1), 70–86. https://doi.org/10.1177/104649648902000106

Griffith, J. (1988). Measurement of Group Cohesion in U. S. Army Units. *Basic and Applied Social Psychology*, *9*(2), 149–171. https://doi.org/10.1207/s15324834basp0902_6

Griffith, T. L. (2012). Technology and Teams: The Next Ten Years. In M. A. Neale & E. A. Mannix (Eds.), *Research on Managing Groups and Teams* (Vol. 15, pp. 245–278). Emerald Group Publishing Limited. https://doi.org/10.1108/S1534-0856(2012)0000015013

Gross, N., & Martin, W. E. (1952). On Group Cohesiveness. *American Journal of Sociology*, *57*(6), 546–564. https://doi.org/10.1086/221041

Gross, E. F. (1957). An empirical study of the concepts of cohesiveness and compatibility (Doctoral dissertation, Harvard University).

Grossman, R., Rosch, Z., Mazer, D., & Salas, E. (2015). What matters for team cohesion measurement? A synthesis. In *Team cohesion: Advances in psychological theory, methods and practice*. Emerald Group Publishing Limited.

Gruber, J. J., & Gray, G. R. (1981). Factor Patterns of Variables Influencing Cohesiveness at Various Levels of Basketball Competition. *Research Quarterly for Exercise and Sport, 52*(1), 19–30. doi:10.1080/02701367.1981.10609291

Hackman, J. R. (2012). From causes to conditions in group research. *Journal of Organizational Behavior*, *33*(3), 428–444. https://doi.org/10.1002/job.1774

Harrell, F. E. (2001). *Regression modeling strategies: With applications to linear models, logistic regression, and survival analysis* (Vol. 608). Springer.

Hausdorf, P. A., Risavy, S. D., & Hunter, P. E. (2014). Effective HR Project Execution: Understanding Project, Team, and Stakeholder Issues. In R. J. Klimoski, B. A. Dugan, C. Messikomer, & F. Chiocchio (Eds.), *Advancing Human Resource Project Management* (pp. 206–237). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118915912.ch9

Hill, A. D., White, M. A., & Wallace, J. C. (2014). Unobtrusive measurement of psychological constructs in organizational research. *Organizational Psychology Review*, *4*(2), 148–174. https://doi.org/10.1177/2041386613505613

Hung, H., & Gatica-Perez, D. (2010). Estimating Cohesion in Small Groups Using Audio-Visual Nonverbal Behavior. *IEEE Transactions on Multimedia*, *12*(6), 563–575. https://doi.org/10.1109/TMM.2010.2055233

Ingraham, L. H., & Manning, F. J. (1981). Cohesion: Who needs it, what is it and how do we get it to them? *Military Review*, 61(6). 2-12.

Johannes, B., Sitev, A. S., Vinokhodova, A. G., Salnitski, V. P., Savchenko, E. G., Artyukhova, A. E., Bubeev, Y. A., Morukov, B. V., Tafforin, C., Basner, M., Dinges, D. F., & Rittweger, J. (2015). Wireless Monitoring of Changes in Crew Relations during Long-Duration Mission Simulation. *PLoS ONE*, *10*(8), e0134814. https://doi.org/10.1371/journal.pone.0134814

Kazdin, A. E. (1979). Unobtrusive measures in behavioral assessment. *Journal of Applied Behavior Analysis*, *12*(4), 713–724.

Kennedy, D. M., & McComb, S. A. (2014). When teams shift among processes: Insights from simulation and optimization. *Journal of Applied Psychology*, *99*(5), 784–815. https://doi.org/10.1037/a0037339

Kozlowski, S. W. J. (2015). Advancing research on team process dynamics: Theoretical, methodological, and measurement considerations. *Organizational Psychology Review*. https://doi.org/10.1177/2041386614533586

Kozlowski, S. W. J., & Chao, G. T. (2012). The Dynamics of Emergence: Cognition and Cohesion in Work Teams: THE DYNAMICS OF EMERGENCE. *Managerial and Decision Economics*, *33*(5–6), 335–354. https://doi.org/10.1002/mde.2552

Kozlowski, S. W. J., & Klein, K. J. (2000). *A Multilevel Approach to Theory and Research in Organizations: Contextual, temporal, and emergent processes.* 90.

Kozlowski, S. W. J., Link to external site, this link will open in a new window, Chao, G. T., & Link to external site, this link will open in a new window. (2018). Unpacking team process dynamics and emergent phenomena: Challenges, conceptual advances, and innovative methods. *American Psychologist*, *73*(4), 576–592. http://dx.doi.org.portal.lib.fit.edu/10.1037/amp0000245

Lawler, E. E., Mohrman, S. A., & Benson, G. (2001). *Organizing for high performance: Employee involvement, TQM, reengineering, and knowledge management in the fortune 1000 ; the CEO report* (1. ed., 1. HB print., [rev. and updated ed.]). San Francisco, Calif. : Jossey-Bass.

Lewin, K. (1935). *A Dynamic Theory of Personality* (1st ed.). McGraw-Hill.

Lott, A. J., & Lott, B. E. (1965). Group cohesiveness as interpersonal attraction: A review of relationships with antecedent and consequent variables. *Psychological Bulletin*, *64*(4), 259–309. https://doi.org/10.1037/h0022386

Maman, L. (2020). Multimodal Groups' Analysis for Automated Cohesion Estimation. *Proceedings of the 2020 International Conference on Multimodal Interaction*, 713–717.

Marks, M. A., DeChurch, L. A., Mathieu, J. E., Panzer, F. J., & Alonso, A. (2005). Teamwork in Multiteam Systems. *Journal of Applied Psychology*, *90*(5), 964–971. https://doi.org/10.1037/0021-9010.90.5.964

Mathieu, J. E. (1991). A cross-level nonrecursive model of the antecedents of organizational commitment and satisfaction. *Journal of Applied Psychology, 76*(5), 607–618. https://doi.org/10.1037/0021-9010.76.5.607

Mathieu, J. E., Kukenberger, M. R., D'Innocenzo, L., & Reilly, G. (2015). Modeling reciprocal team cohesion–performance relationships, as impacted by shared leadership and members' competence. *Journal of Applied Psychology, 100*(3), 713–734. https://doi.org/10.1037/a0038898

Matusik, J. G., Heidl, R., Hollenbeck, J. R., Yu, A., Lee, H. W., & Howe, M. (2019). Wearable bluetooth sensors for capturing relational variables and temporal variability in relationships: A construct validation study. *Journal of Applied Psychology*, *104*(3), 357–387. https://doi.org/10.1037/apl0000334

McClurg, C. E., Chen, J. L., Petruzzelli, A., & Thayer, A. L. (2017). Challenges and New Directions in Examining Team Cohesion Over Time. In E. Salas, W. B. Vessey, & L. B. Landon (Eds.), *Research on Managing Groups and Teams* (Vol. 18, pp. 261–286). Emerald Publishing Limited. https://doi.org/10.1108/S1534-085620160000018011

McCormack, R. K., Brown, T. A., Perry, S., & Myers, C. (2017). *Measuring Team Performance and Coordination in a Mixed Human- Synthetic Team Training Environment*. 11.

Mikalachki, A., University of Western Ontario, & School of Business Administration. (1969). *Group cohesion reconsidered: A study of blue collar work groups*. School of Business Administration, University of Western Ontario.

Moos, R. H. (1980). *Group environment scale*. Palto Alto, CA: Consulting Psychologists Press.

Morgeson, F. P., & Campion, M. A. (1997). Social and cognitive sources of potential inaccuracy in job analysis. *Journal of Applied Psychology*, *82*(5), 627–655. https://doi.org/10.1037/0021-9010.82.5.627

Mullen, B., & Copper, C. (1994). The relation between group cohesiveness and performance: An integration. *Psychological Bulletin*, *115*(2), 210–227. https://doi.org/10.1037/0033-2909.115.2.210

Nanninga, M. C., Zhang, Y., Lehmann-Willenbrock, N., Szlávik, Z., & Hung, H. (2017). Estimating verbal expressions of task and social cohesion in meetings by quantifying paralinguistic mimicry. *Proceedings of the 19th ACM International Conference on Multimodal Interaction - ICMI 2017*, 206–215. https://doi.org/10.1145/3136755.3136811

Olguin, D. O., Waber, B. N., Taemie Kim, Mohan, A., Ara, K., & Pentland, A. (2009). Sensible Organizations: Technology and Methodology for Automatically Measuring Organizational Behavior. *IEEE Transactions on Systems, Man, and Cybernetics, Part B (Cybernetics)*, *39*(1), 43–55. https://doi.org/10.1109/TSMCB.2008.2006638

Olguin, D., & Pentland, A. (2010). Sensor-based organisational design and engineering. *International Journal of Organisational Design and Engineering*, *1*(1/2), 69. https://doi.org/10.1504/IJODE.2010.035187

Orvis, K. L., Diego, S., Duchon, A., & DeCostanza, A. (2013). *Developing Systems-based Performance Measures: A Rational Approach*. 12.

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Principles for the Validation and Use of Personnel Selection Procedures. (2018). *Industrial and Organizational Psychology*, *11*(S1), 1–97. https://doi.org/10.1017/iop.2018.195

Reiter, J. P. (2017). Survey Error. In N. Balakrishnan, T. Colton, B. Everitt, W. Piegorsch, F. Ruggeri, & J. L. Teugels (Eds.), *Wiley StatsRef: Statistics Reference Online* (pp. 1–5). John Wiley & Sons, Ltd. https://doi.org/10.1002/9781118445112.stat04232.pub2

Robertson, T. (2010) Artemis Spaceship Bridge Simulator (PC version) [Video game].

Rosh, L., Offermann, L. R., & Van Diest, R. (2012). Too close for comfort? Distinguishing between team intimacy and team cohesion. *Human Resource Management Review*, *22*(2), 116–127. https://doi.org/10.1016/j.hrmr.2011.11.004

Salas, E., Grossman, R., Hughes, A. M., & Coultas, C. W. (2015). Measuring Team Cohesion: Observations from the Science. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *57*(3), 365–374. https://doi.org/10.1177/0018720815578267

Santoro, J. M., Dixon, A. J., Chang, C.-H., & Kozlowski, S. W. J. (2015). Measuring and Monitoring the Dynamics of Team Cohesion: Methods, Emerging Tools, and Advanced Technologies. In *Team Cohesion: Advances in Psychological Theory, Methods and Practice* (Vol. 17, pp. 115–145). Emerald Group Publishing Limited. https://doi.org/10.1108/S1534-085620150000017006

Siebold, G. L. (1988). *Development of the platoon cohesion index* (Vol. 816). US Army Research Institute for the Behavioral and Social Sciences.

Siebold, G. L. (1999). The Evolution of the Measurement of Cohesion. *Military Psychology*, *11*(1), 5–26. https://doi.org/10.1207/s15327876mp1101_2

Siebold, G. L. (2006). Military Group Cohesion. In *Military life: The psychology of serving in peace and combat: Military performance, Vol. 1* (pp. 185–201). Praeger Security International.

Siebold, G. L., & Kelly, D. R. (1988). *Development of the Combat Platoon Cohesion Questionaire* (Vol. 817). US Army Research Institute for the Behavioral and Social Sciences. Chicago

Spector, P. E. (2006). Method Variance in Organizational Research: Truth or Urban Legend? *Organizational Research Methods*, *9*(2), 221–232. https://doi.org/10.1177/1094428105284955

Tausczik, Y. R., & Pennebaker, J. W. (2010). The Psychological Meaning of Words: LIWC and Computerized Text Analysis Methods. *Journal of Language and Social Psychology*, *29*(1), 24–54. https://doi.org/10.1177/0261927X09351676

Terada, K., & Yamada, S. (2017). Mind-Reading and Behavior-Reading against Agents with and without Anthropomorphic Features in a Competitive Situation. *Frontiers in Psychology*, *8*. https://doi.org/10.3389/fpsyg.2017.01071

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124–1131. https://doi.org/10.1126/science.185.4157.1124

Visser, P. S., Krosnick, J. A., & Lavrakas, P. J. (2000). Survey research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 223–252). Cambridge University Press.

Webb, E. and Weick, K.E. (1979) Unobtrusive Measures in Organizational Theory: A Reminder. *Administrative Science Quarterly*, *24*, 650-659. https://doi.org/10.2307/2392370

Webb, E. J., Campbell, D. T., Schwartz, R. D., & Sechrest, L. (1966). *Unobtrusive measures: Nonreactive research in the social sciences.* Rand Mcnally.

Yukelson, David; Weinberg, Robert; Jackson, Allen (1984). A Multidimensional Group Cohesion Instrument for Intercollegiate Basketball Teams. *Journal of Sport Psychology, 6*(1), 103–117. doi:10.1123/jsp.6.1.103

Zaccaro, S. J., & Lowe, C. A. (1988). Cohesiveness and Performance on an Additive Task: Evidence for Multidimensionality. *The Journal of Social Psychology*, *128*(4), 547–558. https://doi.org/10.1080/00224545.1988.9713774

Zaccaro, S. J., & McCoy, M. C. (1988). The Effects of Task and Interpersonal Cohesiveness on Performance of a Disjunctive Group Task1. *Journal of Applied Social Psychology*, *18*(10), 837–851. https://doi.org/10.1111/j.1559-1816.1988.tb01178.x

Zhang, Y., Olenick, J., Chang, C.-H., Kozlowski, S. W. J., & Hung, H. (2018). TeamSense: Assessing Personal Affect and Group Cohesion in Small Teams through Dyadic Interaction and Behavior Analysis with Wearable Sensors. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, *2*(3), 150:1-150:22. https://doi.org/10.1145/3264960

Zhu, B., Guo, X., Barner, K., & Boncelet, C. (2019). Automatic Group Cohesiveness Detection With Multi-modal Features. *2019 International Conference on Multimodal Interaction*, 577–581. https://doi.org/10.1145/3340555.3355716

APPENDICES

Appendix A

Select Cohesion Questionnaires

Scale	Items
Multidimensional Sport Cohesion Instrument (MSCI; Yukelson 1984)	1. Compared to other athletic teams that you have been a member of, how much do you value your membership on this team 2. Rate the degree to which your team has well defined roles in that each person knows what is expected of them. 3. How much do you feel your role or contribution to the team is valued by your teammates? 4. How much do you feel your role or contribution to the team is valued by the coaching staff? 5- How much do you enjoy playing with this particular team? 6. Do you feel you are an accepted member of this team? 7. In general, how much confidence do you have in your teammates' capabilities? 8. How good do you think the teamwork is on your team? 9. Rate the degree of pride you feel in being a member of this team. 10. In general, how much admiration do you have for your teammates? 11. Rate the degree of unselfishness on your team (i.e. teammates are willing to sacrifice their own glory for the benefit of the team). 12. How important is it to you that your teammates are on the same wavelength with one another (i.e. teammates are thinking alike in order to achieve successful team performance). 13. Do you feel your teammates have a clear understanding of the goals the team is striving to achieve? 14. Are you committed to the operating procedures your coach sets down for your team? 15. Rate the degree of support and mutual respect players have for one another. 16. How well do you think your teammates work together within their roles in order to achieve successful team performance? 17. How well does your coach prepare your team, both mentally and physically to demonstrate its skills during competition (i.e. strategy, roles and operating procedures are well understood). 18. Hon strong a sense of belonging do you feel you have to your team? 19. Do your teammates make you feel significant and worthwhile? 20. How satisfied are you with the friendships that you have developed within your team? 21. In general, I feel my role or contribution to the team is not valued "by my teammates. 22. In general, I do not feel much pride in being a member of this team. 23. In general, I think the teamwork on our team is poor. 24. Rate the degree of loyalty you have to your team.

	25. How much faith do you have in the players who are starters on your team in terms of their ability to execute the skills that are expected of them? 26. How much faith do you have in the players who are substitutes on your team in terms of their ability to execute the skills that are expected of them? 27. Rate the degree to which your coach creates an atmosphere where players have the right and freedom to express their ideas and feelings in a democratic way. 28. In general, our team seems to fall apart easily, and lose its intensity in crucial situations (i.e. when the going gets tough). 29. Do teammates tolerate different behavior by other team members off the field? 30. Conflict never seems to be resolved on our team (i.e. teammates argue a lot and have trouble getting along with one another). 31. Do you feel your team has an effective method by which to re-evaluate the goals and objectives the team is working toward 32. In general, I do not feel a strong sense of belongingness to this team. 33. Rate the degree of intensity with which your team works toward its goals. 34. To what extent do your teammates pick up the slack for one another when certain members are not playing well? 35. Do you feel your team is disciplined in terms of carrying out or executing the strategies that have been set down by your coach? 36. To what extent does someone on your team take charge when things are going bad, which in turn, gets the rest of the team to work together in a coordinated manner. 37. Do you perceive your team to be closely knit? 38. How well do you feel people on your team get along with one another off the playing field? 39. Do you desire to continue to be a member of this team? 40. Do you feel your team sticks together well when things are going bad? 41. Are you committed to your role on the team?
Team Cohesion Questionnaire (TCQ; Gruber et al., 1981)	1. How satisfied are you with your individual performance? 2. How satisfied are you with the performance of your team as a whole? 3. How important is it for me to participate in basketball to be with the guys? 4. How important is it for me to participate because I enjoy playing the game? 5. How important is it for me to participate so that I may be admired by others? 6. How much influence do you believe you had on the members of your team as far as the goals of the group were concerned? 7. How much do you like to play basketball in comparison to other activities? 8. How much did you like playing with this particular group of fellows? 9. How strong a "sense of belonging" did you have toward your team? 10. How good was the teamwork on your team?

	11. How closely knit do you think your team was? 12. Compared to other groups that you belong to, how much do you value your membership on this basketball team? 13. In terms of your definition of success in athletics, how satisfied are you about what was accomplished by the team this season?
Group Environment Questionnaire (GEQ; Brawley et al., 1987)	1. I do not enjoy being a part of the social activities of this team. 2. I'm not happy with the amount of playing time I get 3. I am not going to miss the members of this team when the season ends. 4. I am unhappy with my team's level of desire to win. 5. Some of my best friends are on this team. 6. This team does not give me enough opportunities to improve my personal performance. 7. I enjoy other parties more than team parties 8. I do not like the style of play on this team. 9. For me this team is one of the most important social groups to which I belong. 10. Our team is united in trying to reach its goals for performance 11. Members of our team would rather go out on their own than get together as a team. 12. We all take responsibility for any loss or poor performance by our team. 13. Our team members rarely party together. 14. Our team members have conflicting aspirations for the team's performance 15. Our team would like to spend time together in the off season. 16. If members of our team have problems in practice, everyone wants to help them so we can get back together again.` 17. Members of our team do not stick together outside of practices and games. 18. Our team members do not communicate freely about each athlete's responsibilities during competition or practice.
Work-adapted Group Environment Questionnaire (Carless & De Paola, 2000)	1. Our team is united in trying to reach its goals for performance 2. I'm unhappy with my team's level of commitment to the task (R) 3 Our team members have conflicting aspirations for the team's performance (R) 4. This team does not give me enough opportunities to improve my personal performance (R) 5. Our team would like to spend time together outside of work hours 6. Members of our team do not stick together outside of work time (R) 7. Our team members rarely party together (R) 8. Members of our team would rather go out on their own than get together as a team (R) 9. For me this team is one of the most important social groups to which I belong 10. Some of my best friends are in this team

Combat Platoon Cohesion Questionnaire (CPCQ; Siebold & Kelly, 1988)	Based on your observations, HOW IMPORTANT IS EACH OF THE FOLLOWING TO THE FIRST-TERM SOLDIERS IN YOUR PLATOON? 1. Loyalty to the United States Army. 2. Loyalty to the unit or organization. 3. Taking responsibility for their actions and decisions. 4. Accomplishing all assigned tasks to the best of their ability. 5. Putting what is good for their fellow soldiers and mission accomplishment ahead of personal desires. 6. Dedication to serving the United States, even to risking their lives in its defense. 7. Having high moral and personal standards. 8. Commitment to working as members of a team. 9. Dedication to learning their job and doing it well. 10. Personal drive to succeed in the Army and advance. 11. Being honest, open, and truthful. 12. Taking responsibility to ensure the job gets done. 13. Being disciplined and courageous in battle. 14. Standing up for what they firmly believe is right. 15. Building and maintaining physical fitness and stamina Based on your observations, HOW IMPORTANT IS EACH OF THE FOLLOWING TO THE LEADERS(NCO AND OFFICER) IN YOUR PLATOON? 16. Loyalty to the United States Army. 17. Loyalty to the unit or organization. 18. Taking responsibility for their actions and decisions. 19. Accomplishing all assigned tasks to the best of their ability. 20. Putting what is good for their fellow soldiers and mission accomplishment ahead of personal desires. 21. Dedication to serving the United States, even to risking their lives in its defense. 22. Having high moral and personal standards. 23. Commitment to working as members of a team. 24. Dedication to learning their job and doing it well. 25. Personal drive to succeed in the Army and advance. 26. Being honest, open, and truthful. 27. Taking responsibility to ensure the job gets done. 28. Being disciplined and courageous in battle. 29. Standing up for what they firmly believe is right. 30. Building and maintaining physical fitness and stamina These statements are all about the FIRST-TERM SOLDIERS IN YOUR PLATOON. 31. In this platoon the first-termers really care about what happens to each other. 32. Soldiers here can trust one another. 33. First-termers in this platoon feel very close to each other. 34. Soldiers like being in this platoon. 35. First-termers in this platoon really respect one another.

	36. Soldiers in this platoon like one another These statements are about the FIRST TERM-SOLDIERS IN YOUR PLATOON. For each statement, select the response that best describes your opinion. 37. Do the soldiers in your platoon make each other feel like doing a good job? 38. How well do the soldiers in your platoon work together? 39. To what extent do members of your platoon help each other to get the job done? 40. To what extent do members of your platoon encourage each other to succeed when in the field or at competitions? 41. Do the numbers of your platoon work hard to get things done? 42. To what extent do the members of your platoon pull together and share the load while in the field? These item concern the LEADERS IN YOUR PLATOON (NCO AND OFFICER). 43. First-term soldiers respect the leaders In this platoon. 44. When a soldier in this platoon goes for help, his leaders listen well and care about what the soldier says. 45. Leaders trust the first-term soldiers in this platoon. 46. Leaders really understand the soldiers in this platoon. 47. When asked for help in solving a personal problem, leaders in this platoon do their best to help out. 48. When a soldier wants to talk, his leaders make themselves available. 49. Leaders like being in this platoon. 50. Leaders in this platoon respect each other. 51. Leaders in this platoon care about one another as individuals. 52. The leaders in this platoon are the kind that soldiers want to serve under in combat. 53. The leaders in this platoon can really apply their knowledge to solve problems in the field. 54. The chain of command works well around here. 55. The leaders keep their soldiers well informed about what is going on. 56. Leaders keep themselves informed about the progress soldiers are making in their training. 57. The leaders in this platoon are experts and rcýn show tix- soldiers how best to perform a task. 58. The leaders work right along with their soldiers under the same hardships in the field. These are statements about the environment in your platoon. 59. The people in this platoon know what is expected of them. 60. Rules are consistently enforced. 61. The reasons for being rewarded or promoted are well known. 62. The behaviors that will get you in trouble or punished are well known. 63. The priorities in this platoon are clear.

	These statements about the FIRST-TERM SOLDIERS IN YOUR PLATOON. 64. The soldiers in this platoon feal they play an important part in accomplishing the platoon's mission. 65. Soldiers here are proud to be in this platoon. 66. First-term soldiers feel this platoon's wartime mission is very important. 67. The soldiers in this platoon are proud to be in the Army. 68. First-term soldiers feel the A=T has an important job to do in defending the United States in today's world How satisfied are the FIRST-TERM SOLDIERS IN YOUR PLATOON with the following aspects of platoon life? 69. The food served in the platoon dining facility. 70. The quality of the barracks or other on-post housing. 71. The availability of good off-post housing. 72. The time available for personal needs like going to the PX, cleaners, bank or barber shop. 73. The time available to spend with friends or family. 74. The quality and frequency of platoon parties and social gatherings. Next are some more statements about THE FIRST-TERM SOLDIERS IN YOUR PLATOON. 75. All in all, the duties soldiers perform in this platoon make them feel like they are serving their country. 76. Soldiers in this platoon have opportunities to better themselves. 77. Soldiers in this platoon can make progress toward achieving their educational goals. 78. Around here you can get the skills and training you want. 79. Soldiers assigned to this platoon can maintain a good standard of living For these general statements about your platoon, use the scale below to select your response to each statement 80. This platoon is very cohesive. 81. There is a very high degree of teamwork and cooperation among first-term soldiers In this platoon. 82. The first-term soldiers in this platoon get along very well with one another. 83. In this platoon, the leaders really care about what happens to the first-term soldiers. 34. Overall the leaders in this platoon are very good. 85. Even if this platoon was under a great deal of stress or difficulty, it would pull together to get the job done. 86. This is a very high performing platoon. 87. The leaders in this platoon appreciate the contributions of the first-term soldiers. 88. The first-term soldiers appreciate the contributions of the leaders in the platoon

	For each of the next statements, ABOUT YOUR PLATOON, use the scale printed below to select your response to each statement 89. In the event of combat, describe the confidence first-term soldiers would have in each other. 90. In the event of combat, describe the confidence first-term soldiers would have in their platoon leaders. 91. In the event of combat, describe the confidence platoon leaders would have in their soldiers. 92. In the event of combat, describe the confidence platoon leaders would have in each other. 93. Describe the confidence first-term soldiers in your platoon have in their weapons and equipment. 94. How high is the morale in your platoon? 95. Describe the state of your platoon's readiness. 96. Describe the state of discipline in your platoon. 97. How high is the determination or "will" to win in combat in your platoon? 98. Describe the degree of confidence members of this platoon have that it would perform well in combat
Platoon Cohesion Index (PCI; Siebold, 1988)	1. First-termers in this platoon uphold and support Army values, 2. Leaders in this platoon set the example for Army values 3. First-termers trust each other in this platoon 4. First-termers in this platoon care about each other. 5. How well do first-termers in your platoon work together to get the job done? 6. First-termers in this platoon pull together to perform as a team. 7. Leaders in this platoon trust each other 8. Leaders in this platoon care about each other. 9. First-termers in this platoon can get help from their leaders on personal problems. 10. Leaders and first-termers in the platoon care about one another. 11. Leaders and first-termers in this platoon train well together 12. Leaders in this platoon have the skills and abilities to lead first-termers into combat. 13. First-termers in this platoon know what is expected of them. 14. In this platoon the behaviors that will get you in trouble are well known. 15. First-termers in this platoon feel they play an important part in accomplishing the unit's mission. 16. First-termers are proud to be members of this platoon. 17. How satisfied are the first-termers in this platoon with the time available for family, friends and personal needs? 18. How satisfied are the first-termers with the social events in this platoon? 19. First-termers in this platoon feel they are serving their country. 20. First-termers in this platoon have opportunities to better themselves.

Appendix B

Items Adapted from the Moos Group Environment Scale

Scale

1 = Strongly disagree
5 = Strongly agree

Social Cohesion Items

1. There is a feeling of unity and cohesion in my team.
2. There is a strong feeling of belongingness among my team members.
3. Members of my team feel close to each other.

Task Cohesion Items

4. Members of my team share a focus on our work.
5. My team concentrates on getting things done.
6. My team members pull together to accomplish work.

Appendix C

Computer-game-specific Self-efficacy

Scale

1 = Not at all true
4 = Exactly true

Items

1. I can always manage to solve difficult problems within a videogame if I try hard enough.
2. In a videogame, if someone opposes me, I can find the means and ways to get what I want.
3. It is easy for me to stick to my plans and accomplish my goals in a videogame
4. I am confident that I could deal efficiently with unexpected events in a videogame.
5. Thanks to my resourcefulness, I know how to handle unforeseen situations in a videogame
6. I can solve most problems in a videogame if I invest the necessary effort.
7. I can remain calm when facing difficulties in a videogame because I can rely on my coping abilities.
8. When I am confronted with a problem in a videogame, I can usually find several solutions.
9. If I am in trouble in a videogame, I can usually think of a solution.
10. I can usually handle whatever comes my way in a videogame.