

Fall 2021

It's Not Just a Game: Exploring the Effects of an Escape Room Team Building Intervention

Andrew C. Griggs M.S.

Embry-Riddle Aeronautical University - Daytona Beach, griggsa2@my.erau.edu

Follow this and additional works at: <https://commons.erau.edu/edt>



Part of the [Human Factors Psychology Commons](#)

Scholarly Commons Citation

Griggs, Andrew C. M.S., "It's Not Just a Game: Exploring the Effects of an Escape Room Team Building Intervention" (2021). *PhD Dissertations and Master's Theses*. 625.

<https://commons.erau.edu/edt/625>

This Dissertation - Open Access is brought to you for free and open access by Scholarly Commons. It has been accepted for inclusion in PhD Dissertations and Master's Theses by an authorized administrator of Scholarly Commons. For more information, please contact commons@erau.edu.

IT'S NOT JUST A GAME: EXPLORING THE EFFECTS OF AN ESCAPE ROOM TEAM
BUILDING INTERVENTION

By

ANDREW C. GRIGGS

B.S., Psychology, Louisiana State University, Shreveport, 2016

M.S., Human Factors, Embry-Riddle Aeronautical University, 2019

A dissertation submitted to the Department of Human Factors and Neurobiology
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Human Factors

Embry-Riddle Aeronautical University
Daytona Beach, Florida
Fall 2021

Signature Page

IT'S NOT JUST A GAME: EXPLORING THE EFFECTS OF AN ESCAPE ROOM TEAM
BUILDING INTERVENTION

By

ANDREW C. GRIGGS

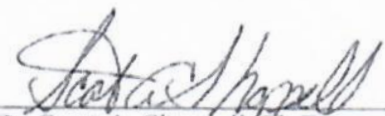
This dissertation was prepared under the direction of the candidate's Dissertation Committee Chair, Dr. Elizabeth H. Lazzara and has been approved by the members of the dissertation committee. It was submitted to the College of Arts and Sciences and was accepted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy in Human Factors.



Dr. Elizabeth H. Lazzara, Ph.D.
Committee Chair



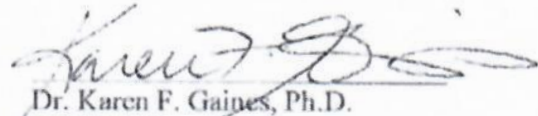
Dr. Joseph R. Keebler, Ph.D.
Committee Member



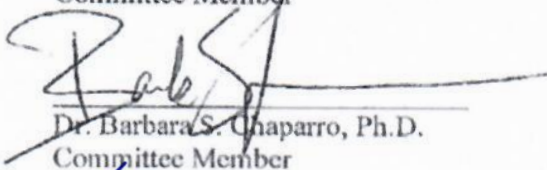
Dr. Scott A. Shappell, Ph.D.
Department Chair, Human Factors



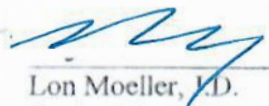
Dr. Shawn M. Doherty, Ph.D.
Committee Member



Dr. Karen F. Gaines, Ph.D.
Dean, College of Arts and Sciences



Dr. Barbara S. Chaparro, Ph.D.
Committee Member



Lon Moeller, J.D.
Senior Vice President for Academic
Affairs and Provost



Dr. Tara N. Cohen, Ph.D.
Committee Member

12/6/2021

Date

Acknowledgements

I'd first like to sincerely thank my advisor, Dr. Elizabeth H. Lazzara, for your immeasurable patience and invaluable guidance throughout my time at Embry-Riddle. It has been an honor to work with you, and I'll never be able to adequately thank you enough for all that you've done.

Thank you as well to my other committee members, Dr. Joseph R. Keebler, Dr. Shawn M. Doherty, Dr. Barbara S. Chaparro, and Dr. Tara N. Cohen, for your expertise and willingness to be a part of this project. I am extremely fortunate to have such a diverse and personable group of people to lean on. Thank you, Dr. Gaines, Dr. Shappell, Dr. Blickensderfer and Provost Moeller for being a part of this process.

I'd also like to thank and acknowledge my parents, Mandy and Andy Griggs, for being my rock over the past few years. There is no way I could have made it this far without your support. Thank you as well to Lizzie, Jimmy, and all the other family members who've supported me. I love and appreciate you all more than I could ever adequately express in words.

Thank you to my friend Nick, for putting up with my incessant grumbles throughout this process and for being a source of motivation on days where I needed it most. Thank you to my friend Todd, for being a constant source of "inspiration" in recent years and helping me to laugh when it was tough to even smile. Many thanks as well to other friends and colleagues, both local and afar, for your support.

Thank you to Jordan Rogers for assisting in the theoretical development of the behavioral measures and recruitment materials used in this work. Special thanks must also be given to Kimberly Williams, Sarah Napoli, and Addison Rohrbacher for their help in braving the task of coding teamwork behaviors at my side.

Abstract

Escape rooms have been used as a training intervention in multiple contexts, but their efficacy as a team building intervention is not well understood. The purpose of this study was to assess the effects of a team building escape room on perceptions of team processes and perceived team effectiveness, the sustainability of these effects, as well as relationships between team processes and task completion in this context. This research utilized archival data of 33 healthcare teams ($n = 145$ participants) completing a team building escape room and prospectively collected follow-up data from the same participants ($n = 49$ participants). Analyses indicated that team process perceptions did not significantly correlate with team process behaviors, participants' perceptions of team processes returned to baseline after one year, and that team process perceptions and behaviors were not predictive of task completion. A significant improvement in perceived team effectiveness was observed immediately following participation in the escape room. This improvement was positively influenced by task completion. However, this effect did not persist; participants' perceived team effectiveness returned to baseline after one year. This study has demonstrated the utility of an escape room team building intervention in improving perceptions of team effectiveness up to one month after the activity, including the positive influence of task completion on this outcome. Implications of these results and considerations for future research are discussed. This work has provided a foundation for future research to continue exploring the utility of team building escape rooms using a multi-method approach.

Keywords: escape room, team building, team processes, teams, teamwork

Table of Contents

Title Page	i
Signature Page	ii
Acknowledgements	iii
Abstract	iv
Table of Contents	v
List of Figures	ix
List of Tables	x
Chapter One: Introduction	1
Background	1
Problem Statement	2
Statement of Purpose.....	4
Chapter Two: Review of Related Literature	6
Introduction	6
Escape Rooms	6
Prior Escape Room Research	8
Challenges and Limitations Associated with Prior Escape Room Research	9
Conceptualizing Teamwork through Team Processes	12
Action Processes.....	14
Transition Processes	15
Interpersonal Processes.....	16
Escape Rooms as Testbeds for Teams Research.....	16
Escape Rooms and Superordinate Team Processes	19
Hypothesis 1	20
Hypothesis 2	21
Hypothesis 3	23
Escape Rooms and Subordinate Team Processes	25
Goal Specification	26
Hypothesis 4.....	27
Hypothesis 5.....	27
Monitoring Progress Towards Goals.....	27
Hypothesis 6.....	28

Hypothesis 7.....	29
Motivating and Confidence Building	29
Hypothesis 8.....	30
Hypothesis 9.....	31
Conceptualizing Attitudes about Teamwork through Perceived Team Effectiveness	31
Perceived Team Effectiveness and Escape Rooms	33
Hypothesis 10.....	34
Hypothesis 11.....	35
Hypothesis 12.....	36
Summary	37
Chapter Three: Materials and Methods.....	39
Introduction	39
Research Design.....	39
Population and Sample.....	39
Population.....	39
Sample	40
Research Methodology.....	40
Data Collection	40
Participant Eligibility Requirements	41
Participants’ Protection.....	41
Legal and Ethical Consideration.....	42
Materials.....	42
Escape Room	42
Survey Metrics	45
Demographics	45
Perceptions of Team Processes.....	46
Perceived Team Effectiveness.....	47
Behavioral Metrics	48
Behavioral Indicators of Goal Specification	48
Behavioral Indicators of Monitoring Progress Towards Goals	49
Behavioral Indicators of Motivation and Confidence Building	50
Extraction of Behavioral Data from Videos	50

Behavioral Metric Data Collection Sheet	51
Reliability Assessment	51
Chapter Four: Results	53
Introduction	53
Missing and Excluded Data	53
Data Analysis	53
Power Analysis.....	55
Statistical Assumptions of Selected Analyses.....	55
Descriptive Statistics	56
Sample Characteristics	56
Escape Room Variables.....	61
Reliability of Survey Metrics	62
Reliability of Behavioral Metrics	63
Survey Data	64
Behavioral Data	66
Inter-Item Correlations	66
Results of Inferential Analyses	67
Immediate Effects on Superordinate Team Processes (H1)	67
Differences in Effects on Superordinate Team Processes Based on Task Completion (H3)	67
Sustainment of Effects on Superordinate Team Processes (H2)	67
Effects of Subordinate Team Processes on Task Completion (H4-H9)	69
Immediate Effects on Perceived Team Effectiveness (H10).....	72
Sustainment of Effects on Perceived Team Effectiveness (H11).....	73
Influence of Task Completion on Perceived Team Effectiveness (H12)	74
Exploratory Analyses	76
Chapter Five: Discussion.....	81
Summary of Results	81
Superordinate Team Processes	82
Subordinate Team Processes and Task Completion.....	83
Perceived Team Effectiveness.....	84
Exploratory Analyses	86
Implications.....	88

Theoretical Implications	88
Practical Implications	90
Limitations	92
Recommendations for Future Work	94
Chapter Six: Conclusion	98
References	101
Appendices	112
Appendix A	112
Appendix B	113
Appendix C	115
Appendix D	117
Appendix E	118
Appendix F	121
Appendix G	121
Appendix H	122
Appendix I	122
Appendix J	123
Appendix K	124
Appendix L	125
Appendix M	127
Appendix N	127
Appendix O	128
Appendix P	128

List of Figures

Figure 1: Hypothesis 1	21
Figure 2: Hypothesis 2	23
Figure 3: Hypothesis 3	24
Figure 4: Hypothesis 4	27
Figure 5: Hypothesis 5	27
Figure 6: Hypothesis 6	29
Figure 7: Hypothesis 7	29
Figure 8: Hypothesis 8	30
Figure 9: Hypothesis 9	31
Figure 10: Hypothesis 10	35
Figure 11: Hypothesis 11	36
Figure 12: Hypothesis 12	37
Figure 13: Layout of the Escape Room	43
Figure 14: Layout of the Control Room	44
Figure 15: Estimated Marginal Means of Perceived Team Effectiveness	77

List of Tables

Table 1: Examples of Team Process Survey Items.....	47
Table 2: Perceived Team Effectiveness Items	48
Table 3: Characteristics of Participants' Education in Archival Sample.....	56
Table 4: Job Roles Reported by Escape Room Participants in Archival Sample.....	57
Table 5: Prior Escape Room Experience in Archival Sample	58
Table 6: Prior Team Building Experience in Archival Sample	58
Table 7: Characteristics of Participants' Education in Prospective Sample	59
Table 8: Job Roles Reported by Escape Room Participants in Archival Sample.....	59
Table 9: Overview of Team Turnover in the Prospective Sample.....	60
Table 10: Additional Escape Room Experience in Prospective Sample	60
Table 11: Additional Team Building Experience in Prospective Sample	61
Table 12: Overview of Escape Outcome	62
Table 13: Overview of Time to Escape, Hints Used, and Task Completion	62
Table 14: Summary of Survey Metrics' Reliability.....	63
Table 15: Summary of Behavioral Metrics' Inter-Rater Reliability.....	64
Table 16: Summary of Perceptions of Team Processes at Each Time Period.....	65
Table 17: Summary of Perceived Team Effectiveness at Each Time Period	65
Table 18: Overview of Behavioral Data Extracted from Escape Room Recordings.....	66
Table 19: Summary of Hypothesis 2	67
Table 20: Summary of Hypotheses 4-9	69
Table 21: Summary of Hypothesis 10	72
Table 22: Summary of Hypothesis 11	73
Table 23: Summary of Hypothesis 12	74
Table 24: Summary of Performed Analyses and Hypothesis Testing	81
Table 25: Summary of Exploratory Analyses.....	82

Chapter One: Introduction

Background

For decades, teams have been viewed as critical assets across multiple industries (Ilgen, 1999). Many industries utilize teams to meet the dynamic and growing demands on today's workforce that cannot be met by individuals alone. Without teamwork, it is unlikely that many industries could function; teams must work together effectively to be of use to organizations. Team effectiveness is subsequently important to many facets of society.

The effectiveness of teams is often conceptualized through the lens of inputs, processes, and outputs (Ilgen et al., 2005; McGrath, 1964). Inputs are present before a team begins a task and refer to internal or external characteristics of resources available to the team such as individual differences in expertise or the composition of the team (Ilgen et al., 2005). Outcomes are the products of teamwork and often refer to the criteria that is used to assess team performance following a task, or how effectively a team achieved their shared goal (Ilgen et al., 2005). Processes refer to "members' interdependent acts that convert inputs to outcomes through cognitive, verbal and behavioral activities directed toward organizing taskwork to achieve collective goals" (Marks et al., 2001, p. 357). Team processes are the mechanisms by which a team coordinates their efforts to work together during a task. Team processes have been demonstrated to have multiple positive relationships with outcomes such as team performance and member satisfaction (LePine et al. 2008). Given the inherent importance of teams today, there is a continuously growing body of scientific literature dedicated to the study of teams and interventions that can improve team processes and outcomes.

Organizations often utilize varying team interventions to improve team processes and outcomes, such as team building or team training (Shuffler et al. 2011). Such interventions are

often referred to as team development interventions (TDIs) and can encompass both technical competencies (team training) as well as non-technical competencies (team building) (Shuffler et al., 2011). Team training interventions are characterized by an emphasis on specific knowledge, skills, and attitudes (KSAs) required for optimal team performance (Shuffler et al. 2011). Conversely, team building interventions seek to provide opportunities to improve interpersonal relationships and social interactions between team members (Shuffler et al., 2011). A primary goal of team interventions is to examine team processes (Salas & Cannon-Bowers, 2000). This is supported by previous research which has shown that team training and team building are effective tools in improving team processes (Klein et al., 2009; Lacerenza et al., 2018; Salas et al., 1999; Shuffler et al., 2011).

In the past five years, escape rooms have been receiving increased attention as a game-based avenue to facilitate team training and team building (Friedrich et al., 2019; Gordon et al., 2019; Jambhekar et al., 2019; Warmelink et al., 2017; Zhang et al., 2018). Escape rooms are a recreational, team-based activity wherein multiple individuals must work together to solve a series of challenges or puzzles in a limited amount of time (Nicholson, 2015). Successfully “escaping the room” is dependent on a team’s ability to solve all the challenges or puzzles in a room before their time runs out.

Problem Statement

Organizations require interventions that can foster improvements in teamwork that transfer to multiple contexts. Escape rooms hold promise as a game-based team intervention towards this end, but the utility of escape rooms must be studied more thoroughly. Escape rooms in the current literature base are emblazoned with novelty; this area of research is still very young, and the current literature lacks consistency across studies concerning their methodologies

and metrics to assess improvements in teamwork or team outcomes. Escape rooms have been used as a team intervention in a variety of domains, but applications of an escape room as a team intervention have largely manifested as an educational aide or team training, focusing primarily on the acquisition of specific skills or knowledge. Escape room team building interventions are largely nascent in the literature; very few published studies have examined escape rooms as an alternative team building mechanism. Furthermore, there are multiple shortcomings in the methodology of published team building escape room studies concerning the constructs that have been utilized to assess teamwork or team outcomes. These shortcomings can be pragmatically addressed through the inclusion of team processes and perceived team effectiveness as constructs in future escape room research.

Team development interventions should examine team processes (Salas & Cannon-Bowers, 2000). Escape rooms function as a good testbed to examine team processes due to their task demands; the design of an escape room often forces interdependence and cooperation among its participants, such as the teamwork needed to solve a puzzle with elements located at different physical positions in the room (Cohen et al., 2020). Furthermore, many competencies required to excel in an escape room, such as collaboration and the generation of novel solutions, are transferable to a wide variety of contexts. Despite the theoretical links between the tasks associated with an escape room and team processes, the current published literature utilizing escape rooms is not grounded in team process theory. A prior systematic review of escape room studies that have been performed using healthcare samples has not identified any studies that have leveraged measures of team processes (Griggs et al., 2020).

In addition to team development interventions focusing on team processes, a key outcome of such interventions is team effectiveness (Klein et al., 2009; Lacerenza et al., 2018).

The characteristics of an escape room can function as a mechanism to reinforce positive perceptions of a teams' effectiveness by providing opportunities for the team to succeed, but this has not yet been assessed as a team outcome. Beyond the constructs studied in prior work, there are also many shortcomings surrounding the experimental designs of escape room team building interventions in research.

The present literature base has not evaluated the influence of participation in an escape room team building activity on perceptions of team processes and team effectiveness, nor have long-term effects of such an intervention been assessed. Prior studies have also not examined relationships between task completion in an escape room and team processes or perceptions of team effectiveness. Specifically, it is not yet known whether teams must solve puzzles or complete challenges for improvements in team outcomes to manifest. It is also not yet known whether the magnitude of such effects is differentially impacted by the quantity of puzzles or challenges that are completed by participant teams. Prior studies using escape rooms as a team building intervention are also limited to simple pre-post designs; longitudinal data must be evaluated to discern the sustainability of escape room team building interventions.

Statement of Purpose

Teams are essential assets to organizations, but they require interventions to improve team processes and outcomes. Escape rooms have been leveraged as an avenue to facilitate team building, but the methodology surrounding their use in research can be improved. Therefore, the purpose of this study was to empirically assess the efficacy of an escape room team building intervention to improve team processes and team outcomes, to assess the sustainability of such effects, as well as to explore relationships between teamwork and task completion in an escape room. This study aimed to advance the science underlying escape rooms in research by using

novel constructs and methodology in its evaluation of an escape room team building intervention.

This research sought to contribute to the current literature by empirically examining variables related to team building that have not yet been thoroughly assessed in the context of escape room team interventions. It is important to consider both team processes and team outcomes, as outcomes alone do not always accurately reflect the work that was done to arrive at successful task completion (Essens et al., 2005). This research aimed to illustrate the effects of participation in an escape room team building activity on perceptions of team processes and perceived team effectiveness using psychometrically validated metrics. This work also assessed relationships between team processes and task completion in the room to better understand how teamwork contributed to team effectiveness. Additionally, this research explored relationships between participant teams' task completion in the escape room and their improvements in team outcomes to inform future design decisions concerning the use of escape rooms in improving teams, such as the level of difficulty required to either foster or preclude improved team outcomes. Finally, this research leveraged longitudinal data to assess the sustainability of an escape room team building intervention.

Chapter Two: Review of Related Literature provides an in-depth review of the prior research that has laid the foundation for this work as well as the theoretical rationale that guided the selection of constructs and experimental design in this work.

Chapter Two: Review of Related Literature

Introduction

This chapter discusses a review of related literature concerning escape rooms, their use in teams research, team processes, and perceived team effectiveness.

Escape Rooms

Escape rooms are “live-action, team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited amount of time" (Nicholson, 2015, p. 1). The characteristics of an escape room combine elements of chance, group interactions, and time pressures to create an engaging experience (Kolar, 2017). Nicholson (2015) denotes multiple precursors to escape rooms including live-action role playing, point-and-click adventures, puzzle and treasure hunts, interactive theatre and haunted houses, adventure and game show movies, and a themed entertainment industry. Escape rooms are a relatively new recreational activity which started in Japan in 2007 (SCRAP, 2007). Escape rooms have rapidly garnered popularity in recent years, and today, there are a multitude of businesses offering escape rooms as a recreational group activity internationally. There are at least 4,096 escape rooms located across 1,769 different sites in 68 different countries (Dilek & Dilek, 2018).

Escape rooms are designed for teams of participants which can vary in size. A survey of 175 escape room businesses across the globe revealed an average team size of 4.58 people (Nicholson, 2015). Generally, team sizes range from two to eight participants (Cohen et al., 2020). To facilitate time pressures during the activity, teams are often given a predetermined amount of time to complete the puzzles or challenges throughout the escape room. These puzzles or challenges can be presented in a variety of ways, including different types of puzzles for

participants to complete as well as different techniques to organize the presentation of these puzzles to participants.

Escape rooms have leveraged a multitude of different types of puzzles. Nicholson (2015) offers a detailed discussion of the most common puzzle types that have been utilized in escape rooms internationally, with some common examples consisting of searching for physical objects hidden in the room, noticing something “obvious” in the room, using something in an unusual way, or searching for objects in an image (p. 19). Usually, successful completion of a puzzle functions as progress towards a larger meta-puzzle that must be completed to achieve the win-condition of the game (i.e., escaping the room). However, this does not always have to be accomplished in a linear fashion. Nicholson (2015) also denotes three conventions that have been utilized to organize the presentation of puzzles in an escape room: sequential, open structure, and path-based. The most common convention regarding puzzle organization is path-based, wherein players are presented with multiple sequences of puzzles simultaneously, with each sequence leading towards the completion of a meta-puzzle. Each of these sequences of puzzles must be completed to escape the room; however, each path may be completed in any order, and team members can work towards the completion of multiple paths simultaneously. The second most common convention is sequential puzzle organization, which involves the presentation of a single path of puzzles that must be solved in a linear fashion to make progress towards completion of a larger meta-puzzle. The least common convention is an open puzzle structure, which features a non-sequential collection of puzzles that, when solved, each function as progress towards completion of a meta-puzzle needed to “escape the room.” These puzzle organization conventions are not fixed, and some facilities utilize a hybrid model that leverages different puzzle organizations at different points of progress throughout the escape room. Puzzles

in an escape room may also reflect characteristics of the escape room's theme or narrative (Nicholson, 2015).

Escape rooms can feature a simple collection of puzzles or tasks with no theme or narrative such that each puzzle is unrelated thematically to each other puzzle and they are not accompanied by any narrative elements. Conversely, the development of puzzles in an escape room can also be guided by its narrative or theme. Escape rooms often utilize a compelling narrative to foster immersion and engagement during the activity (Nicholson, 2018). An escape room can feature a consistent narrative which places team members into specific task roles during the escape room without a consistent theme that connects the puzzles throughout the room. Like a movie set without a script, an escape room can also have a consistent theme with no narrative. For example, an escape room may be modeled thematically after a spaceship or an ancient Greek city while also featuring no narrative elements related to these themes that guide the players. Finally, an escape room can feature both a consistent narrative and theme, wherein narrative elements of the room are accompanied by puzzles that are related to the room's theme (Nicholson, 2015).

Prior Escape Room Research

Escape rooms can be a valuable testbed for research (Cohen et al., 2020). Escape rooms have been used as an educational aid as well as avenues to facilitate team training and team building. Escape rooms can be leveraged as an educational aid by incorporating elements of desired learning outcomes into the task demands of puzzles throughout the escape room (Cohen et al., 2020). For example, if an escape room was desired to educate nursing participants on a particular skill, such as dosage calculations, these competencies can be embedded into the task demands of puzzles within the escape room and must be demonstrated by the participants to

succeed. By incorporating learning outcomes into puzzle design, escape rooms have been used to beneficially augment education in a wide variety of domains such as computer security (Béguin et al., 2019), manufacturing practices (Berthod et al., 2019), chemistry (Dietrich, 2018), cryptography (Ho, 2018), engineering (Borrego et al., 2017), entomology (Healy, 2019), forensic science (Ferreiro-González et al., 2019), programming (López-Pernas et al., 2019), and robotics (Giang et al., 2018). Escape rooms have also been utilized to foster team training in a similar fashion by functioning as simulation-based avenues to practice domain-specific competencies related to areas such as disaster preparedness (Patineau et al., 2019), patient safety in healthcare (Diemer et al., 2019; Zhang et al., 2019), pharmacology (Eukel et al., 2017), and nursing (Edwards et al., 2019).

Conversely, puzzles in an escape room can feature very generic task demands which are not bound to any specific learning outcomes. This is the key distinction between current applications of an escape room in research; their use in education and team training are bound by desired learning outcomes, while their use in team building does not feature a similar emphasis on specific learning outcomes. Applications of an escape room as an avenue to foster team building are more limited in the current literature base in comparison to education or training applications (Griggs et al., 2020); however, they have been successfully utilized to improve teamwork and communication among health profession students (Friedrich et al., 2019; Kutzin, 2019), enhance collective orientation (Gordon et al., 2019), and foster team cohesiveness (Cohen et al., 2021; Warmelink et al., 2017).

Challenges and Limitations Associated with Prior Escape Room Research

Given the novelty and recent adaptation of escape rooms as a research testbed, it is unsurprising that there are challenges or limitations associated with their use. First, since escape

rooms are an interactive and dynamic experience, it is very difficult to fully anticipate the myriad behaviors individuals may exhibit while completing the activity. As a result, some participants may try to gain an unfair advantage while completing puzzles or challenges in the room (i.e., cheating). Cheating, an action that gives players an unfair advantage that is also considered unfair by the game developer (Webb & Soh, 2007), can manifest in a variety of ways during an escape room activity, such as attempts to forcefully open a lock without first obtaining the correct combination (Cohen et al., 2020). Cheating can also preclude meaningful comparisons of groups in an escape room if left unchecked or unaccounted for, as assessments of a team that cheated are no longer a direct product of their teamwork or performance in the room alone (Cohen et al., 2020).

A second challenge associated with escape rooms in research can be found in standardizing the process of resetting the escape room between trials (Cohen et al., 2020). A key component of escape room activities is exploration; players often begin exploring the room conservatively or tentatively at first but will begin to explore the room and its physical props more aggressively as they continue to look for clues (Nicholson, 2015). This exploratory nature of escape rooms often ensures that the physical layout of a room and its artifacts will change dramatically as a team attempts to complete the activity. It is, therefore, very important that the room is reset in a systematic way between participant teams to afford for more consistency in comparisons across groups (Cohen et al., 2020). Inconsistencies between the physical environments across groups can have downstream impacts on data collected across teams.

A third challenge is that researchers must also consider how they will systematize their interactions with teams during the activity, such as the provision of hints. Hints are tools often used by facilitators of escape rooms to assist teams in progressing past a point in the activity that

is giving them difficulty (Cohen et al., 2020). Hints can be verbally offered to participants during the activity and may include a suggestion for where to find a clue to a puzzle or how to synthesize clues towards a puzzle's completion. Hints should be considered heavily in research, however, as they can have negative impacts on data collection if offered inconsistently. Like inconsistencies in the physical layout of the escape room, inconsistencies in the provision of hints can skew comparisons across teams in the activity. Hints can introduce additional variance such that participants' perceptions or behaviors are invariably altered as a result of having received the hint(s) (Cohen et al., 2020). Consistency in the provision of hints can help to minimize the amount of such variance that is introduced in data collection.

A fourth challenge for researchers to overcome in escape room research involves participant recruitment. It is inconvenient for participants to travel to distant simulation sites (Rosen et al., 2016), which can subsequently lead to difficulties in achieving large sample sizes in escape room research. Researchers are, therefore, recommended to develop rooms that are proximally located to their sample of interest to minimize the amount of travel or logistics that are associated with participation (Cohen et al., 2020). While the recreational connotation of escape rooms can serve as an alluring incentive to participants during recruitment, it can also lead to response bias if participants do not take the activity or any related metrics seriously (Cohen et al., 2020).

These challenges discussed so far have implications for the use of escape rooms in any research capacity and are relevant considerations for the use of escape rooms as an avenue to augment education and to facilitate team training or team building. There are additional limitations in the current literature base reporting the use of escape rooms as a teams research testbed, including the constructs that have been measured and their experimental designs.

Conceptualizations of teamwork in escape room research have thus far been oversimplified. Of the escape room team building research that has been conducted, no studies to date have utilized measures of team processes to operationalize teamwork. Additionally, most escape room team building research has relied on self-reported perceptions concerning teamwork that have not been corroborated with observable teamwork behaviors. As self-reported perceptions do not always align with individuals' exhibited behaviors, Cohen et al., (2020) recommend utilizing both survey and observational data to measure constructs related to teamwork. This approach has not yet been reported in the current literature base. As mentioned previously, a key outcome of team development interventions is team effectiveness (Klein et al., 2009; Lacerenza et al., 2018). Despite the multiple opportunities to reinforce perceptions of effectiveness found in the puzzles of an escape room (i.e., multiple opportunities for success), no measures of team effectiveness have been reported in the literature. It is important to consider both the processes a team engages in during task completion as well as the impact these processes may have on team outcomes, such as their perceptions concerning their ability to effectively work together to complete a shared goal. There are also limitations in the experimental designs that have been reported in the current escape room team building literature. The present literature base favors simple, pre-post, within groups comparisons. As a result, assessments of the sustainability of effects of an escape room team building activity through longitudinal data collection have yet to be performed.

Conceptualizing Teamwork through Team Processes

Industries rely on teams to complete tasks that are beyond the scope of what an individual can achieve while working alone. Teamwork, the ability to work together with others to achieve a shared goal (Mathieu et al., 2001), is vitally important to the wellbeing of many industries as a

result. Teams are commonplace in many organizations and provide critical functions within areas such as “hospitals, schools, flight decks, nuclear power plants, oil rigs, the military, and corporate offices” (Salas et al., 2018, p. 593). Compared to the work of lone individuals, teams can provide benefits to organizations by taking on greater amounts of work, affording capabilities to provide support to one another during task completion, self-monitoring to reduce errors, and dynamically shifting the workload between team members as needed (Goodwin et al., 2018). Given the importance of teamwork across these industries, many researchers have sought to model the impacts of teamwork on team effectiveness. Such models provide a framework to better understand the factors that can influence whether a team is able to effectively accomplish their shared goal.

As stated previously, team effectiveness is often conceptualized through the lens of inputs, processes, and outputs (Ilgen et al., 2005; McGrath, 1964). The input-process-outcome (IPO) heuristic is the most prevalent conceptualization of the relationships among variables that are associated with team effectiveness (Grossman et al., 2017). This perspective views team effectiveness as the product of a constellation of varying team member characteristics, tools, technologies, and contexts (inputs), that subsequently impact the activities of team members during task completion (processes), ultimately leading to team effectiveness (outcomes) (LePine et al., 2008; McGrath, 1964). Team processes have also been viewed as a mediating influence on team outcomes, as the actions of team members can differentially contribute to task completion (Ilgen et al., 2005; Mathieu et al., 2008). Marks et al., (2001) refer to other non-behavioral mediating influences related to cognitive, emotional, or affective states as emergent states. Additionally, models of team effectiveness view the performance of teams through an episodic approach, wherein different performance episodes during a task’s completion may each be

characterized by distinct goals and sub-goals that necessitate different facets of teamwork at different points of task completion.

Team processes are often used to conceptualize different facets of teamwork. Team processes refer to “members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing taskwork to achieve collective goals” (Marks et al., 2001, p. 357). Put more simply, team processes refer to the specific behavioral functions that enable a team to work together towards a shared goal. Marks et al. (2001) have published a taxonomy of team processes that has received significant attention in the teams literature. This taxonomy provides a framework that is grounded in validated teams theory through which teamwork can be assessed over time as a team works to complete their task. This framework takes an episodic approach, such that teams progress through multiple performance episodes during a task's completion. Marks et al. (2001) have identified 10 critical team processes that teams can engage in during these performance episodes, such as goal specification, monitoring progress towards their goals, and motivation or confidence building. Each of these team processes are mapped to three distinct categories (i.e., action phase processes, transition phase processes, and interpersonal processes). Each of these categories represent differing behaviors members of a team can engage in during task completion that culminate in what is colloquially known as teamwork. These categories are not rigid, however. Teams can exhibit transition, action, or interpersonal processes simultaneously as they work together towards a shared goal (Marks et al., 2001).

Action Processes

The action phase of Marks et al.'s (2001) taxonomy is associated with periods of time wherein team members are performing actions which directly contribute towards task completion

(i.e., taskwork). There are four action processes described in Marks et al.'s (2001) taxonomy: 1) systems monitoring, 2) team monitoring and backup behavior, 3) coordination, and 4) monitoring progress towards goals. Systems monitoring refers to efforts of team members to monitor team resources or other factors of the team's working environment with the goal of facilitating successful task completion (LePine et al., 2008). Team monitoring and backup behavior characterizes attempts of team members "going out of their way to assist other members in the performance of their tasks" (LePine et al., 2008, p. 276). This can involve indirect assistance to teammates such as feedback or coaching, direct help to teammates such as assistance with taskwork, or attempts to behaviorally compensate for members of their team, such as assisting a team member with their taskwork (LePine et al., 2008). Coordination characterizes team members synchronizing or aligning the sequencing or timing of their activities with their other team members (LePine et al., 2008; Marks et al., 2001). Monitoring progress towards goals refers to attempts by team members to attend to, interpret, and communicate information needed to assess the team's progress towards a shared goal (LePine et al., 2008; Marks et al., 2001).

Transition Processes

The second group of team processes are related to the transition phase. Transition phases refer to times between performance episodes wherein a team is focused on evaluating or planning activities which can facilitate task completion (LePine et al., 2008; Marks et al., 2001). There are three transition processes outlined in Marks et al.'s (2001) taxonomy: 1) mission analysis, 2) strategy formulation, and 3) goal specification. Mission analysis refers to the "identification and evaluation of team tasks, challenges, environmental conditions, and resources available for performing the team's work" (LePine et al., 2008, p. 276). Strategy formulation

involves the development and adjustment of plans which can guide successful task completion (LePine et al., 2008). Goal specification is characterized by actions that seek to denote, clarify, or prioritize goals that are needed to ensure successful task completion (LePine et al., 2008).

Interpersonal Processes

While transition and action processes are bounded in their relation temporally to performance episodes (i.e., between and during task completion respectively), interpersonal processes can occur throughout both transition and action phases of a performance episode. Interpersonal processes can function as the foundation for the effectiveness of other team processes. Marks et al.'s (2001) taxonomy describes three interpersonal team processes: 1) conflict management, 2) affect management, and 3) motivating and confidence building. As the name would imply, conflict management refers to proactive and retroactive behaviors to mitigate conflict within the team (LePine et al., 2008). Affect management characterizes team members' efforts to "foster emotional balance, togetherness, and effective coping with stressful demands and frustration" (LePine et al., 2008, p. 277). Motivation and confidence building refers to attempts to both build or maintain motivation and confidence within the team concerning their ability to effectively complete their shared task(s) (LePine et al., 2008).

Escape Rooms as Testbeds for Teams Research

Escape rooms have garnered significant attention in the teams research literature within the past five years. Given the team-based nature of escape rooms and the emphasis they place on effective teamwork to succeed, escape rooms are well suited to function as testbeds to systematically examine constructs related to teamwork in active problem-solving scenarios (Cohen et al., 2020). To succeed, teams must exhibit multiple competencies, such as teamwork, communication, delegation, and critical thinking (Nicholson, 2015). Subsequently, many studies

in the reported literature have focused on constructs that are relevant to teams. Additionally, the characteristics of escape rooms' designs and game mechanics lend themselves to teams research applications.

A variety of constructs related to teams have been studied in the escape room literature that are related to the attitudes, behaviors, and cognitions of teams. In other words, escape room constructs have included measures of how teams feel, act, and think. For example, escape rooms can be used to assess attitudes related to team orientation (Cohen et al., 2020; Gordon et al., 2019), trust, team efficacy, and satisfaction (Cohen et al., 2020). Escape rooms are also interactive, enabling researchers to examine the behaviors of team members during the activity and how they interact with elements of the room or each other. This can be seen in the escape room literature that has included measures of collaboration (Pan et al., 2017; Zhang et al., 2018), communication (Bakhsheshi, 2019; Clarke et al., 2016; Friedrich et al., 2019; Pan et al., 2017; Williams, 2018), conflict management (Pan et al., 2017), leadership (Järveläinen & Paavilainen-Mäntymäki, 2019; Wu et al., 2018), and problem-solving (Järveläinen & Paavilainen-Mäntymäki, 2019). Escape rooms are also well suited to examine behavioral indicators of team processes (Cohen et al., 2020); however, such investigations have not yet been reported in the literature. Escape rooms can also be leveraged to influence the cognitions of teams, such as shared mental models (Pan et al., 2017); however, this is most often seen through attempts to foster learning in team training or education (Bartlett & Anderson, 2019; Beguin et al., 2019; Berthod et al., 2019; Cohen et al., 2020; Dietrich et al., 2018; Giang et al., 2018; Ouariachi & Wim, 2020; Ross & Bell, 2019; Veldekamp et al., 2020).

In addition to the constructs that can be measured in an escape room during research, the design characteristics of an escape room, such as variations in how parameters of its game

mechanics are configured (e.g., allowed time, allowed hints, number of puzzles, puzzle difficulty, etc.) can be used to explore research questions related to teams. For example, pressures related to limited time have been observed to place emphasis on effective communication and problem-solving skills within a team to succeed (Bakhsheshi, 2019; Pan et al., 2017). Time limitations can be varied in an escape room to facilitate more or less pressure on its teams as desired. Additionally, time pressures can facilitate more genuine interactions in an escape room than may be otherwise afforded in other simulated contexts (Cohen et al., 2020; Pan et al., 2017), as each member is incentivized to only engage in interactions which are perceived to positively and immediately contribute to the team's shared goal (i.e., escaping the room before their allotted time runs out). Such contributions towards effective performance are rewarded via game mechanics by solving puzzles that function as progress towards escaping the room (Bakhsheshi, 2019). Team performance in an escape room can be easily operationalized as a number of puzzles completed, the time required to complete tasks, number of hints used, or a binary outcome of whether a team was able to successfully escape the room or not.

Aside from the gamified mechanics of escape rooms, other design characteristics of escape rooms are useful in investigating research questions related to teams. When developing an escape room for research, researchers are afforded a large amount of control over elements in the escape room environment (Cohen et al., 2020). Such control allows for the development of systematic task demands through puzzles offered consistently across groups and consistency in the physical environment (e.g., the locations of puzzles or physical props embedded in the room) (Cohen et al., 2020; Nicholson, 2015). This, in turn, provides researchers with multiple points of comparisons across teams which can be used to assess group differences as well as incentivize competition among participants (Cohen et al., 2020). Behavioral data concerning these points of

comparisons can be collected observationally through measures of team member actions and communications during the activity, while perceptions related to team constructs can be assessed prior to and following participation in an escape room through survey methodologies (Cohen et al., 2020). Finally, while many considerations related to the use of escape rooms in research presuppose the development of a dedicated escape room site (Clarke et al., 2016; Cohen et al., 2020), escape rooms are being explored as portable interventions that can be rapidly assembled or deployed (Veldekamp et al., 2020).

Escape Rooms and Superordinate Team Processes

Marks et al.'s (2001) taxonomy suggests that narrow teamwork processes (i.e., the specific team processes discussed above) load onto three broad process dimensions (i.e., transition, action, and interpersonal processes), which then load onto a more general teamwork process factor. In this paper, these dimensions of transition, action, and interpersonal processes are referred to as superordinate team processes, while the specific team processes that load onto each of these three dimensions are referred to as subordinate team processes. Operational definitions of other constructs included in this paper are provided in Appendix A.

Escape rooms are a promising testbed to observe team processes at the superordinate level of measurement. In a meta-analysis of 138 articles published in the teams literature that leveraged the team process taxonomy of Marks et al. (2001), LePine et al., (2008) have posited that the role team processes play in contributing to team effectiveness is moderated by two factors (task interdependence and team size), such that team processes are most critical when a team's task is characterized by high levels of interdependence (i.e., team members are reliant on each other for successful task completion) and when the size of a team completing the task is large. Towards this end, escape rooms often feature sets of interdependent tasks that are designed

to be completed by a team of multiple individuals in a limited amount of time. Given these inherent time pressures and the interdependence among team members associated with puzzles in an escape room, the characteristics of an escape room emphasize effective cognitive and social skills to succeed (i.e., effective teamwork) (Pan et al., 2017). Escape rooms can function as testbeds for researchers to gain insights into the effects of superordinate team processes on task completion by enabling observations of the effects action, transition, and interpersonal team processes have on the interactions between team members and their interactions with elements of the escape room (Cohen et al., 2020).

Hypothesis 1

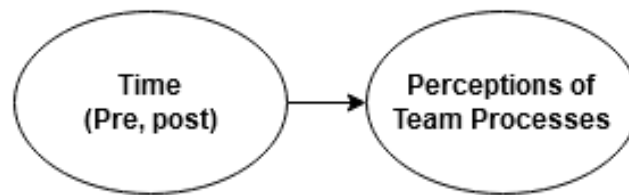
There is reason, therefore, to explore this theoretical link between superordinate team processes and escape rooms. The use of an escape room as an intervention for team building may foster improvements in perceptions of superordinate team processes by providing teams with a competitive and risk-free environment to work together while maintaining significant time pressures and interdependence among multiple team members. Escape rooms require teamwork among participants to succeed and the game mechanics of an escape room actively reward effective teamwork in the form of progression through a room's puzzles. Each puzzle functions as an opportunity to reinforce positive perceptions of teamwork in a team. When a team solves a puzzle as a group, it demonstrates the efficacy of their attempts to coordinate their efforts together towards escaping the room. Therefore, escape rooms as a team building intervention provide multiple opportunities to engage in, practice, and improve competencies related to teamwork in organizational teams. Such improvements can be empirically assessed by performing within teams comparisons of participants' perceptions of superordinate team

processes before and after participation in the escape room. With this in mind, I propose the following hypothesis:

H₁: Participants' perceptions of team processes will significantly improve following participation in the room

Figure 1

Hypothesis 1



Hypothesis 2

After determining if there are significant effects on participants' perceptions of superordinate team processes resulting from an escape room team building intervention, the sustainability of such effects should be assessed. Organizations utilize teams interventions to improve teams, but such interventions must result in effects that are both desired by the organization and that are sustained over time. It is important that effects of teams interventions are sustained in order to preclude the need for repeated interventions; interventions that must be frequently repeated in order to sustain positive effects offer comparably less utility to organizations than an intervention that can achieve similar effects without repeatedly expending large amounts of time or resources. The sustainability of an escape room team building intervention should be assessed to inform organizations whether such an intervention must be repeated to maintain improvements over time. If the effects of such an intervention are not sustained, an escape room team building activity must be repeated to maintain any beneficial effects over time. Conversely, if effects are sustained over time, this research will have

demonstrated the longevity of benefits that can be realized from an escape room team building activity. Such sustainability coupled with the increasing availability of escape room interventions due to the growing popularity of the escape room industry elucidate the potential utility escape rooms offer concerning team building.

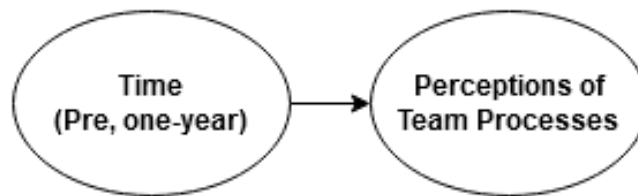
While data reported in prior escape room research typically falls within the scope of effects observed immediately following participation in an escape room, two studies have reported outcomes at later time periods. Escape rooms have been demonstrated to improve team outcomes (Cohen et al., 2021) and learning outcomes (Berthod et al., 2019) up to one month after the activity. Even though attenuation occurred in the case of team outcomes in one study (Cohen et al., 2021), effects reported in this study were still significantly higher than baseline one month after the intervention. This suggests that some degree of positive effects resulting from participation in an escape room team building activity are resilient to losses over time. Prior research has posited that team training interventions that incorporate active learning positively impact the transfer of training (i.e., the transfer of KSAs from the training environment to a desired operating environment) (Lazzara et al., 2021). Similarly, as an escape room team building activity emphasizes engagement with active problem-solving scenarios under time pressure, it is plausible that influences on team processes resulting from participation in an escape room team building activity will transfer to participant teams' working environments. This, in turn, may lead to improvements in teamwork through practice effects wherein perceived and actual teamwork become intertwined in a cyclical upward spiral. Said differently, an escape room team building activity aimed to improve participants' perceptions of their teamwork can manifest as actual improvements in teamwork in their operational environments, subsequently improving or maintaining future teamwork perceptions and behaviors (i.e., sustainment). Such

effects can be assessed by performing longitudinal within-teams comparisons. To empirically assess the sustainability of effects of participation in an escape room team building intervention on superordinate team processes, I propose the following hypothesis:

H₂: Participants' perceptions of team processes will be significantly higher than baseline one year later

Figure 2

Hypothesis 2



Hypothesis 3

Since completing an escape room is reliant on effective teamwork, teams that can frequently exhibit transition, action, and interpersonal team processes should successfully complete more tasks (i.e., puzzles) than teams that do not. Each puzzle in an escape room has beginning and end points that, while obfuscated to participants, are defined a priori, and can function as individual performance episodes.

Transition processes assist a team in coordinating their efforts between puzzles. For example, transition processes can influence how teams communicate the conditions or capabilities needed to solve a puzzle and escape the room (mission analysis), how teams specify the steps needed to solve individual puzzles (goal specification), and the tactics teams intend to leverage to solve puzzles (strategy formulation). Action processes assist a team in coordinating their efforts during a puzzle's completion. For instance, action processes can influence how teams determine whether their actions are contributing to puzzle completion (monitoring

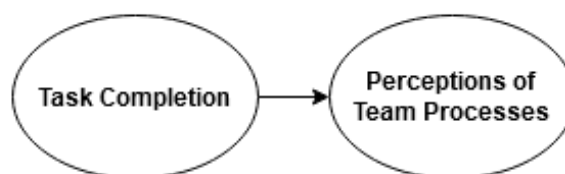
progress towards goals), how team members make direct or indirect attempts to assist each other while trying to solve a puzzle (team monitoring and backup behavior), and whether teams are able to synchronize their efforts to solve a puzzle together (coordination). While transition and action processes can influence teamwork between and during puzzles respectively, interpersonal processes can take place across varying puzzles in an escape room as they are not bound temporally to any particular performance episode. Specifically, interpersonal processes can influence how teams choose to manage interpersonal conflict during the entire escape room activity (conflict management), whether teams engage in behaviors that attempt to facilitate social harmony, a sense of togetherness, and minimize the cognitive effects of stress or frustration (affect management), as well as the ability of team members to build or maintain positive beliefs about the team's ability to successfully complete their shared task (motivating and confidence building).

Given these theorized contributions of transition, action, and interpersonal processes to task completion in this context, there is reason to expect group differences in perceptions of team processes based on the number of puzzles solved by each team. To empirically determine if significant group differences in perceptions of superordinate team processes arise as a function of task completion, I propose the following hypothesis:

H₃: Perceptions of team processes will significantly differ by task completion

Figure 3

Hypothesis 3



Escape Rooms and Subordinate Team Processes

In addition to the above theorized effects of superordinate team processes, escape rooms also have the potential to place emphasis on specific, subordinate team processes across each dimension outlined by Marks et al. (2001) (i.e., action, transition, and interpersonal processes) by varying task characteristics such that different teamwork functions are emphasized for successful task completion (i.e., solving puzzles) and ultimately escaping the room. By empirically examining effects of subordinate team processes in an escape room team building intervention, this research can inform future designs concerning escape room interventions that optimally facilitate improvements in specific teamwork functions.

It is recommended that researchers utilize both survey and observational data to measure constructs in an escape room intervention (Cohen et al., 2020), as self-reported perceptions are susceptible to bias and do not always accurately reflect individuals' behaviors. Therefore, a multi-method approach utilizing both survey-based and behavioral data analysis should be implemented to foster convergent validity. This study will utilize both self-reported perceptions as well as behavioral indicators of subordinate team processes to better assess effects of teamwork on task completion in this context.

Rather than attempt to empirically observe effects of each subordinate team process proposed by Marks et al. (2001), one process from each dimension was selected as a target to measure behaviorally during this intervention: goal specification (transition process), monitoring progress towards goals (action process), and motivating and confidence building (interpersonal process). Methodological concern with the three subordinate processes mentioned above functions as a cross section of all superordinate team processes while simultaneously reducing potential rater fatigue during behavioral data coding.

Goal Specification

As stated previously, escape rooms feature multiple puzzles which can function as independent performance episodes in observational research. Successful task completion within each performance episode functions as progress towards a larger shared goal. Each of these constituent performance episodes necessitates their own goals as escape rooms often leverage a variety of puzzle types in their design.

Teams that effectively specify their goals should complete more tasks; effective goal specification provides teams with clear expectations concerning what is needed for successful task completion, while ineffective goal specification creates ambiguity in the teams' purpose (Marks et al., 2001). In a meta-analysis of 38 studies, Kleingeld et al. (2011) identified a strong, positive relationship between group goals and team performance, with specific yet difficult goals demonstrating a larger effect on team performance compared to nonspecific goals. When teams effectively specify their goals, they facilitate a shared understanding of what needs to be done to ensure successful task completion. In an escape room, goal specification also improves the ability of a team to monitor progress towards their shared goal (i.e., escaping the room) by providing benchmarks to assess their performance. Conversely, if teams fail to denote specific goals, it is difficult to foster a shared understanding of what needs to be accomplished to complete the task at hand as each team member may have a differing interpretation of what needs to be done.

Differences in goal specification during task completion should, therefore, have effects on participants' performance in the room and, subsequently, behavioral indicators and perceptions associated with goal specification. To empirically examine the effects of perceptions

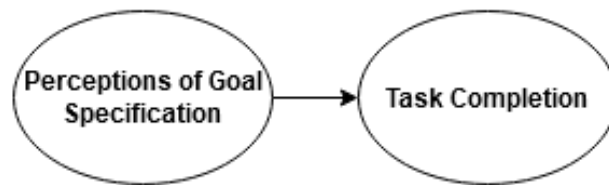
and behavioral indicators of goal specification on task completion, I propose the following two hypotheses:

Hypothesis 4

H4: Perceptions of goal specification will be a significant predictor of task completion

Figure 4

Hypothesis 4

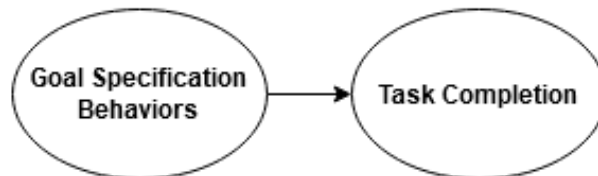


Hypothesis 5

H5: Goal specification behavior will be a significant predictor of task completion

Figure 5

Hypothesis 5



Monitoring Progress Towards Goals

There are continuous opportunities for teams to monitor their progress towards shared goals during an escape room team building activity. Such monitoring behaviors attempt to identify differences between the teams' current progress and their desired outcomes (Marks et al., 2001). These monitoring behaviors can be oriented around the overall goal of the team (i.e., escaping the room in a limited amount of time) or the completion of individual puzzles.

Teams that engage in more team monitoring should complete more tasks. Teams that monitor progress towards goals are positioned to adapt their strategies to ensure success; monitoring progress towards goals can serve as real-time feedback to the team and can inform how their performance should be altered to accomplish their shared goal (Grossman et al., 2017). Specifically, team monitoring improves the ability of a team to coordinate and engage in performance-based feedback, which subsequently improves team performance (Marks & Panzer, 2004); monitoring progress can inform whether the teams' strategies are effective or ineffective. Monitoring progress also helps build a shared understanding of a teams' progression towards their shared goal by highlighting what work has been done and what still needs to be completed. Conversely, teams that fail to monitor their progress are unaware if their actions are positively contributing towards successful task completion or how their strategies could be pragmatically improved (Marks et al., 2001). This can result in the duplication of team efforts, wherein time is wasted on a previously completed goal, or the continued implementation of strategies that are not contributing towards successful task completion.

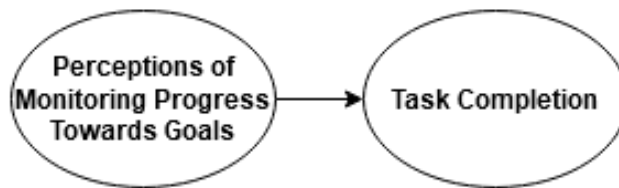
Variance in monitoring progress towards goals should, therefore, have differential effects on participants' performance in the room as well as behavioral indicators and perceptions associated with monitoring progress towards goals. To empirically examine the effects of perceptions and behavioral indicators of monitoring progress towards goals on task completion, I propose the following two hypotheses:

Hypothesis 6

H₆: Perceptions of monitoring progress towards goals will be a significant predictor of task completion

Figure 6

Hypothesis 6

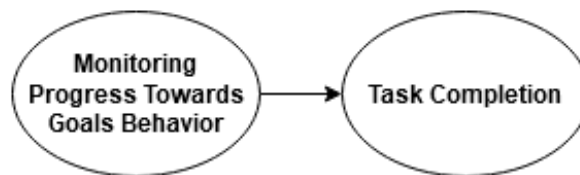


Hypothesis 7

H7: Monitoring progress toward goals behavior will be a significant predictor of task completion

Figure 7

Hypothesis 7



Motivating and Confidence Building

The characteristics of an escape room provide multiple opportunities for team members to exhibit motivation and confidence building. These behaviors can take the form of verbal communications or actions that attempt to foster a sense of shared motivation and confidence within the team (Marks et al., 2001). Motivating and confidence building attempts to augment team performance in real time both during and between puzzles as a team works towards escaping the room.

Teams that motivate and build confidence should complete more tasks, as their team members are receiving iterative encouragement and affirmation from their peers to maintain high performance. Teams composed of individuals that motivate each other ensure that team members

are highly engaged with the current task and wish to complete it successfully. Teams that build confidence also ensure that team members have positive attitudes about their ability to complete their shared task (i.e., confidence). Conversely, teams that fail to exhibit confidence in their work, lack motivation to complete their shared task(s), or actively demotivate members of their team are not positioned to maintain high performance. Without motivation, teams are not inclined to engage with the task at hand and may be indifferent towards their performance. Teams that do not foster confidence in their members may be less equipped to adapt their strategies and may accept a less desirable outcome (i.e., not solving a puzzle or escaping the room) more readily.

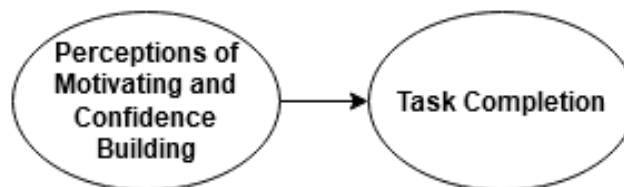
Motivating and confidence building should, therefore, have differential effects on task completion in the context of an escape room. To empirically examine the effects of perceptions and behavioral indicators of motivating and confidence building on task completion, I propose the following two hypotheses:

Hypothesis 8

H₈: Perceptions of motivating and confidence building will be a significant predictor of task completion

Figure 8

Hypothesis 8

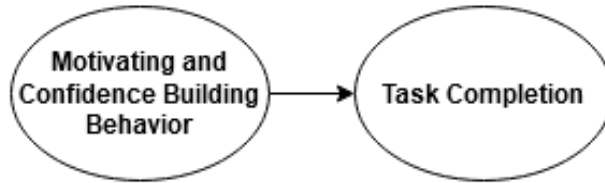


Hypothesis 9

H₉: Motivating and confidence building behavior will be a significant predictor of task completion

Figure 9

Hypothesis 9



Conceptualizing Attitudes about Teamwork through Perceived Team Effectiveness

Team performance and team effectiveness are often used as interchangeable terms, but they are arguably distinct. Team performance has an emphasis on the execution of specific actions within a team needed for successful task completion; measures of team performance often consider the extent to which a team executed actions that were required to be efficacious in a specific context. Effectiveness, however, is more generalizable and refers to a constellation of team outcomes that can be measured across a variety of contexts (e.g., satisfaction derived from a team's work, or judgements of the timeliness or quality of a team's work) (Gibson et al., 2003).

Since the primary purpose of teams is to complete tasks, the results of team performance are often a primary team outcome of interest when evaluating a team (Mathieu et al., 2008). The criteria used to assess teams can vary by organization and can take many forms, which has led to difficulty in developing measures of team effectiveness that can generalize to multiple organizations. Many operationalizations of team effectiveness subsequently rely on measures of performance in the team's context. However, such performance-based outcome assessments are often organizationally specific (Mathieu et al., 2008), so it is important to consider additional

team outcomes which may generalize to multiple contexts. Team outcomes can also include measures of team members' affective reactions following task completion, such as satisfaction, commitment, or viability (Mathieu et al., 2008). Perceived team effectiveness can also be operationalized as an affective reaction outcome. Measures of perceived team effectiveness as an affective reaction often manifest as self-reported perceptions concerning the extent to which a team was able to meet the demands that were placed upon it and are valued by their organization (Essens et al., 2005). It is a holistic reflection of individual team members' beliefs about whether their team was able to successfully coordinate their efforts to achieve a shared goal.

Team processes set the stage for team outcomes such as perceived team effectiveness. In a prior meta-analysis, LePine et al., (2008) identified significant, positive relationships between team processes measured both at the superordinate and subordinate levels of measurement and team effectiveness, which they operationalized as measures of team performance and team member satisfaction. From these results, LePine et al. (2008) argue that high quality team processes can both convert a team's inputs into effective task completion as well as "foster perceptions of a satisfying team experience" (LePine et al., 2008, p. 278). That is, high quality team processes can both improve the effectiveness of a team as well as their satisfaction derived from their teamwork. Every subordinate team process outlined in Marks et al.'s (2001) taxonomy represents an activity within teamwork that "can be performed anywhere from very well to very poorly" (p. 362). Consequently, high quality team processes should have differential effects on outcomes like perceived team effectiveness as a result of the team performing varying teamwork functions very well or very poorly. Given the importance of measuring both processes and outcomes in teams research (Essens et al., 2005), relationships between team processes and team effectiveness (LePine et al., 2008; Marks et al., 2001), as well as the general intention of team

development interventions to improve team effectiveness (Klein et al., 2009; Lacerenza et al., 2018), this study included a measure of perceived team effectiveness as an outcome variable of interest in its design.

Perceived Team Effectiveness and Escape Rooms

Perceived team effectiveness is an affective judgement that is oriented around prior experiences working in a team and whether those experiences are characterized by fulfilling the demands that were placed on the team. Forward-facing perceptions concerning a team's ability to fulfill future organizational demands have been conceptualized as collective efficacy or team efficacy. Similarly to self-efficacy, team efficacy has four primary sources: mastery experience, vicarious experience, social persuasion, and affective state (Bandura, 1997). Of these sources, past mastery experiences (i.e., perceptions that prior performance was successful) have been demonstrated to have the largest impact on team efficacy (Goddard et al., 2004). As organizations typically utilize measures of team performance to evaluate team effectiveness, so do individuals in assembling their attitudes about their prior work (perceived team effectiveness) and future work (team efficacy).

An escape room team building intervention can be used to improve perceptions of team effectiveness by providing opportunities for teams of individuals to garner mastery experiences (i.e., shared experiences of completing puzzles) in a risk-free environment. Escape rooms often encourage participants to work as a team, as the interdependent nature of puzzles in an escape room typically ensures that cooperation is required to succeed. Additionally, the technical competencies required to complete puzzles in an escape room can be minimal and not bound to any particular domain, allowing individuals from a wide variety of backgrounds to participate in a level playing field and meaningfully contribute towards task completion.

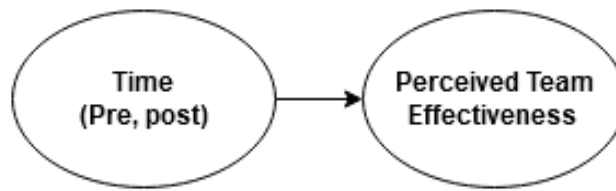
Hypothesis 10

Perceived team effectiveness is a reflection of perceptions of the work done by a team. The characteristics of puzzles in an escape room as well as the gamified and competitive nature of the experience can function as mechanisms to reinforce positive perceptions of team effectiveness by providing multiple opportunities for a team to succeed. Specifically, puzzles in an escape room can facilitate mastery experiences that are meaningful to a variety of individuals and subsequently foster improvements in participants' perceptions about their work; solving puzzles is evidence of a team's coordination being effective in this context. Since escape rooms often utilize multiple puzzles of varying difficulties, some level of success concerning task completion is likely. Assuming that individuals can garner any amount of success in the room or make progress towards the completion of any puzzle, they will have garnered shared mastery experience that was not present before the activity. As the activity ensures repeated exposure to opportunities to garner mastery experiences by encouraging participants to solve multiple puzzles in a limited amount of time, participation in an escape room team building activity should differentially affect perceptions of team effectiveness. This can be observed by comparing participants' perceptions of team effectiveness before and after the escape room team building activity. To empirically examine the effects of participation in an escape room team building intervention on perceptions of team effectiveness, I propose the following hypothesis:

H₁₀: Participants' perceptions of team effectiveness will significantly improve following participation in the room

Figure 10

Hypothesis 10



Hypothesis 11

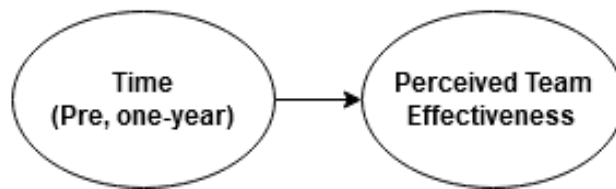
Like team processes, the sustainability of effects of participation in an escape room team building intervention on perceived team effectiveness should be assessed to determine whether such an intervention must be repeated to maintain these effects over time. One study has reported improvements in perceived group cohesion observed immediately after and one month after participation in an escape room team building activity (Cohen et al., 2021). While Cohen et al. (2021) note that improvements in perceived group cohesion were highest immediately after the activity compared to one month after the activity, there was still a significant improvement in perceived group cohesion reported by participants at the one-month time-period compared to baseline. This suggests that effects on similar, self-reported team variables may have some resilience against losses over time. Improved perceptions of team effectiveness resulting from mastery experiences garnered during participation in an escape room team building activity may facilitate future mastery experiences in participants' operational environments. Thus, an escape room team building activity aimed to improve participants' perceptions of their team's effectiveness can bolster actual team effectiveness in their operational environments, subsequently improving or maintaining future perceptions (i.e., sustainment). Longitudinal within-teams comparisons can be utilized to determine whether effects on perceptions of team effectiveness are sustained over time. To empirically assess the sustainability of effects of

participation in an escape room team building intervention on perceived team effectiveness, I propose the following hypothesis:

H₁₁: Participants' perceptions of team effectiveness will be significantly higher than baseline one year later

Figure 11

Hypothesis 11



Hypothesis 12

Similarly to the above theorized relationships between team processes and task completion in an escape room, perceptions of team effectiveness may also be differentially influenced by task completion. An effective team (i.e., one that escapes the room) is one that exhibits high quality team performance and achieves a desired outcome (i.e., solves multiple puzzles needed to escape the room). Each puzzle that is encountered and successfully completed by a team functions as a positive contribution towards shared mastery experience among participants and should subsequently bolster perceptions of their effectiveness. As stated previously, escape rooms often leverage many different puzzles of varying difficulties. Thus, it is likely that a given sample of teams will experience varying levels of success or solve varying amounts of puzzles during an escape room team building activity. Variance in team performance in this context should therefore have differential influence on perceptions of effectiveness following the activity. Teams that successfully complete more tasks that contribute towards the teams' shared goal (i.e., completing puzzles that contribute towards escaping the room) should,

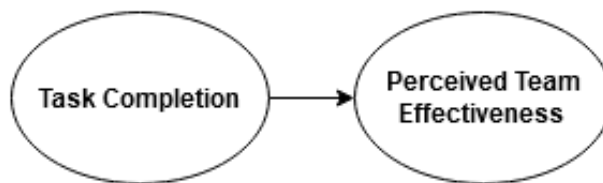
therefore, be characterized by larger amounts of mastery experience within the team and subsequently report higher perceptions of team effectiveness compared to participant teams that completed fewer tasks in this context.

To empirically determine if task completion significantly influences perceptions of team effectiveness, I propose the following hypothesis:

H₁₂: Task completion will significantly predict perceived team effectiveness

Figure 12

Hypothesis 12



Summary

Teams are vital components across myriad industries in the modern workforce. As a result, the effectiveness of teams is important for many facets of society. Theorists have leveraged models to conceptualize the effectiveness of teams in terms of inputs, processes, and outcomes to better understand factors that influence team effectiveness before and during task completion.

The taxonomy of team processes proposed by Marks et al., (2001) has garnered significant attention in the teams literature as a framework for conceptualizing teamwork and its impact on team effectiveness. Their view of team processes takes an episodic approach and describes the functions of varying team behaviors during tasks (action processes), between tasks (transition processes), and interpersonal activities that can occur at any point during task completion (interpersonal processes). Team processes can positively impact team effectiveness.

The characteristics of escape rooms lend themselves to investigations of perceptions of team processes and perceived team effectiveness. In particular, goal specification, monitoring progress towards goals, and motivating and confidence building are in high demand during an escape room and are likely to foster team effectiveness in this context. Additionally, escape rooms are composed of multiple constituent performance episodes in the form of their puzzles, which provide multiple opportunities to reinforce perceptions of effectiveness.

I have proposed multiple hypotheses to empirically assess the prevalence of immediate effects on team processes (H_1) and team effectiveness (H_{10}) resulting from participation in an escape room team building intervention, the sustainability of these effects one year later (H_2 , H_{11}), as well as relationships between task completion in an escape room and team processes (H_3 , H_4 - H_9) and team effectiveness (H_{12}). *Chapter Three: Materials and Methods* provides an overview of how this research was performed.

Chapter Three: Materials and Methods

Introduction

Chapter Three provides an overview of the materials and methods that were involved in the present research. Specifically, this chapter describes the current study's design, the population and sample from which data were collected, participant eligibility and protection, legal and ethical considerations, the materials involved in this work, metrics used to assess perceptions of team processes and team effectiveness, the materials used to collect behavioral indicators of team processes, and an inter-rater reliability assessment of collected behavioral data.

Research Design

This study used a quasi-experimental, repeated measures design. Within groups comparisons were performed to better understand the effects of an escape room team building intervention on perceptions of team processes and team effectiveness over time. Differences in perceived team effectiveness based on task completion were assessed to better understand the relationship between performance and team outcomes in an escape room team-building activity. Predictive relationships between team processes and task completion were also assessed using perceptions and behavioral indicators of three teamwork functions (goal specification, monitoring progress towards goals, motivating and confidence building) to better understand the relationship between teamwork and task completion in this context.

Population and Sample

Population

The theme, narrative, or puzzles associated with an escape room activity can be designed without placing emphasis on any particular task-domain, such that individuals from a variety of

backgrounds, education, or expertise can successfully complete an escape room activity within the allotted time. Therefore, the population for this study is considered to be work teams, which refers to teams composed of two or more interdependent individuals working towards a shared goal (Benishek & Lazzara, 2019).

Sample

This study utilized data collected from a sample of healthcare employees at Cedars-Sinai Medical Center, a large tertiary hospital located in Los Angeles, California. Specifically, this sample encompassed prior participants of an escape room team building activity held with employees of Cedars-Sinai. While teamwork is often considered a critical component of effective healthcare teams (Rosen et al., 2018), the results of this study may have a caveat concerning their generalizability to non-healthcare work teams.

Research Methodology

Data Collection

This study utilized an archival data set from an escape room designed and implemented as a team building intervention in 2019 at Cedars-Sinai. Measures of perceived team effectiveness were collected immediately before and after participation in the escape room. Perceptions of team processes were collected immediately before participation in the escape room. This study also incorporated longitudinal data from prior participants of the escape room at Cedars-Sinai. The same measures of perceived team effectiveness and perceptions of team processes utilized in the assembly of the archival data set were administered again to prior participants online via Qualtrics, a popular survey distribution service, approximately one year after the escape room team building intervention was initially implemented at Cedars-Sinai. This prospective survey data enabled within groups comparisons at the one-year time point.

Additionally, teams were recorded using audio-visual equipment. These recordings were analyzed to identify behavioral indicators of team processes and the number of steps completed to solve puzzles by each team.

Participant Eligibility Requirements

All prior participants of the escape room team building activity held at Cedars-Sinai were eligible to respond to surveys administered during prospective data collection. Eligibility requirements to participate in the escape room team building activity included three criteria: 1) participants had to be at least 18 years old, 2) participants had to be employed by Cedars-Sinai, and 3) participants had to enroll in the activity with members of their current work team. There were not any requirements concerning clinical experience or prior clinical training. Participant recruitment concerning both the escape room team building activity and prospective survey data collection from prior participants was not limited to any particular healthcare role or department; participants in both archival and prospective samples included a variety of professions that may be directly or indirectly involved in the delivery of care to patients.

Participants' Protection

Apart from participants' provided email addresses, all personally identifying information was removed from the archival data set. Email addresses were retained to allow for recruitment via email for prospective survey data collection. Audiovisual recordings of participants completing the escape room activity were collected and stored on a password protected cloud server. No individuals outside of the research team had access to audiovisual recordings of participants. Only one video was downloaded from the password protected cloud server and stored locally at a time during behavioral data collection. Following behavioral data collection and analysis, each video was deleted and stored only on the password protected cloud server.

Concerning prospective survey data collection, no personally identifying information was recorded outside of participants' email address.

Legal and Ethical Consideration

Participation in the escape room team building activity was completely voluntary. The activity was compliant with the American Psychological Association Code of Ethics and had received approval from the Institutional Review Board (IRB) at Cedars-Sinai. Each participant completed an informed consent form, agreed to have their actions recorded before attempting to complete the activity, and participants were not at risk of significant physical or psychological harm as a result of participation in the activity.

Prospective data collection abided by the American Psychological Association Code of Ethics. Additionally, approval was requested and received from both Embry-Riddle Aeronautical University's IRB as well as Cedars-Sinai's IRB before prospective survey data collection began. Participants were requested to complete an informed consent form and were not exposed to significant risks of physical or psychological harm. Aside from email addresses, no personally identifying information was collected during prospective survey data collection.

Materials

Escape Room

In 2019, 145 participants ($n = 33$ teams) completed an escape room team building activity at Cedars-Sinai. This escape room was developed by OR360° simulation lab personnel at Cedars-Sinai for the purpose of improving team processes and outcomes. The escape room was housed in a simulation facility located approximately one mile from the main medical center in Los Angeles, California. Teams of 2 to 7 individuals had to work together to solve a series of puzzles and "escape the room" within an allotted time limit of 45 minutes. The escape room

team building activity featured 17 steps needed to solve puzzles that followed a linear progression towards ultimately escaping the room. During participation, two research team members located in a separate “control room” viewed and communicated with participants through audiovisual equipment. Participants were able to verbally request up to three hints from the research team members during the activity to aid in their progression through the puzzles. The research team members developed a standardized list of hints to be given to participants depending on their current progression through puzzles in the room at the time they requested the hint. This hint sheet was printed on laminated paper so that research team members could mark off participants’ progression through the room in real-time using a dry erase marker. Figure 13 and Figure 14 provide images of the layout of the escape room and the control room respectively.

Figure 13

Layout of the Escape Room



Figure 14

Layout of the Control Room



The escape room was themed after a hospital trauma bay and featured multiple physical props in the room corresponding to this theme, such as a crash cart, gurney, anatomical diagrams on the walls, medication vials, and phlebotomy equipment. As the use of consistent theme and narrative can improve participant engagement during an escape room activity (Nicholson, 2015), the OR360° simulation lab escape room also featured narrative components. These narrative components centered on preparing the trauma bay for the arrival of a 48-year-old female who fell from the window of a 3-story building and received severe head trauma and bone fractures in her arms and legs. The escape room concluded when participants successfully hung a blood bag for the arriving patient, but this blood bag was hidden in the room and multiple puzzles had to be solved before it could be located. Before entering the room, participants were instructed by a

research team member to watch two videos which provided an overview of the rules of the activity and introduced these narrative components.

Escape Room Recordings

In addition to allowing research team members to observe and communicate with participants, audiovisual equipment installed in the control room and escape room were utilized to record participants' verbal communications and behaviors during the activity. The escape room featured two cameras positioned at opposing angles throughout the room to capture behaviors during the activity. Research team members in the control room could remotely operate these cameras to cover different angles of the room during the activity or to zoom in or out as needed. Participants were also outfitted with a large number on a piece of paper hung on their clothing to assist in coding behavioral data from recordings and to preclude the need for personally identifying information. The control room featured a digital video feed from the two cameras installed in the escape room, speakers to broadcast participants' verbal communications, and recording equipment. Video and audio data were compiled, recorded, and stored on a password protected cloud service for later analysis.

Survey Metrics

Demographics

Employees of Cedars-Sinai were notified of the escape room team building activity via an internal organizational email. Interested participants were provided with a description of the study and were redirected to an online demographic questionnaire. This questionnaire collected a variety of data including participants' email address, age, gender, current job role, highest education attained, the length of time they've worked in their current job role, the length of time they've spent working with their current team, how many days they interact with their other team

members per week, whether they had prior experience in an escape room, the number of prior escape rooms they've completed, and whether they had prior team building experience with their current team. Email addresses provided by participants of this escape room team building activity were utilized to collect longitudinal data from prior participants in prospective survey data collection. Similar items were administered during prospective data collection with the addition of an item related to team turnover. See Appendix B for an overview of demographic items used in the archival sample and Appendix C for an overview of demographic items used in the prospective sample.

Perceptions of Team Processes

Participants provided self-reported perceptions of team processes immediately before the escape room team building activity using a 10-item version of a scale developed by Mathieu et al. (2020). This scale was administered again to a sample of employees that were prior escape room participants at Cedars-Sinai approximately one year after the escape room team building activity. There are multiple iterations of this team process scale with varying numbers of items, ranging from 10 items to 50 items. Mathieu et al., (2020) provide evidence of the construct and content validity of each iteration of this scale through confirmatory factor analysis. Notably, the psychometric properties of the 10-item version were assessed utilizing a sample of healthcare teams from five different healthcare facilities in the United States. Each iteration of the scale features multiple items which ask respondents to consider to what degree their current team exhibits a variety of transition, action, and interpersonal team processes. Items are scored using a 1-5 Likert-type response scale (1 = *not at all*; 2 = *very little*; 3 = *to some extent*; 4 = *to a great extent*; 5 = *to a very great extent*). These responses are averaged across each superordinate team process dimension and are used to infer perceptions concerning a variety of team processes, with

higher values corresponding to perceptions that each group of team processes is exhibited more often by the team. Table 1 provides examples of items from this scale and their associated team processes. See Appendix D for a full list of team process survey items utilized in this study.

Table 1

Examples of Team Process Survey Items

Item Prompt	Items	Associated Team Process
<p>Read each item carefully and select the most accurate response. As you read each item, think about your current team at Cedars-Sinai and consider the following prompt:</p> <p><i>To what extent does our team actively work to do each of the following...</i></p>	<p>Ensure that everyone on our team clearly understands our goals?</p>	<p>Goal Specification (Transition Process)</p>
	<p>Seek timely feedback from stakeholders (e.g., customers, top management, other organizational units) about how well we are meeting our goals?</p>	<p>Monitoring Progress Towards Goals (Action Process)</p>
	<p>Encourage each other to perform our very best?</p>	<p>Motivation and Confidence Building (Interpersonal Process)</p>

Perceived Team Effectiveness

Five items from a scale developed by Gibson et al., (2003) were used to measure perceived team effectiveness in the archival data set (i.e., immediately before and after the escape room activity). These items were administered again to a sample of employees that were prior escape room participants at Cedars-Sinai during prospective data collection approximately one year after the escape room team building activity. Items from this scale ask respondents to reflect on the effectiveness of their current team and to indicate how accurate a variety of statements are concerning their current team. Items were scored using a 1-7 Likert-type response scale (1 = *very inaccurate*; 2 = *mostly inaccurate*; 3 = *slightly inaccurate*; 4 = *uncertain*; 5 =

slightly accurate; 6 = *mostly accurate*; 7 = *very accurate*). The total sum of responses was used to infer respondent’s perceptions concerning the effectiveness of their team, with higher values indicating more positive perceptions about the team’s ability to work together effectively. See Table 2 for a full list of perceived team effectiveness items utilized in this study.

Table 2

Perceived Team Effectiveness Items

Prompt:
 Think about your current work team as you complete each of the following items.
 Read each item carefully and select the most accurate response.

Item	Response Format/Response Options
This team has a low error rate.	<input type="radio"/> Strongly Disagree
This team does high-quality work.	<input type="radio"/> Disagree
This team consistently provides high-quality output.	<input type="radio"/> Somewhat Disagree
This team is consistently error-free.	<input type="radio"/> Neither Agree nor Disagree
This team needs to improve its quality of work.*	<input type="radio"/> Somewhat Agree
	<input type="radio"/> Agree
	<input type="radio"/> Strongly Agree

*Indicates a reverse-scored item

Behavioral Metrics

Behavioral Indicators of Goal Specification

Goal specification is characterized by actions that seek to denote, clarify, or prioritize goals that are needed to ensure successful task completion (LePine et al., 2008). Goal specification can manifest in an escape room in a variety of ways, such as verbal communications that clarify which puzzles must be completed to escape the room or to denote what must be completed to solve individual puzzles. A set of operationally defined examples of goal specification were determined before coding behavioral data from archival videos of teams’ performance during the activity. Specifically, these operationally defined examples of goal specification centered around transcribed statements from each participant to another team

member or to the rest of their team that denoted, clarified, or prioritized goals related to puzzle completion in the escape room (e.g., verbal statements such as: “We will have to solve all four of these puzzles before we can progress”; “We should focus on this puzzle before moving to another”). These operationally defined examples of goal specification were used as a guide when recording frequency counts of the number of times each team member engaged in goal specification during the recorded videos.

Behavioral Indicators of Monitoring Progress Towards Goals

Monitoring progress towards goals refers to attempts by team members to attend to, interpret, and communicate information needed to assess the team’s progress towards a shared goal (LePine et al., 2008; Marks et al., 2001). Like goal specification, monitoring progress towards goals can manifest in an escape room in a variety of ways, such as verbal communications which announce the completion of a puzzle to the rest of the group or clarifying if a current strategy is ineffective in contributing towards a puzzle’s completion. A set of operationally defined examples of monitoring progress towards goals were determined before coding behavioral data. Specifically, operationally defined examples of monitoring progress towards goals centered around transcribed statements from one team member to another or the rest of their team that update the team on their current progress, identify discrepancies between their current and desired performance, or inquire as to whether a task has been completed (e.g., verbal statements such as: “We just solved another puzzle”; “We’ll have to work faster if we want to complete this puzzle in time”). These operationally defined examples of monitoring progress towards goals were used as a guide when recording the number of times each team member engaged in monitoring progress towards goals during the recorded videos.

Behavioral Indicators of Motivation and Confidence Building

Motivation and confidence building refers to attempts to both build or maintain motivation and confidence within the team concerning their ability to effectively complete their shared task(s) (LePine et al., 2008). In an escape room, this can take a variety of forms, such as verbal (e.g., statements of affirmation to team members) or non-verbal (e.g., gestures such as a high-five or a pat on the back) communications that attempt to foster motivation and confidence within the team. A set of operationally defined examples of motivation and confidence building were determined before coding behavioral data. Specifically, operationally defined examples of motivation and confidence building centered around transcribed statements from one team member to another team member or the rest of their team that seek to provide positive affirmations concerning motivation and confidence (e.g., verbal statements such as: “We’re doing great, let’s keep it up!”). These operationally defined examples of motivation and confidence building were used as a guide when recording the number of times each team member engaged in motivating and confidence building during the recorded videos.

Extraction of Behavioral Data from Videos

The extraction of behavioral team process data from recorded videos was achieved using Observer XT, a behavioral research software package produced by Noldus Information Technology. Observer XT allows researchers to review video recordings, record the frequency and duration of behaviors at the individual level, and to export this data for analysis in other statistical software. I reviewed each recording of participants completing the escape room team building activity at Cedars-Sinai and, using the operational definitions provided above, recorded the occurrence of goal specification, monitoring progress towards goals, and motivating and confidence building behaviors at the individual level. Task completion was also measured by

recording the timing and number of up to 17 steps completed to solve puzzles by each participant team. Data recorded for each participant team using this software was then exported into Excel and cleaned for later assessments of inter-rater reliability and statistical analysis.

Behavioral Metric Data Collection Sheet

Behavioral data corresponding to each subordinate team process was recorded in Observer XT by the principal investigator and exported to a dynamic Excel sheet with multiple columns and rows. Each participant in the activity was assigned to a group of rows with multiple entries provided across columns for each behavioral indicator of team processes under investigation. An additional column for each team process data point contained a transcription of a statement that was spoken by the escape room participant. Another column provided a timestamp for each data point. The provided transcriptions and timestamps for each behavioral indicator of team processes were used by raters during assessments of inter-rater reliability to corroborate the ratings assigned for each team process indicator collected by the principal investigator in Observer XT.

Reliability Assessment

It is important that behavioral measures exhibit high reliability regardless of the rater(s) performing the observation (Hallgren, 2012). Three research assistants were enlisted to assist in assessments of inter-rater reliability of the team process behavioral data collected in this study. These three research assistants were provided with a training document (see Appendix E) which described the purpose of the behavioral data being collected, an overview of team process theory, operational definitions of the team process behaviors under observation, what to expect in the escape room recordings, and detailed instructions for corroborating the data collected by the principal investigator. A series of meetings were held with the research assistants to build a

shared understanding of the operational definitions of each team process behavior, to answer questions, and clarify how the inter-rater reliability assessment process was to be performed.

Following the first training meeting, the research assistants were provided with incomplete data sheets corresponding to a participant team from the escape room activity. These data sheets listed behavioral events for each participant in the team, timestamps for when these events occurred, transcriptions of what was said by the participant at that time in the video recording, and a blank space to store their ratings of whether each event corresponded to goal specification, monitoring progress towards goals, or motivating and confidence building. The degree to which research assistants and the principal investigator categorized each team process behavior consistently was used to assess inter-rater reliability, with consensus among the raters indicating the reliability of the collected behavioral data and disagreements among the raters reflecting non-reliable data. Additional meetings were held between the principal investigator and research assistants wherein discrepancies in the data from the first reviewed video were identified and discussed to bolster inter-rater reliability. Following these training meetings, review of each participant video continued until all participant teams had been reviewed by at least two individuals, with a smaller sample of videos being reviewed by all individuals.

Chapter Four: Results

Introduction

The purpose of this work was to assess the effects of participation in a team building escape room on perceptions of team processes and perceived team effectiveness, the sustainability of these effects over time, as well as relationships between team processes, perceived team effectiveness, and task completion in this context. The prior chapter discussed the design of this work as well as the materials and methods utilized in data collection. *Chapter Four* discusses the analyses used in this research, including procedures for handling missing and excluded data, data analysis, power analysis, descriptive statistics, inter-item correlations, statistical tests, their associated statistical assumptions, their results, and exploratory analyses.

Missing and Excluded Data

Missing data was not imputed in either the archival data set or among prospectively collected survey data. Cases were excluded listwise in longitudinal within groups analysis (i.e., data had to be present at each time point to be included in data analysis). Due to logistical challenges and limitations in the archival data set, data corresponding to participants' self-reported perceptions of team processes were unavailable at the immediate post-activity time period. Self-reported team process data were only collected immediately before the escape room activity (archival data set) and approximately one year after the escape room activity (prospectively collected data). This precluded the availability of data needed to test Hypothesis 1 and Hypothesis 3.

Data Analysis

Prospectively collected online survey data was downloaded from the survey distribution service as an Excel .csv file. This data was imported into IBM's SPSS Version 28.0 for statistical

analysis. Before performing any inferential statistical tests, the reliability of survey measures was assessed with Cronbach's alpha and the reliability of behavioral metrics was assessed using percent agreement and Fleiss' kappa.

Percent agreement was calculated by comparing the proportion of team process data points collected from the videos where all raters were in agreement (i.e., all raters gave the same rating of goal specification, monitoring progress towards goals, or motivating and confidence building for a given event's transcribed statement and timestamp) against instances where at least one rater categorized a given event differently from another rater. The number of events with complete agreement were divided by the total number of events to calculate an overall measure of percent agreement for all the behavioral data collected in this study. Fleiss' kappa was also utilized as an additional measure of inter-rater reliability. Fleiss' kappa is a measure of inter-rater reliability designed for categorical data or multiple raters and ranges typically from zero to one, with values closer to one indicating perfect agreement among raters and values at zero or below reflecting disagreement between raters (Zapf et al., 2016). Common cut-off ranges for Fleiss kappa are as follows: (<0.00 – *Poor Agreement*; 0.01 to 0.20 – *Slight Agreement*; 0.21 to 0.40 – *Fair Agreement*; 0.41 to 0.60 – *Moderate Agreement*; 0.61 to 0.80 – *Substantial Agreement*; 0.81 to 1.00 – *Almost Perfect Agreement*) (Landis & Koch, 1977). Fleiss' kappa was computed following review of all raters reviewing their first recording of participants completing the escape room activity to serve as a preliminary measure of inter-rater reliability. Fleiss' kappa was later computed a second time with a sample of three videos reviewed by all raters at the end of the behavioral data collection process to serve as a measure of inter-rater reliability following all rater training and to account for practice effects.

Power Analysis

I performed multiple power analyses using G*Power 3.1 (Faul et al., 2007) to determine the required sample sizes to detect significant differences in prospectively collected data. Concerning within groups comparisons using prospective data to test Hypothesis 2, G*Power calculated that responses from at least 55 prior participants were needed to detect significant effects of participation in the escape room on respondents' perceptions of team processes over time with a moderate effect size. Concerning within groups comparisons using prospective data to test Hypothesis 11, G*Power calculated that responses from at least 27 prior participants were needed to detect significant effects of participation in the escape room on respondents' PTE over time with a moderate effect size. In summary, least 55 responses from prior participants were needed to test the proposed hypotheses utilizing prospective data with sufficient statistical power (H₂ and H₁₁). Observed power of analyses utilizing archival data alone (H₁, H₃, H₄-H₉, H₁₀, and H₁₂) are presented below in the section "Results of Inferential Analyses."

Statistical Assumptions of Selected Analyses

An overview of the statistical assumptions associated with each analysis in this study is available in Appendix F-Appendix I. Appendix F lists the assumptions of MANOVA, which was appropriate to test Hypothesis 1 through Hypothesis 3. Appendix G lists the assumptions of multiple regression, which was appropriate to test Hypothesis 4 through Hypothesis 9. Appendix H lists the assumptions of paired samples t-test, which was appropriate to test Hypothesis 10 and Hypothesis 11. Finally, Appendix I lists the assumptions of bivariate regression, which was appropriate to test Hypothesis 12. Each list of assumptions was aggregated from Pallant (2020) and Laerd Statistics (2015; 2017). In addition to assessments of reliability, the assumptions of

each statistical test were assessed before beginning data analysis (sample size, normality, linearity, etc.).

Descriptive Statistics

Sample Characteristics

Archival Data Set. The archival data set contained information for 145 individuals who participated in the Cedars-Sinai escape room team building activity in 2019 ($N = 145$ participants). The average age of participants in the archival sample was 34.45 years (Range = 18 to 66; $SD = 8.32$). Age data was unavailable for three participants. The archival sample was composed of 102 females (70.3%) and 40 males (27.6%). Gender data was unavailable for three participants (2.1%). Concerning the highest education achieved by participants in this sample, most reported having achieved at least a bachelor's degree (BA, BS, BSN) ($n = 42$; 29%). See Table 3 for an overview of participants' self-reported education.

Table 3

Characteristics of Participants' Education in Archival Sample

Education Response Category	Frequency Count (Percentage)	Specific Responses (If Provided)
High School Diploma	4 (2.8%)	n/a
Associates Degree (AA)	4 (2.8%)	n/a
Bachelor's Degree (BA, BS, BSN)	42 (29%)	n/a
Master's Degree (MA, MS, MBA, etc.)	41 (28.3%)	n/a
MD	35 (24.1%)	1 "Intern"
PhD or Other Doctorate	9 (6.2%)	1 "Doctorate of Pharmacy"
Other	5 (3.4%)	1 "DO" 1 "MD and PhD or other doctorate" 1 "NP" 1 "Registered Dietitian...post BS accredited program"
Total	140 (96.6%)	n/a
Missing Response	5 (3.4%)	n/a

Participants embodied a variety of healthcare roles including nurses, surgeons, researchers, and other non-clinical staff. Table 4 provides an overview of the job roles reflected in the archival sample. Most participants reported that they fulfilled a clinical role at Cedars-Sinai while fewer participants fulfilled non-clinical roles. “Clinical – Other MD” was the most frequently reported participant job role ($n = 31$), and most participants within this category specified “Resident” as their title ($n = 10$). A full list of string responses given by participants when selecting their job role can be found in Appendix J.

Table 4

Job Roles Reported by Escape Room Participants in Archival Sample

Job Role Response Category	Frequency Count (Percentage)
Clinical - Nursing - BSN	25 (17.2%)
Clinical - Nursing - MSN	17 (11.7%)
Clinical - Nursing - NP	3 (2.1%)
Clinical - Nursing - Other	1 (0.7%)
Clinical - Surgeon	7 (4.8%)
Clinical - Other MD	31 (21.4%)
Clinical - Other Clinical Role	19 (13.1%)
Non-Clinical - Administrative	11 (7.6%)
Non-Clinical - Research	16 (11%)
Non-Clinical - Executive Leadership	2 (1.4%)
Non-Clinical - HR	5 (3.4%)
Non-Clinical - Other	5 (3.4%)
Missing Data	3 (2.1%)

Participant teams were composed of individuals who work with one another at Cedars-Sinai. Participants reported that they interact with the other team members they participated in the escape room with for an average of 3.23 days a week (Range = 0 to 5; $SD = 1.82$ days). Concerning prior escape room and team building experience, 79 participants (54.5%) reported that they have participated in an escape room before and 29 participants (20%) reported that they have completed a team building exercise with their current escape room team before. Of the participants who have participated in an escape room before, the average number of prior escape

rooms they've participated in was 3.37 at the time of data collection (Range = 1 to 60; $SD = 7.3$). See Tables 5 and 6 for an overview of participants' responses concerning their prior escape room and team building experience.

Table 5

Prior Escape Room Experience in Archival Sample

Have you participated in an escape room before?	Frequency Count (Percentage)
No	63 (43.4%)
Yes	79 (54.5%)
Missing Response	3 (2.1%)

Table 6

Prior Team Building Experience in Archival Sample

Have you completed any team building exercises with this team before?	Frequency Count (Percentage)
No	111 (76.6%)
Yes	29 (20.0%)
Missing Response	5 (3.4%)

Prospective Data Set. The prospectively collected data set contained one-year follow-up information for 49 individuals who participated in the Cedars-Sinai escape room team building activity in 2019 ($N = 49$ prior participants). The average age of participants in the prospective sample was 37.65 years (Range = 24 to 58; $SD = 9.05$). Age data was unavailable for three participants. The sample was composed of 41 females (83.67%) and 8 males (16.33%). Concerning the highest education achieved by participants in the prospective sample, most reported having achieved at least a master's degree (MA, MS, MBA, etc.) ($n = 21$; 42.86%). Table 7 provides an overview of participants' self-reported education in the prospective sample.

Table 7*Characteristics of Participants' Education in Prospective Sample*

Education Response Category	Frequency Count (Percentage)
Bachelor's Degree (BA, BS, BSN)	16 (32.65%)
Master's Degree (MA, MS, MBA, etc.)	21 (42.86%)
MD	11 (22.45%)
PhD or Other Doctorate	1 (2.04%)

Prior participants in the prospective sample still embodied a variety of clinical and non-clinical healthcare roles. Table 8 provides an overview of the job roles reflected in the prospective sample. Most participants still reported that they fulfil a clinical role at Cedars-Sinai with fewer participants fulfilling non-clinical roles. “Non-Clinical – Research” was the most frequently reported individual participant job role category ($n = 10$). A full list of string responses given by participants when selecting their job role can be found in Appendix K.

Table 8*Job Roles Reported by Escape Room Participants in Archival Sample*

Job Role Response Category	Frequency Count (Percentage)
Clinical - Nursing - BSN	6 (12.24%)
Clinical - Nursing - MSN	6 (12.24%)
Clinical - Nursing - NP	2 (4.08%)
Clinical - Nursing - Other	2 (4.08%)
Clinical - Surgeon	3 (6.12%)
Clinical - Other MD	8 (16.33%)
Clinical - Other Clinical Role	4 (8.16%)
Non-Clinical - Administrative	5 (10.20%)
Non-Clinical - Research	10 (20.41%)
Non-Clinical - HR	2 (4.08%)
Non-Clinical - Other	1 (2.04%)

Most participants in the prospective sample reported that they still work with at least one of the same teammates they completed the escape room team building activity in 2019 with, but 5 participants (10.2%) reported not working with any of the same prior teammates. Table 9 describes the degree of team member turnover reported by prior participants in the prospective

sample. Of the participants that reported working with at least one of their prior teammates, the mean number of days a week they interact with their teammate(s) was 2.77 (Range = 1 to 5; *SD* = 1.52 days).

Table 9

Overview of Team Turnover in the Prospective Sample

Response Category	Frequency Count (Percentage)
I work with <i>none</i> of the same teammates	5 (10.2%)
I work with <i>only one</i> of the same teammates	1 (2.04%)
I work with <i>some</i> of the same teammates	28 (57.14%)
I work with <i>all</i> of the same teammates	15 (30.61%)

Concerning additional escape room and team building experience, 6 participants (12.24%) reported that they have participated in additional escape rooms with their prior Cedars-Sinai teammates and 11 participants (22.45%) reported that they have completed additional team building exercises with their prior teammates. Of the participants who have participated in additional escape rooms, the average number of total prior escape rooms they’ve participated in at the time of data collection was 2.46 (Range = 0 to 10; *SD* = 2.48). See Tables 10 and 11 for an overview of participants’ responses concerning their additional escape room and team building experience.

Table 10

Additional Escape Room Experience in Prospective Sample

Have you participated in any additional escape room activities with the team of individuals you completed the escape room with at Cedars-Sinai?	Frequency Count (Percentage)
No	43 (87.76%)
Yes	6 (12.24%)

Table 11

Additional Team Building Experience in Prospective Sample

Have you participated in any other additional team building exercises with the team of individuals you completed the escape room with at Cedars-Sinai?	Frequency Count (Percentage)
No	38 (77.55%)
Yes	11 (22.45%)

The above variables related to age, gender, job role, highest education, prior escape room experience, the number of prior escape rooms completed by participants, and prior team building experience were explored as potential covariates in later regression analyses. There is merit in exploring the influence of such demographic variables in escape room research to determine characteristics of participants that can have differential impacts on the efficacy of the intervention. However, the inclusion of these covariates did not yield a predictive or parsimonious model linking team process behaviors and team process perceptions to task completion.

Escape Room Variables

A total of 33 teams participated in the escape room team building activity at Cedars-Sinai. Teams ranged in size from three to seven team members, with an average team size of 4.39 members ($SD = .97$). Video recordings were unavailable for 3 participant teams. In instances where video recordings were unavailable, the number of steps completed to solve puzzles and behavioral indicators of team processes were unable to be collected. Of the 33 teams that participated in the escape room, 27 teams escaped in the allotted 45 minutes (81.8%) leaving only 6 teams that did not escape (18.2%). The mean duration of time taken by participant teams to escape or attempt to escape was 2314.48 seconds (approximately 38.57 minutes) (Range = 1683 to 2700 seconds/28.05 minutes to 45 minutes; $SD = 354.88$ seconds/5.91 minutes).

Participant teams utilized an average of 2.48 hints out of the available 3 as they completed the activity (Range = 1 to 3; $SD = 0.67$). Concerning task completion during the activity, participant teams completed an average of 16.13 steps out of 17 needed to solve all the puzzles necessary to escape the room (Range = 11 to 17; $SD = 1.93$).

Table 12

Overview of Escape Outcome

Escape Outcome	Frequency Count (Percentage)
Did Not Escape	6 (18.2%)
Escaped	27 (81.8%)

Table 13

Overview of Time to Escape, Hints Used, and Task Completion

Category	<i>N</i>	Minimum	Maximum	Mean	<i>SD</i>
Time to Escape (in seconds)	33	1683	2700	2314.48	354.88
Number of Hints Used	33	1	3	2.48	0.67
Number of Steps Completed to Solve Puzzles	30	11	17	16.13	1.93

Reliability of Survey Metrics

The reliability of all survey metrics was assessed at each time point they were administered using Cronbach’s alpha. Items for both survey measures of perceived team effectiveness and perceptions of team processes demonstrated acceptable reliability at each time point. See Table 14 for a summary of reliability coefficients corresponding to each survey metric at each time point.

Table 14*Summary of Survey Metrics' Reliability*

Measure	Time	Cronbach's Alpha Value
Perceived Team Effectiveness	Immediately <i>Before</i> Escape Room	.83
	Immediately <i>After</i> Escape Room	.84
	<i>1 Year</i> After Escape Room	.78
Perceptions of Team Processes	Immediately <i>Before</i> Escape Room	.93
	<i>1 Year</i> After Escape Room	.93

Reliability of Behavioral Metrics

As discussed in *Chapter Three: Materials and Methods*, the inter-rater reliability of behavioral data extracted from video recordings of participant teams completing the escape room team building activity were assessed using percent agreement and Fleiss' kappa. Percent agreement was calculated by comparing the proportion of behavioral events extracted from video recordings categorized as goal specification, monitoring progress towards goals, and motivation and confidence building with total consensus across raters (i.e., all raters categorized a given behavioral event in the same way) against the total number of behavioral events with at least one rater that categorized the event differently than other raters (i.e., disagreement in categorization occurred with at least one rater). The number of events with complete agreement were divided by the total number of events to calculate an overall measure of percent agreement. In total, 3,088 behaviors were extracted by the principal investigator and reviewed by the research assistants from the recorded videos. After comparing the proportion of data points with consensus among raters against the total number of data points, an overall percent agreement of 91.45% was observed (n of agreement = 2,824 data points; n of disagreement = 264 data points).

Following review of the first video recording by the principal investigator and research assistants, Fleiss' kappa was calculated as a preliminary measure of inter-rater reliability. The

reviewers achieved a coefficient of .62 at this stage, indicating substantial agreement. Fleiss' kappa was calculated again using a sample of three videos reviewed by all raters at the end of the behavioral coding process. The reviewers achieved a coefficient of .84 at this stage, indicating almost perfect agreement. These results support the inter-rater reliability of behavioral data extracted from videos of participants completing the escape room team building activity.

Table 15

Summary of Behavioral Metrics' Inter-Rater Reliability

Measure	Time	Fleiss' Kappa Value
Behavioral Indicators of Team Processes	Following First Video Review	.62
	End of Video Review Process	.84

Survey Data

Perceptions of Team Processes. Perceptions of team processes were collected from participants immediately before and approximately one year after the escape room team building activity at Cedars-Sinai. Data were missing for four participants in the archival data set at the time period immediately before the escape room and data were missing for two participants in the prospective data set. Responses to items corresponding to transition, action, and interpersonal team processes were averaged to create aggregates of perceptions of each team process domain to be used in subsequent analyses, with higher averages reflecting more positive attitudes about the team processes exhibited by a team. See Table 16 for a summary of perceptions of team processes at each time period. Ocular inspection of the data for each team process domain at each time point illustrated a mean increase in perceptions of transition processes and interpersonal processes from baseline at the one-year time period, as well as a mean decrease in perceptions of action processes from baseline at the one-year time period.

Table 16*Summary of Perceptions of Team Processes at Each Time Period*

Time Period	Subscale	N	Minimum	Maximum	Mean	SD
Immediately Before Participation	Transition Processes	141	2.33	5.00	3.72	.67
	Action Processes	141	1.50	5.00	3.88	.68
	Interpersonal Processes	141	1.33	5.00	3.88	.73
One-Year After Participation	Transition Processes	47	2.33	5.00	3.84	.76
	Action Processes	47	2.50	5.00	3.82	.71
	Interpersonal Processes	47	1.67	5.00	3.93	.84

Perceived Team Effectiveness. Perceptions of team effectiveness were collected from participants immediately before, immediately after, and one year after the escape room team building activity at Cedars-Sinai. Data were missing for four participants in the archival data set at the time period immediately before the escape room and data were missing for two participants at the time period immediately after the escape room. Responses to each of the five items in the scale were summed at each time point respectively and used in subsequent analyses, with higher sums reflecting positive attitudes of teams' perceptions of their effectiveness. See Table 17 for a summary of perceived team effectiveness descriptive statistics at each time period. Ocular inspection of the data at each time period illustrated a mean increase from baseline immediately after participation in the escape room activity, with means remaining slightly higher than baseline at the one-year time period.

Table 17*Summary of Perceived Team Effectiveness at Each Time Period*

Time Period	N	Minimum	Maximum	Mean	SD
Immediately Before Escape Room	141	10	35	26.33	5.02
Immediately After Escape Room	143	12	35	28.9	4.96
1 Year After Escape Room	49	15	35	27.45	4.29

Behavioral Data

There was a large degree of variance reflected in the prevalence of the observed team process behaviors, both within counts of individual behaviors and across counts of the three observed behaviors. Goal specification was the most prevalent, with a mean frequency count of 69.9 behaviors at the team-level (Range = 22 to 137; $SD = 28.93$). Monitoring progress towards goals was observed less frequently, with a mean frequency count of 26.77 behaviors at the team level (Range = 7 to 62; $SD = 14.71$). Motivating and confidence building occurred the least often among the three observed behaviors, with a mean frequency count of 6.27 behaviors at the team-level (Range = 0 to 13; $SD = 3.18$).

Table 18

Overview of Behavioral Data Extracted from Escape Room Recordings

Category	N	Minimum	Maximum	Mean	SD
Count of Goal Specification Behavior	30	22	137	69.9	28.93
Count of Monitoring Progress Towards Goals Behavior	30	7	62	26.77	14.71
Count of Motivating and Confidence Building Behavior	30	0	13	6.27	3.18

Inter-Item Correlations

Relationships between variables were assessed using Pearson correlation. Large, significant correlations were identified between perceptions of action processes and transition processes collected immediately before the escape room ($r = .742$; $p < .001$) and collected one year after the escape room ($r = .881$; $p < .001$), perceptions of action processes and interpersonal processes collected immediately before the escape room ($r = .802$; $p < .001$) and collected one year after the escape room ($r = .747$; $p < .001$), as well as monitoring progress towards goals behaviors and goal specification behaviors during the escape room ($r = .704$; $p < .001$). Notably, no significant correlations between perceptions of team processes and team process behaviors were identified. See Appendix L for a full correlation matrix.

Results of Inferential Analyses

Immediate Effects on Superordinate Team Processes (H1)

As mentioned in the above section on missing data, logistical challenges and limitations in the archival data set precluded the availability of data corresponding to participants' self-reported perceptions of team processes at the immediate post-activity time period. As the data necessary to assess differences in perceptions of team processes immediately after the activity were unavailable, I was unable to test Hypothesis 1.

Differences in Effects on Superordinate Team Processes Based on Task Completion (H3)

Similarly to Hypothesis 1, the data necessary to assess differences in perceptions of team processes based on task completion were unavailable. As a result, I was unable to test Hypothesis 3.

Sustainment of Effects on Superordinate Team Processes (H2)

A within-groups repeated measures MANOVA was used to assess effects of participation in the escape room team building activity on perceptions of team processes over time. This analysis was used to test Hypothesis 2:

Table 19

Summary of Hypothesis 2

Hypothesis Number	Hypothesis
2	H ₂ : Participants' perceptions of team processes will be significantly higher than baseline one year later

The suitability of the data for MANOVA was assessed before beginning data analyses. The independent variable was a categorical variable of time with two levels (i.e., immediately before participation and approximately one year after participation). The multivariate dependent variables concerning team processes were operationalized as averages of individual scale

responses corresponding to perceptions of transition processes, action processes, and interpersonal processes. Thus, as there were three continuous dependent variables and a single categorical independent variable in this design, the assumptions of MANOVA related to variables utilized in the analysis were satisfied. There are 145 participants in the archival sample and 49 participants in the prospective sample. Data were collected independently in each sample (i.e., data for each subject was independent of data collected for other subjects) and there are more participants than dependent variables included in this design, which satisfies assumptions of MANOVA related to independence of observations and sample size.

The presence of multivariate outliers in perceptions of team processes was assessed using Mahalanobis distances and critical values. Based on the results of this assessment, one case was identified as a multivariate outlier. This case was retained, however, to bolster statistical power. Thus, the assumption of MANOVA related to outliers was violated. Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Both tests were significant, indicating non-normally distributed data. Thus, the assumption of MANOVA related to normality was violated. Linearity and sphericity could not be assessed due to a lack of between-subject factors. Multicollinearity was assessed using Pearson correlation, with a preponderance of significant, moderate inter-item correlations between data collected at each time point indicating multicollinearity. No significant correlations above .7 were observed in subscale averages for perceptions of transition, action, and interpersonal team processes between the two time periods. Thus, the assumption of MANOVA related to multicollinearity was satisfied.

There was not a significant difference in multivariate perceptions of team processes between baseline and the one-year time period, $F(3, 43) = 1.511, p = .225$; Wilk's $\Lambda = .905$; partial $\eta^2 = .095$; observed power = .371. As only 49 participants were available in the

prospective data set, with 3 participants having missing team process perception data at the one-year time period, this analysis was slightly underpowered. Based on the observed results there was insufficient evidence to support this hypothesis; participants' perceptions of team processes were not significantly higher than baseline at the one year time period.

Effects of Subordinate Team Processes on Task Completion (H4-H9)

A multiple linear regression was used to identify relationships between perceptions of three subordinate team processes (goal specification, monitoring progress towards goals, and motivating and confidence building), behavioral indicators of these team processes, and task completion. This analysis was used to test Hypotheses 4 through 9:

Table 20

Summary of Hypotheses 4-9

Targeted Team Process	Hypothesis Number	Hypothesis
Goal Specification	4	H4: Perceptions of goal specification will be a significant predictor of task completion
	5	H5: Goal specification behavior will be a significant predictor of task completion
Monitoring Progress Towards Goals	6	H6: Perceptions of monitoring progress towards goals will be a significant predictor of number of puzzles completed
	7	H7: Monitoring progress toward goals behavior will be a significant predictor of task completion
Motivating and Confidence Building	8	H8: Perceptions of motivating and confidence building will be a significant predictor of task completion
	9	H9: Motivating and confidence building behavior will be a significant predictor of task completion

Predictive regression variables concerning perceptions of these team processes were operationalized as individual scale responses corresponding to goal specification, monitoring progress towards goals, and motivating and confidence building. Predictive regression variables concerning behavioral indicators of these team processes were operationalized as frequency counts obtained from raters viewing audiovisual recordings of participants in the escape room

and the transcribed statements and timestamps associated with goal specification, monitoring progress towards goals, and motivating and confidence building. The predicted dependent variable in this regression was task completion operationalized as a frequency count of the number of steps completed by participant teams to solve puzzles during the escape room activity. This provided a more granular assessment of task completion in the room than is afforded by a simple binary variable of escape outcome (i.e., did the team escape or were they unable to escape within the allotted time). As this analysis utilized a single continuous dependent variable and multiple, continuous independent variables, the assumptions of multiple regression related to variables utilized in the analysis were satisfied.

Linearity, normality, homoscedasticity, and independence of residuals were assessed via ocular inspection of the normal probability plot (P-P) of the regression standardized residuals and a scatter plot of regression standardized residuals and predicted values. See Appendix M for the SPSS generated normal probability plot. See Appendix N for the scatterplot of predicted and residual values. These results demonstrated a slightly curvilinear relationship between residual and predicted values. Ocular inspection of the scatterplot revealed an approximately rectangular distribution of predicted and residual values. Thus, the assumptions of linearity, normality, homoscedasticity, and independence of residuals were partially violated.

This analysis utilized data from 128 participants; perceptions of team processes were unavailable for some participants at the time period immediately before the escape room and video recordings were unavailable for some participant teams, precluding the extraction of behavioral data or task completion data from those teams. Still, there were more than 15 cases in the model per predictor, thus, the assumption of multiple regression related to sample size was satisfied. The presence of outliers in perceptions of team processes and team process behavioral

data was assessed using Mahalanobis distances and critical values. Based on the results of this assessment, one case was identified as an outlier in team process perception data and two cases were identified as outliers in team process behavioral data. These cases were retained, however, to bolster statistical power. Thus, the assumption of multiple regression related to outliers was violated.

Multicollinearity was assessed using Pearson correlation as well as tolerance and variance inflation factor (VIF) statistics. Perceptions of team processes and team process behaviors did not exhibit any significant inter-item correlations with task completion above .3, indicating little to no relationship between the independent and dependent variables. Perceptions of team processes also did not exhibit any significant inter-item correlations with team process behaviors, indicating little to no relationship between independent variables. However, collinearity diagnostics performed in SPSS identified no tolerance statistics below .1 or VIF statistics above 10. Thus, the assumption of multicollinearity was partially satisfied. No measures included in this model were aggregated from other predictive variables, thus there are no violations of singularity.

Perceptions and behavioral indicators of all studied team processes were not statistically significant predictors of task completion in the escape room, $F(6, 121) = 1.662, p = .136$, adjusted $R^2 = .03$. Based on the observed results, there was insufficient evidence to support these hypotheses; perceptions and behaviors associated with subordinate team processes did not significantly predict task completion.

Immediate Effects on Perceived Team Effectiveness (H10)

A paired-samples t-test was utilized to assess effects of participation in the escape room team building activity on perceived team effectiveness (PTE). This analysis was used to test Hypothesis 10:

Table 21

Summary of Hypothesis 10

Hypothesis Number	Hypothesis
10	H ₁₀ : Participants' perceptions of team effectiveness will significantly improve following participation in the room

The independent variable was a categorical variable of time with two levels (immediately before participation and immediately after participation). The dependent variable concerning perceptions of PTE was operationalized as an aggregated sum of each participants' PTE scale responses at the two time periods. As this analysis utilized a single, continuous dependent variable and a single, categorical independent variable of time, the assumptions of paired-samples t-test related to variables utilized in the analysis were satisfied. The presence of outliers in perceived team effectiveness data was assessed using Mahalanobis distances and critical values. No outliers were detected, thus satisfying the assumption of paired-samples t-test related to significant outliers. Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Both tests were significant for PTE at each time period, indicating non-normally distributed data. Thus, the assumption of normality was violated.

Results of the paired-samples t-test indicated that there was a statistically significant increase in participants' perceived team effectiveness immediately following participation in the escape room team building activity at Cedars-Sinai, $t(138) = -6.195, p < .001$. Aggregated sums of perceived team effectiveness increased from an average of 26.35 at baseline to 28.87

following participation in the escape room team building activity. Cohen’s *d* was utilized to calculate an effect size for this analysis. A value of -.525 was observed, indicating a medium effect size (Cohen, 1988). Based on the observed results, there was sufficient evidence to support this hypothesis; participants’ perceived team effectiveness significantly improved following participation in the escape room.

Sustainment of Effects on Perceived Team Effectiveness (H11)

A paired-samples t-test was also utilized to assess effects of participation in the escape room team building activity on PTE over time. This analysis was used to test Hypothesis 11:

Table 22

Summary of Hypothesis 11

Hypothesis Number	Hypothesis
11	H ₁₁ : Participants' perceptions of team effectiveness will be significantly higher than baseline one year later

The independent variable was a categorical variable of time with two levels (immediately before participation and one year after participation). The dependent variable concerning PTE was operationalized as an aggregated sum of each respondents’ PTE scale responses at the two time periods. As this analysis utilized a single, continuous dependent variable and a single, categorical independent variable of time, the two assumptions of paired-samples t-test related to variables utilized in the analysis were satisfied. The presence of outliers in perceived team effectiveness data was assessed using Mahalanobis distances and critical values. No outliers were detected, thus satisfying the assumption of paired-samples t-test related to significant outliers. Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. Both tests were significant when assessing PTE at baseline, indicating non-normally distributed data at that time period. Both tests were not significant when assessing PTE at the one-year time period,

indicating normally distributed data at that time period. Thus, the assumption of normality was partially satisfied.

Results of the paired-samples t-test did not indicate that there was a statistically significant difference in participants’ perceived team effectiveness from baseline to the one-year time period, $t(48) = -.447, p = .657$. Participants perceived team effectiveness remained approximately the same when comparing baseline to one-year follow up data (Baseline average PTE – 27.22; One-year average PTE – 27.45). Cohen’s d was utilized to calculate an effect size for this analysis. A value of -.064 was observed, which does not reach the threshold to be considered a small effect size (Cohen, 1988). As 49 individuals had data able to be analyzed at baseline and the one-year time period, this analysis was sufficiently powered and exceeded the necessary sample size identified in a priori power analyses (27 participants). Based on the observed results, there was insufficient evidence to support this hypothesis; participants’ perceived team effectiveness was not higher than baseline at the one year time period.

Influence of Task Completion on Perceived Team Effectiveness (H12)

A bivariate regression was used to identify relationships between task completion and PTE reported by participants immediately after the escape room team building activity at Cedars-Sinai. This analysis was used to test Hypothesis 12:

Table 23

Summary of Hypothesis 12

Hypothesis Number	Hypothesis
12	H ₁₂ : Task completion will significantly predict perceived team effectiveness

The predictive regression variable concerning task completion was operationalized as the number of steps completed by participant teams to solve puzzles during the escape room activity.

The predicted dependent variable in this regression was PTE operationalized as an aggregated sum of each respondents' PTE scale responses immediately after the escape room activity. As this analysis utilized a single continuous dependent variable and a single continuous independent variable, the assumptions of bivariate regression related to variables utilized in the analysis were satisfied. This analysis utilized data from 130 participants; PTE scale responses were unavailable for some participants at the time period immediately after the escape room and video recordings were unavailable for some participant teams, precluding the extraction of task completion data for those teams. Still, there were more than 15 cases in the model per predictor, thus, the assumption of bivariate regression related to sample size was satisfied. The presence of outliers in PTE and the number of steps completed to solve puzzles was assessed using Mahalanobis distances and critical values. Based on the results of this assessment, no outliers were identified. Thus, the assumption of bivariate regression related to outliers was satisfied.

Linearity, normality, homoscedasticity, and independence of residuals were assessed via ocular inspection of the normal probability plot (P-P) of the regression standardized residuals and a scatter plot of regression standardized residuals and predicted values. See Appendix O for the SPSS generated normal probability plot. See Appendix P for the scatterplot of predicted and residual values. These results demonstrated a linear relationship between residual and predicted values. Ocular inspection of the scatterplot did not reveal an approximately rectangular distribution of predicted and residual values. Thus, the assumptions of linearity, normality, homoscedasticity, and independence of residuals were partially violated. No measures included in this model were aggregated from other predictive variables, thus there are no violations of singularity.

Task completion was a statistically significant predictor of perceived team effectiveness immediately after the activity, $F(1, 128) = 27.453, p < .001$, adjusted $R^2 = .17$. This model accounted for approximately 17% of the variance observed in PTE. Task completion had a moderate, positive beta weight (standardized $\beta = .42$), implying that higher levels of task completion had a moderate, positive influence on participants' perceptions of team effectiveness immediately after participation in the activity. Based on the observed results, there was sufficient evidence to support this hypothesis; task completion significantly predicted participants' perceived team effectiveness immediately after the activity.

Exploratory Analyses

Multiple exploratory analyses were performed to examine relationships between variables collected in this study in greater detail and to explore other methods of aggregating collected data. Specifically, exploratory analyses were performed to examine trends in perceived team effectiveness data, to control for the influence of time in data related to team process behaviors and task completion, as well as to examine task completion as a binary outcome (i.e., whether teams escaped or failed to escape in the allotted time).

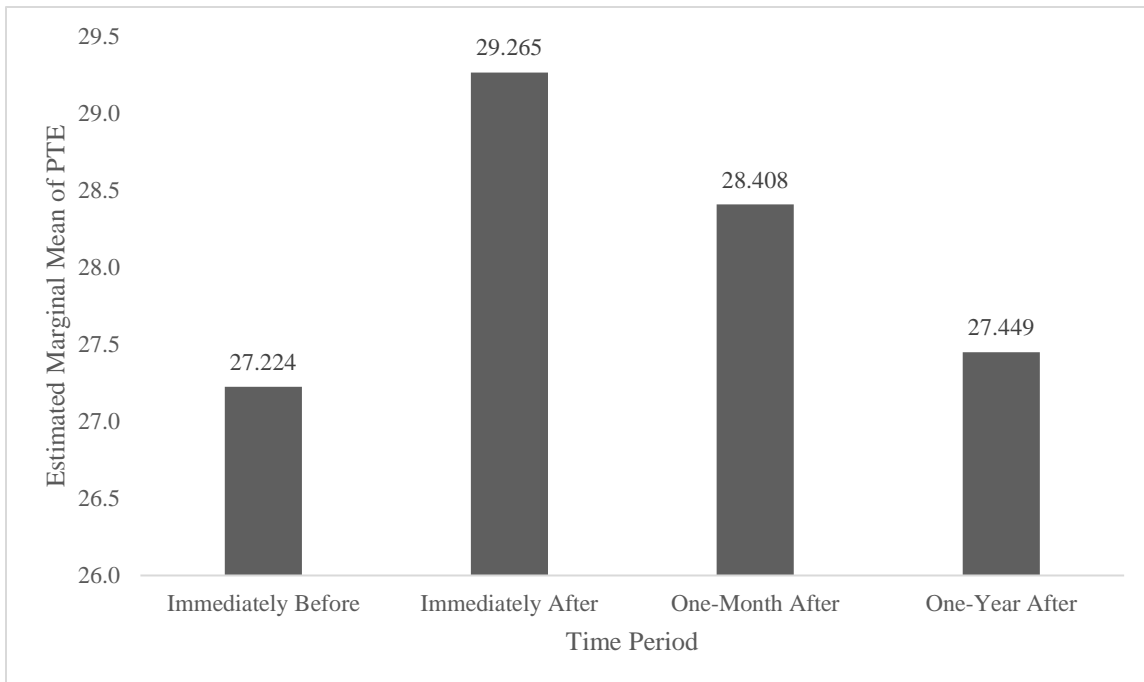
Trends in Perceived Team Effectiveness. While unnecessary to test the hypotheses proposed in this research, data were collected concerning perceived team effectiveness one-month after participants completed the escape room team building activity at Cedars-Sinai. Based on the above observed results demonstrating that one-year perceived team effectiveness data returned to baseline, it is worth exploring this trend further to assess the rate at which improvements in perceived team effectiveness attenuate. Accordingly, I performed a one-way repeated measures ANOVA to explore the effects of participation in the escape room on perceived team effectiveness over time at a more granular level. The independent variable was a

categorical variable of time with four levels (i.e., immediately before participation, immediately after participation, one-month after participation, and one-year after participation). The dependent variable was operationalized as aggregated sums of participants' perceived team effectiveness survey responses at each time period.

Results of this one-way repeated measures ANOVA still demonstrate a statistically significant difference in participants' perceived team effectiveness across the data collected at each time period $F(3, 144) = 5.898, p < .001$. See Figure 15 for a bar graph depicting estimated marginal means of perceived team effectiveness at each time period. These results show that the downward trend in perceived team effectiveness began one month following participation in the escape room team building activity and continued to baseline approximately one year later.

Figure 15

Estimated Marginal Means of Perceived Team Effectiveness



I performed a post-hoc paired samples t-test to assess whether participants' perceived team effectiveness was higher than baseline at the one-month time period. Results of this paired samples t-test indicate that participants' perceived team effectiveness was still significantly higher than baseline at the one-month time period, $t(113) = -4.428, p < .001$, thus, mirroring results observed in prior work utilizing similar team variables (e.g., Cohen et al., 2021).

Controlling for the Influence of Time in Behavioral Data. Escape rooms are a timed activity, and as such, teams are given a limited amount of time to complete all the puzzles necessary to escape the room. Subsequently, teams that can complete the steps necessary to escape the room quickly inherently have less time for their behaviors to be observed which can result in lower frequency counts of observed behaviors. With this in mind, there is merit in examining the rate at which participants exhibited team process behaviors and the rate at which teams solved puzzles.

I performed a multiple linear regression to assess the effects of team process perceptions and behaviors on task completion while controlling for the influence of time (i.e., a rate of behaviors and a rate of task completion). Like in prior analyses, the predictive regression variables included survey responses corresponding to the three subordinate team processes under observation: monitoring progress towards goals, goal specification, and motivating and confidence building. The predictive regression variables also included ratios of frequency counts of each of these subordinate team process divided by the duration of time participants were in the activity in seconds. This served as a measure of the rate at which participants engaged in each of the team process behaviors under observation. The dependent variable was a ratio of the number of steps completed by participant teams to solve puzzles divided by the duration of time

participants were in the activity in seconds. This served as a measure of the rate at which participant teams completed tasks.

Regression analysis indicated that the model was significant overall, $F(6, 121) = 6.213, p < .001$, adjusted $R^2 = .198$. This model accounted for approximately 19.8% of the variance observed in participants' rate of task completion. However, the only significant predictor of task completion identified from the model was the rate of participants' monitoring progress toward goals behaviors, which had a moderate, negative beta weight ($p < .001$, standardized $\beta = -.438$). In this sample, as the rate of participants' monitoring progress towards goals behaviors increased, the rate of their task completion decreased.

Predicting Binary Escape Outcome. Prior analyses operationalized task completion at a granular level (i.e., the number of steps completed to solve puzzles). However, the design of an escape room activity also lends itself to a more holistic and intuitive measure of task completion: escape outcome (i.e., did a team escape or fail to escape). Naturally, this begs the question of whether the collected team process variables could be predictive of a binary escape outcome in this context.

I performed a binary logistic regression to determine whether perceptions and behaviors associated with goal specification, monitoring progress towards goals, and motivating and confidence building were predictive of escape outcome. Like in prior analyses, predictive regression variables concerning perceptions of team processes were operationalized as individual scale responses corresponding to goal specification, monitoring progress towards goals, and motivating and confidence building. Predictive regression variables concerning behavioral indicators of these team processes were operationalized as frequency counts obtained from raters viewing audiovisual recordings of participants in the escape room and the transcribed statements

and timestamps associated with goal specification, monitoring progress towards goals, and motivating and confidence building. The dependent variable was operationalized as a categorical variable of escape outcome with two levels: escaped or did not escape. Results of this analysis indicated that the logistic regression model was not statistically significant $\chi^2(6) = 7.121, p = .310$; neither perceptions nor behaviors associated with team processes significantly predicted escape outcome.

As previously mentioned, there is merit in controlling for the influence of time in behavioral data collected in this study. This logistic regression analysis was repeated to determine whether rates of team process behaviors facilitated better model fit. Predictive regression variables included ratios of frequency counts of each subordinate team process divided by the duration of time participants were in the activity in seconds which served as a measure of the rate at which participants engaged in each of the team process behaviors. Predictive regression variables also included survey responses corresponding to the three subordinate team processes. The dependent variable was still operationalized as a categorical variable of escape outcome with two levels. Results of this analysis utilizing rates of behaviors rather than behavioral frequency counts indicated that the logistic regression model was not statistically significant, $\chi^2(6) = 6.364, p = .384$; neither perceptions nor rates of behaviors associated with team processes significantly predicted escape outcome.

Chapter Five: Discussion

Summary of Results

See Table 24 for a summary of hypotheses proposed in this work and the results of performed analyses. See Table 25 for a summary of exploratory inquiries and analyses.

Table 24

Summary of Performed Inferential Analyses and Hypothesis Testing

Hypotheses	Analysis Performed	Result	Outcome
H1: Participants' perceptions of team processes will significantly improve following participation in the room	N/A; Data were unavailable		Hypothesis could not be tested
H3: Perceptions of team processes will significantly differ by task completion	N/A; Data were unavailable		Hypothesis could not be tested
H2: Participants' perceptions of team processes will be significantly higher than baseline one year later	Within-groups, repeated measures MANOVA	<i>No</i> significant difference detected	Hypothesis <i>not</i> supported
H4: Perceptions of goal specification <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H5: Goal specification behavior <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H6: Perceptions of monitoring progress towards goals <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H7: Monitoring progress toward goals behavior <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H8: Perceptions of motivating and confidence building <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H9: Motivating and confidence building behavior <i>will</i> be a significant predictor of task completion	Multiple linear regression	<i>Not</i> a significant predictor of task completion	Hypothesis <i>not</i> supported
H10: Participants' perceptions of team effectiveness will significantly improve following participation in the room	Paired-samples t-test	Perceived team effectiveness significantly improved	Hypothesis <i>supported</i>
H11: Participants' perceptions of team effectiveness will be significantly higher than baseline one year later	Paired-samples t-test	<i>No</i> significant difference detected	Hypothesis <i>not</i> supported
H12: Task completion will significantly predict perceived team effectiveness	Bivariate regression	Task completion <i>is</i> a significant predictor of perceived team effectiveness immediately after the activity	Hypothesis <i>supported</i>

Table 25*Summary of Exploratory Analyses*

Analysis Group	Specific Inquiry	Analysis Performed	Result
Trends in Perceived Team Effectiveness	What trends are present in PTE data over time?	Within-groups, repeated measures ANOVA	Significant differences in PTE over time were observed; PTE begins to decrease as early as one month after the activity
	How does PTE at one-month compare to baseline?	Paired-sample t-test	PTE was still significantly higher than baseline at the one-month time period
Controlling for the Influence of Time in Behavioral Data	Do team process perceptions and rates of team process behaviors predict the rate of participants' task completion?	Multiple linear regression	The model was statistically significant ($p < .001$) and predicted 19.8% of the variance observed in rate of task completion. Rate of monitoring progress towards goals was the only significant predictive variable and had a moderate, negative beta weight (standardized $\beta = -.438$)
Predicting Binary Escape Outcome	Do team process perceptions and behaviors predict escape outcome?	Binary logistic regression	The model was not statistically significant ($p = .310$); team process perceptions and behaviors did not predict escape outcome
	Do team process perceptions and rates of team process behaviors predict escape outcome?	Binary logistic regression	The model was not statistically significant ($p = .384$); team process perceptions and rates of team process behaviors did not predict escape outcome

Superordinate Team Processes

Hypotheses 1 through 3 centered on perceptions of superordinate team processes.

Hypotheses 1 and 3 were unable to be tested. Hypothesis 2 proposed that perceptions of team processes would be significantly higher than baseline a year following participation in the escape room and was assessed using a within-groups repeated measures MANOVA. No significant differences in participants' perceptions of superordinate team processes were detected between data collected immediately before the escape room and data collected at the one year time period. Based on these results, this hypothesis was not supported; there was no sustained effect on participants' perceptions of superordinate team processes.

Prior research has demonstrated that effects of participation in an escape room team building intervention wane with time. Despite the theorized influence of opportunities to practice

teamwork that are inherent in escape room design, results of the present study corroborate this trend observed in similar teamwork variables for perceptions of team processes. The lack of an observed effect that is sustained over time may be attributable to the small sample utilized in this study or the presence of team turnover among teams in the prospectively collected sample. There may also be an intrinsic limit on the magnitude of effects on team processes that can be garnered from a single instance of participation in a team building escape room, as is the case with many team interventions. Organizations must dedicate resources to foster sustainment (Lazzara et al., 2021), and concerning an escape room team building intervention, it may be that such an intervention must be repeated over time to foster sustainment. Further research is needed to better understand the effects of an escape room team building intervention on perceptions of superordinate team processes over time.

Subordinate Team Processes and Task Completion

Hypotheses 4 through 9 were centered on relationships between subordinate team processes and task completion. These hypotheses proposed that perceptions of goal specification, monitoring progress towards goals, and motivating confidence building (Hypotheses 4, 6, and 8) as well as behaviors associated with these team processes (Hypotheses 5, 7, and 9) would significantly predict task completion (i.e., the number of steps completed to solve puzzles in the escape room). Hypotheses 4 through 9 were assessed using multiple linear regression. Regression analyses indicated that neither perceptions nor behaviors associated with subordinate team processes were significant predictors of task completion in this context. Based on these results, each of these hypotheses related to subordinate team processes were not supported; team process perceptions and behaviors did not influence variance in task completion in a significant way.

There was little variance in task completion in this sample; over 80% of teams escaped the room in the allotted time and the average number of steps completed by participant teams to complete puzzles during the escape room was 16.13 out of a possible 17. The lowest number of steps completed by a participant team to solve puzzles was 11. This high floor in task completion data may explain the lack of predictive ability observed in team process variables. Additionally, perceptions of subordinate team processes were operationalized as responses to single survey items which corresponded to monitoring progress towards goals, goal specification, and motivating and confidence building, which may have contributed to a lack of variance in perception variables included as predictors in the model. Furthermore, the behavioral measure utilized in this study only reflected the preponderance of team process behaviors exhibited by individuals and teams. No assessments of quality or the degree to which a given behavior contributed to immediate or delayed progress towards a puzzle's completion were collected, which could be a pertinent factor to consider in future work. It may also be that, within the context of an escape room, other team processes are more predictive of success. More research is warranted to better understand relationships between subordinate team processes and task completion in an escape room.

Perceived Team Effectiveness

Hypotheses 10 through 12 centered on perceived team effectiveness. Hypothesis 10 proposed that participants' perceived team effectiveness would significantly improve following participation in the escape room and was assessed using a paired-samples t-test. A significant improvement in perceived team effectiveness was observed from baseline to the time period immediately after the escape room. Based on this result, this hypothesis was supported; participants' perceived team effectiveness significantly improved as a result of participation in

the escape room team building activity. It was theorized that the puzzles in an escape room function as opportunities for teams to garner multiple, shared mastery experiences. As the lowest number of steps completed by participant teams to solve puzzles was 11, every team in this sample achieved a moderate level of success and subsequently garnered shared mastery experiences that were not present before the activity. These mastery experiences can explain the observed improvement in perceived team effectiveness. These observed results may also be a function of response bias, which warranted further investigation with longitudinally collected data.

Hypothesis 11 proposed that participants' perceived team effectiveness would remain higher than baseline one year after participating in the escape room activity and was also assessed using a paired-samples t-test. No significant difference in perceived team effectiveness was observed from baseline to the time period approximately one year after the escape room. Based on this result, this hypothesis was not supported; participants' perceived team effectiveness returned to baseline approximately one year after participating in the escape room team building activity. This waning effect was assessed further in exploratory analyses. Results of the present study corroborate immediate trends observed in prior escape room research using similar teamwork variables for perceived team effectiveness. These analyses also demonstrate a lack of sustainment in effects on perceived team effectiveness resulting from participation in an escape room team building activity a year after the activity is held. Concerning short-term effects, further investigation into the magnitude of influence task completion has on perceived team effectiveness was warranted.

Hypothesis 12 proposed that task completion would significantly predict participants' perceived team effectiveness immediately after participating in the escape room activity and was

assessed using bivariate regression. Regression analyses indicated that task completion was a statistically significant predictor of perceived team effectiveness immediately after the activity and accounted for approximately 17% of the variance observed in perceived team effectiveness at that time period. Additionally, task completion had a moderate, positive beta weight (standardized $\beta = .42$), implying that higher levels of task completion had a moderate, positive influence on participants' perceptions of team effectiveness immediately after participation in the activity. Based on the observed results, there was sufficient evidence to support this hypothesis; participants' perceived team effectiveness immediately after the activity was positively influenced by task completion during the activity. It was theorized that task completion in an escape room could function as a safe and replicable environment for teams to garner multiple, shared mastery experiences. These results provide preliminary confirmation towards this end, as the teams that completed more steps necessary to solve puzzles reported higher levels of perceived team effectiveness immediately after the activity.

Exploratory Analyses

Exploratory analyses were utilized to further examine relationships between variables included in this study. The first group of exploratory analyses centered on trends in perceived team effectiveness over time. Results of a one-way repeated measures ANOVA identified a significant difference in perceived team effectiveness across every time period it was collected (immediately before participation, immediately after participation, one-month after participation, and one-year after participation). Notably, perceived team effectiveness began decreasing at the one-month time period before returning to approximately baseline at the one-year time period. A paired-samples t-test revealed that perceived team effectiveness was significantly higher than baseline at the one-year time period. These results demonstrate that participation in a team

building escape room can garner immediate improvement in perceived team effectiveness and that this improvement is sustained up to one-month following participation in the activity.

However, this improvement does not persist after approximately one-year.

Additional exploratory analyses were performed to control for the varying durations of time participant teams were engaged in the escape room activity. This was achieved by dividing behavioral team process data and task completion data by the amount of time participants were engaged in the activity in seconds, thus generating a rate of team process behaviors and a rate of task completion. Results of the multiple linear regression indicated that the model significantly predicted approximately 20% of the variance observed in rates of task completion, however, the only significant predictive variable included in the model was the rate of participants' monitoring progress towards goals behavior which had a negative influence on the rate of task completion. This could be explained by the nature of many recorded instances of monitoring progress towards goals behaviors that were observed from recordings of participants completing the escape room activity. Specifically, many instances of monitoring progress towards goals behaviors manifested as inquiries concerning whether a puzzle had been completed. Instances in which a participant was announcing a puzzle's completion to the rest of the team were far less common. Many recorded monitoring progress towards goals behaviors were, therefore, implicitly associated with tasks not being completed, which may explain the observed negative relationship between rates of monitoring progress towards goals behaviors and rates of task completion.

As the ultimate goal of an escape room is to escape the room in the allotted time, task completion can arguably be operationalized as a binary outcome of whether a team escaped or failed to escape. Binary logistic regressions were used to assess predictive relationships between

perceptions and behaviors associated with subordinate team processes and escape outcome. The first model utilizing perceptions and behavior counts associated with subordinate team processes did not significantly predict escape outcome. The second model utilizing perceptions and rates of behaviors associated with subordinate team processes also did not significantly predict escape outcome. The lack of predictive relationships observed in these binary logistic regressions mirrors the results seen in the regressions utilized to test Hypotheses 4 through 9 and may be attributable to the same characteristics described before (i.e., a lack of variance in task completion across participant teams, reliance on single survey items to operationalize perceptions of subordinate team processes, and a lack of data characterizing the quality of individual instances of team process behaviors).

Implications

Results of the present study have multiple theoretical and practical implications concerning the use of escape rooms as a teams intervention in applied contexts.

Theoretical Implications

The variables included in this study and its experimental design can inform the development of future studies in this domain. This study leveraged novel constructs in its survey-based and behavioral measures of team processes, a theoretical approach that has not yet been applied to this team performance environment. Given the importance of teams in the modern workforce and the relationship between team processes and effectiveness, the importance of assessments of team processes within escape room team interventions cannot be understated.

This study advanced the methodology used to quantify teamwork by collecting behavioral measures of operationalized examples of team processes. This, in turn, highlighted the importance of not only measuring the preponderance of team process behaviors, but also

their quality or the degree to which they contributed to immediate task completion. For example, Kleingeld et al. (2011) has identified a strong, positive relationship between group goals and team performance, with specific yet difficult goals demonstrating a larger effect on team performance compared to nonspecific goals. However, many of the recorded instances of goal specification in behavioral data collected in this study were ambiguous or not specific enough to be readily actionable by another teammate. Similarly, many recorded instances of monitoring progress towards goals were not announcements of a puzzle's completion, but rather inquiries as to why puzzles hadn't yet been completed and were not followed by attempts to make progress by other teammates. Methodological concern with frequency counts of team process behaviors alone may be premature as they do not reflect such qualitative aspects of exhibited team process behaviors during data collection. Behavioral data collection also enabled comparisons between self-reported perceptions and observable behaviors. Comparisons performed using Pearson correlation identified no strong relationships between participants' self-reported perceptions of team processes and the behaviors they engaged in during the activity, which mirrors similar discrepancies reported in other domains and emphasizes the importance of assessing constructs related to teamwork using a multi-method approach. This research is also among the first of its kind to observe changes in perceptions about a teams' ability to work together effectively before and after participation in an escape room team building intervention. By using both a measure of team processes as well as a team outcome measure this study advanced the methodology used to empirically examine the utility of an escape room team intervention.

This study was also novel in its design, leveraging longitudinal data on a scale that has not yet been reported in the escape room literature. By examining the effects of an escape room team building intervention over time, this study enabled insight concerning the sustainability of

improvements resulting from such an activity. Such prospective data collection was required to empirically assess the sustainability of an escape room as a team building intervention. While results reported in this study demonstrate that participation in an escape room can achieve significant improvements in perceived team effectiveness up to one month after the activity, analyses using longitudinally collected data call into question the sustainability of these improvements and whether such immediate effects are more attributable to response bias. Escape room studies utilizing simple pre-post designs are commonplace in the literature, leaving questions unanswered concerning the longevity of benefits that can be attained by participating in an escape room team intervention. This study identified a lack of sustained results in perceptions of team processes and perceived team effectiveness, thus illustrating the importance of longitudinal data collection in escape room research.

Practical Implications

The results of this work have multiple practical implications for researchers and organizations alike. The results presented in this study have demonstrated the efficacy of an escape room team building intervention in improving perceived team effectiveness immediately after the activity and up to one month after the activity. Organizations seeking to improve this outcome in the short-term can consider the development of their own escape room(s) or partnerships with commercial escape room businesses as avenues to improve perceived team effectiveness.

The difficulty of puzzles embedded within escape rooms should be considered when using them as an avenue to improve team effectiveness in the short-term. Data reported in this study show that task completion during the activity had a positive influence on perceived team effectiveness after the activity. Accordingly, if the goal of an intervention is to maximize this

team outcome, the difficulty of puzzles should be set such that participant teams are able to actualize a substantial amount of task completion and subsequently garner multiple, shared mastery experiences.

One must also consider whether there are sufficient resources to support sustainment of effects through repeated exposure (i.e., repeated escape room trials). Data collected in this study illustrates a downward trend in perceived team effectiveness beginning approximately one month after participation in the escape room and continuing to baseline approximately one year later. A similar trend in perceptions of team processes was observed, with self-reported perceptions of team processes also returning to baseline one year later. It appears escape rooms can offer an engaging and dynamic intervention for team outcomes in the short-term, but their utility concerning long-standing effects requires further investigation. Organizations should exercise skepticism when evaluating anecdotal claims of sustained effects against available empirical data.

Concerning team process perceptions and behaviors, this study also demonstrated a lack of significant relationships between participants' self-reported team process perceptions and their observed behaviors. This is not without precedence, however. For decades, prior studies have identified discrepancies between how individuals think they behave and their actual observable behaviors in a variety of contexts (e.g., pro-environmental behaviors – Kormos & Gifford, 2014; hand-washing – O'Boyle et al., 2001, Tibballs, 1996; communication skills in nurses – Mullan & Kothe, 2010; public speaking performance in college students – Rapee & Lim, 1992). This trend in research alongside the discrepancies identified in this study demonstrate the need for organizations to utilize behavioral measures of team processes as reliance on survey-based

methodology alone may not generate an accurate representation of how individuals act in their operational environments.

Limitations

This study had multiple limitations resulting from the data sets used in analyses, measures used to assess team processes and perceived team effectiveness, as well as the design of the escape room utilized in this team intervention.

COVID-19 has inarguably changed how many organizations operate in recent history and the near future. The global pandemic precluded the collection of in-person data due to concerns surrounding opportunities for infection and disease transmission. Given these circumstances, the utilization of an archival dataset was pragmatic. However, the utilization of an archival data set does not provide any opportunities to manipulate variables included in the archival study. There were also no opportunities to increase the sample size of escape room participants retroactively by garnering new participants, so the archival data set was inherently limited in its sample size. The archival data set was missing data for some participants at each time period and featured teams that were unequal in size, however, there was little action that could be taken to ameliorate these limitations. To combat these limitations and enable longitudinal comparisons, prospective data was collected from prior participants of the escape room at Cedars-Sinai. Any respondents in prospective survey data collection had to be at least 18 years old, employees of Cedars-Sinai, prior participants of the escape room held in 2019, and had to have access to an internet connection to respond to surveys. Given that all data in the archival and prospective data sets were collected from healthcare teams, there is a possibility that the results of this research may not generalize to non-healthcare samples.

There were also limitations in the measures utilized in this study. Concerning survey-based measures of team processes, perceptions of subordinate team processes were collected via three survey items that were associated with monitoring progress towards goals, goal specification, and motivating and confidence building respectively. Reliance on only a single survey item to assess a construct is inadvisable and inherently limits variance in collected data, but logistical challenges and characteristics of the archival data set precluded the opportunity to deploy a more exhaustive survey. Additionally, the items used to assess perceived team effectiveness were leveraged from a larger measure which may have influenced the psychometric properties of using a subscale in isolation. There is also a possibility that respondents considered the escape room intervention more heavily when responding to perceived team effectiveness items immediately after the activity and later placed more emphasis on their team's work holistically when responding to longitudinally administered perceived team effectiveness items. Data collected in the short term could have been confounded by an effect of fun or novelty often associated with escape rooms as a result. A portion of the variance observed in perceived team effectiveness immediately after the activity was attributable to task completion during the activity, however, the remaining variance that was unaccounted for may be confounded in such an effect of fun or novelty.

Concerning behavioral measures utilized in this study, only three subordinate team processes were selected from the entire taxonomy developed by Marks et al. (2001). Even though the subordinate team processes under investigation served as a cross-section of action, transition, and interpersonal processes respectively, there are many other facets of teamwork that were not examined behaviorally during data collection. When reviewing recorded videos of teams completing the escape room team building activity, there were multiple conditions in

which data could not be recorded. Data capture was not possible in instances where participants spoke to their teammates in a language that was not English, when participants spoke over each other, or when participants spoke too quietly for their speech to be captured by the microphones. Additionally, data could not be captured in instances where an individual finishes a sentence for another teammate as the transcribed statement could not be attributed to a single team member. The behavioral metric used in this study was also unable to capture implicit coordination or facets of teamwork that take place non-verbally. There was no weighting or scoring of behavioral data captured in this study; statements that were repeated multiple times by a team member were counted the same as statements that were only given a single time when collating frequency counts of team process behaviors within and across teams.

The escape room utilized in this team intervention followed a linear puzzle organization scheme. Participant trials concluded after 45 minutes regardless of whether participants still had puzzles to complete, which artificially limited the duration of time teams could be observed for. Some participant teams began coordinating their actions before the 45-minute timer embedded in the escape room began counting down. No behaviors were recorded before this timer began to avoid artificially inflating behavior counts for some participant teams with recordings that began before the timer started. Some participants would also move out of frame during video recordings, leading to difficulty in data capture.

Recommendations for Future Work

Insights generated from this work can inform future applied escape room research. Concerning data collection during participant trials, it is advised that participants have an identifying label placed on the front and back of their clothing to aid in attributing behaviors to specific team members during data collection. The utility of such labels can be improved by

instructing participants to line up or present their identifying label at the start of any recordings to ensure that video reviewers can attribute behaviors to the correct team member. The clarity of participants' speech can be bolstered by encouraging participants to speak clearly and loudly before entering the escape room. Audio clarity can also be supported by utilizing lapel microphones for each participant rather than the use of static microphones embedded within the room. If the use of individual microphones is not feasible, ensure that the devices that are being used to capture audio are physically distanced from any sources of constant noise that may be present in the escape room, such as the ticking of a clock, an intercom, or an air conditioning vent.

Future work in this domain should seek to replicate and build upon the results observed in the current study. Regarding team processes, future work should include perceptions of team processes in pre-post data collection procedures to enable assessment of the immediate effects of participation in an escape room on perceptions of team processes and whether there are differences in such an immediate effect based on task completion. It is advised that the full version of the metric provided by Mathieu et al. (2020) be used instead of the shortened version to reduce reliance on single items to assess varying constructs. Replication of this study with more variance in task completion regardless of whether task completion is operationalized at the individual puzzle-level or as a binary escape outcome may also uncover relationships between subordinate team processes and task completion that were unable to be detected in this archival sample. Replication of this study with a dedicated control group is recommended to aid in identifying the role of fun or novelty effects resulting from participation in an escape room team intervention as compared against more traditional team interventions. The effects of time should also be controlled for when aggregating behavioral data, as teams that are able to escape the

room before their allotted time runs out artificially limit the duration of time wherein their team process behaviors can be recorded and subsequently limit potential frequency counts of observable behaviors. Exploration of other team process behaviors is warranted as well, as the current study utilized only a small cross section of the multiple team processes proposed by Marks et al. (2001).

There are also many facets of escape rooms' design that can be modified to explore how characteristics of the activity influence team processes or outcomes. The presence or absence of thematic or narrative components could be modified to explore how engagement influences teamwork during the activity or how facets of teamwork influence task completion when participants are engaged in an environment that does not mirror their normal working environment. Other design characteristics may have differential effects in a team intervention, such as the presence or absence of a time limit, the amount of time allowed for participant teams to escape, the presence or absence of hints, the number of possible hints, the number of completed puzzles required to escape, puzzle difficulty, team size, the amount of interdependence across team members needed to complete puzzles, and the organization of puzzles throughout the room. These variables should be explored further to ascertain design characteristics of an escape room that maximize its efficacy as a teams intervention.

Future studies can also examine relationships between variables that were outside of the scope of the present research such as familiarity between team members, collective orientation, the transfer of desired KSAs from the escape room to working environments, or cheating behaviors. For example, the specificity of communicated goals during an escape room may afford clarity in team members' shared mental models, or the amount of motivating and confidence building behaviors exhibited by team members may have positive impacts on

changes in collective orientation. Future studies could also explore the impact of different modalities used in an escape room teams intervention, such as the provision of hints verbally or via written instructions. While typically regarded as a face-to-face activity, this study also provides a foundation for future examinations of escape rooms that have been imported into virtual or mixed reality platforms (ex: Shakeri, et al., 2017; Warmelink, et al., 2017). Escape room interventions that do not require a dedicated physical site may offer increased utility to organizations as they can be rapidly deployed while avoiding many of the logistical challenges associated with running an escape room in person such as the destruction of props or artifacts in the room or resetting puzzles between trials.

Chapter Six: Conclusion

Teams are a critical component of modern organizations. Escape rooms are receiving increasing attention as an avenue for organizations to facilitate team interventions. Despite their growing popularity, the methodology of escape room research can be improved. In particular, more research is needed to better understand the utility of an escape room team building intervention.

Towards this end, the current study aimed to advance the science underlying escape rooms through the inclusion of novel constructs, longitudinal data collection, and a multi-trait multi-method approach to quantifying teamwork. Participants completed an escape room team building activity and completed multiple surveys related to perceptions of team processes and perceived team effectiveness. Behaviors of individuals across teams during the activity were recorded and reviewed to generate data related to task completion (i.e., the number of steps completed to solve puzzles during the escape room) and three subordinate team processes (i.e., goal specification, monitoring progress towards goals, and motivating and confidence building). Effects of participation on perceived team effectiveness and perceptions of team processes over time were also assessed, as well as relationships between these variables and task completion during the activity.

Results of statistical analyses identified a significant improvement in perceived team effectiveness immediately after the activity. This improvement is influenced, in part, by the number of steps participant teams completed to solve puzzles during the activity (i.e., task completion). However, this effect is not sustained; statistical analyses identified no significant difference in perceived team effectiveness from baseline to approximately one year after the activity. A similar trend was observed in participants perceptions of team processes; there was no

significant difference in perceptions of team processes from baseline to approximately one year after the activity. Regression analyses did not identify perceptions or behaviors associated with subordinate team processes as significant predictors of task completion during the activity, however, future investigations featuring qualitative aspects of team processes or different escape room characteristics related to theme or narrative may shed light on how teamwork influences success in the context of an escape room team intervention.

This study can inform the development of similar applied work in the future and demonstrates the potential short-term benefits of an escape room team building activity. The regression analyses performed in this work emphasize the importance of variance in task completion, more exhaustive measures of team process perceptions, and the inclusion of measures of quality in behavioral data collection concerning team processes. The lack of sustainment observed in perceived team effectiveness and perceptions of team processes highlight the importance of longitudinal data collection in future escape room research. Specifically, more data is needed to discern what factors that are unrelated to an escape room team intervention can influence these team outcomes over time and to discern whether short-term effects are confounded with perceptions of fun or novelty. Based on the results of the current study, organizations seeking to utilize an escape room as a team building intervention should consider whether there are adequate resources to facilitate sustainment and whether the difficulty of puzzles in the activity are appropriate such that some degree of task completion is ensured.

Escape rooms are not just a game; they hold promise as an exciting avenue for future research and teams interventions. While this study had limitations, it contributes to the current literature by reporting effects on variables pertinent to teams science that have thus far been

unexplored in this context. There are multiple possibilities for future work to continue advancing the science underlying escape rooms through the modification of escape room design characteristics, the inclusion of other variables related to teamwork, and longitudinal data collection. The popularity of escape rooms is likely to continue growing as will their potential applications in applied work outside that of just a recreational team activity. Still, more work is needed to unlock the full potential of escape rooms in applied contexts.

References

- Bakhsheshi, F. F. (2019). Serious games and serious gaming in escape rooms. *Proceedings of the 2019 International Serious Games Symposium*, 42-47.
<https://doi.org/10.1109/ISGS49501.2019.9047019>
- Bartlett, K., & Anderson, J. (2019). Using an escape room to support the learning of science content. *Proceedings of the 2019 Society for Information Technology & Teacher Education International Conference*, 2021(1), 710-715.
- Béguin, E., Besnard, S., Cros, A., Joannes, B., Leclerc-Istria, O., Noel, A., Roles, N., Taleb, F., Thongphan, J., Alata, E., & Nicomette, V. (2019). Computer-security-oriented escape room. *IEEE Security & Privacy*, 17(4), 78-83.
<https://doi.org/10.1109/MSEC.2019.2912700>
- Benishek, L. E., & Lazzara, E. H. (2019). Teams in a new era: Some considerations and implications. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.01006>
- Berthod, F., Bouchoud, L., Grossrieder, F., Falaschi, L., Senhaji, S., & Bonnabry, P. (2020). Learning good manufacturing practices in an escape room: Validation of a new pedagogical tool. *Journal of Oncology Pharmacy Practice*, 26(4), 853-860.
<https://doi.org/10.1177/1078155219875504>
- Borrego, C., Fernández, C., Blanes, I., & Robles, S. (2017). Room escape at class: Escape games activities to facilitate the motivation and learning in computer science. *Journal of Technology and Science Education*, 7(2), 162-171. <https://doi.org/10.3926/jotse.247>
- Clarke, S., Arnab, S., Keegan, H., Morini, L., & Wood, O. (2016). EscapED: Adapting live-action, interactive games to support higher education teaching and learning practices.

Proceedings of the 5th International Conference on Games and Learning Alliance, 144-153.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Cohen, T. N., Griggs, A. C., Kanji, F. F., Cohen, K. A., Lazzara, E. H., Keebler, J. R., & Gewertz, B. L. (2021). Advancing team cohesion: Using an escape room as a novel approach. *Journal of Patient Safety and Risk Management*, 26(3).

<https://doi.org/10.1177/25160435211005934>

Cohen, T. N., Griggs, A. C., Keebler, J. R., Lazzara, E. H., Doherty, S. M., Kanji, F. F., & Gewertz, B. L. (2020). Using escape rooms for conducting team research: Understanding development, considerations, and challenges. *Simulation & Gaming*, 51(4), 443-460.

<https://doi.org/10.1177/1046878120907943>

Diemer, G., Jaffe, R., Papanagnou, D., Zhang, X. C., & Zavodnick, J. (2019). Patient safety escape room: A graduate medical education simulation for event reporting.

MedEdPORTAL. https://doi.org/10.15766/mep_2374-8265.10868

Dietrich, N. (2018). Escape classroom: The Leblanc process—an educational “escape game”. *Journal of Chemical Education*, 95(6), 996-999.

<https://doi.org/10.1021/acs.jchemed.7b00690>

Dilek, S. E., & Dilek, N. (2018). Real-life escape rooms as a new recreational attraction: The case of Turkey. *Anatolia*, 29(4), 495-506.

<https://doi.org/10.1080/13032917.2018.1439760>

- Edwards, T., Boothby, J., & Succheralli, L. (2019). Escape room: Using an innovative teaching strategy for nursing students enrolled in a maternity clinical course. *Teaching and Learning in Nursing, 14*(4), 251-253. <https://doi.org/10.1016/j.teln.2019.05.001>
- Essens, P., Vogelaar, A., Mylle, J., Blendell, C., Paris, C., Halpin, S., & Baranski, J. (2005). *Military Command Team Effectiveness: Model and Instrument for Assessment and Improvement* (No. RTO-TR-HFM-087). NATO Research and Technology Organization.
- Eukel, H. N., Frenzel, J. E., & Cernusca, D. (2017). Educational gaming for pharmacy students—Design and evaluation of a diabetes-themed escape room. *American Journal of Pharmaceutical Education, 81*(7). <https://doi.org/10.5688/ajpe8176265>
- Friedrich, C., Teaford, H., Taubenheim, A., Boland, P., & Sick, B. (2019). Escaping the professional silo: An escape room implemented in an interprofessional education curriculum. *Journal of Interprofessional Care, 33*(5), 573-575. <https://doi.org/10.1080/13561820.2018.1538941>
- Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175-191. <https://doi.org/10.3758/BF03193146>
- Ferreiro-González, M., Amores-Arrocha, A., Espada-Bellido, E., Aliaño-Gonzalez, M. J., Vázquez-Espinosa, M., González-de-Peredo, A. V., Sancho-Galán, P., Álvarez-Saura, J. A., Barbero, G. F., & Cejudo-Bastante, C. (2019). Escape classroom: Can you solve a crime using the analytical process? *Journal of Chemical Education, 96*(2), 267-273. <https://doi.org/10.1021/acs.jchemed.8b00601>
- Giang, C., Chevalier, M., Negrini, L., Peleg, R., Bonnet, E., Piatti, A., & Mondada, F. (2018). Exploring escape games as a teaching tool in educational robotics. *Proceedings of the*

2018 International EduRobotics Conference, 95-106. https://doi.org/10.1007/978-3-030-18141-3_8

- Gibson, C. B., Zellmer-Bruhn, M. E., & Schwab, D. P. (2003). Team effectiveness in multinational organizations: Evaluation across contexts. *Group & Organization Management*, 28(4), 444-474. <https://doi.org/10.1177/1059601103251685>
- Goddard, R. D., Hoy, W. K., & Hoy, A. W. (2004). Collective efficacy beliefs: Theoretical developments, empirical evidence, and future directions. *Educational Researcher*, 33(3), 3-13. <https://doi.org/10.3102/0013189X033003003>
- Goodwin, G. F., Blacksmith, N., & Coats, M. R. (2018). The science of teams in the military: Contributions from over 60 years of research. *American Psychologist*, 73, 322–333. <https://doi.org/10.1037/amp0000259>
- Gordon, S. K., Trovinger, S., & DeLellis, T. (2019). Escape from the usual: Development and implementation of an ‘escape room’ activity to assess team dynamics. *Currents in Pharmacy Teaching and Learning*, 11(8), 818-824. <https://doi.org/10.1016/j.cptl.2019.04.013>
- Griggs, A. C., Cohen, T. C., Lazzara, E. H., Keebler, J. R., & Doherty, S. M. (2020, March 8-11). *Escape rooms in healthcare research: A review of the literature* [Poster presentation]. 2020 HFES Health Care Symposium, Toronto, Canada.
- Grossman, R., Friedman, S. B., & Kalra, S. (2017). Teamwork processes and emergent states. In E. Salas, R. Rico, & J. Passmore (Eds.), *The Wiley Blackwell Handbook of the Psychology of Team Working and Collaborative Processes* (1st ed., pp. 245-269). John Wiley & Sons.

- Hallgren, K. A. (2012). Computing inter-rater reliability for observational data: an overview and tutorial. *Tutorials in Quantitative Methods for Psychology*, 8(1), 23-24.
<https://doi.org/10.20982/tqmp.08.1.p023>
- Healy, K. (2019). Using an escape-room-themed curriculum to engage and educate generation Z students about entomology. *American Entomologist*, 65(1), 24-28.
<https://doi.org/10.1093/ae/tmz009>
- Ho, A. M. (2018). Unlocking ideas: Using escape room puzzles in a cryptography classroom. *Primus*, 28(9), 835-847. <https://doi.org/10.1080/10511970.2018.1453568>
- Ilggen, D. R. (1999). Teams embedded in organizations: Some implications. *American Psychologist*, 54(2), 129-139. <https://doi.org/10.1037/0003-066X.54.2.129>
- Ilggen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual Review of Psychology*, 56, 517-543. <https://doi.org/10.1146/annurev.psych.56.091103.070250>
- Jambhekar, K., Pahls, R. P., & Deloney, L. A. (2020). Benefits of an escape room as a novel educational activity for radiology residents. *Academic Radiology*, 27(2), 276-283.
<https://doi.org/10.1016/j.acra.2019.04.021>
- Järveläinen, J., & Paavilainen-Mäntymäki, E. (2019). Escape room as game-based learning process: Causation-effectuation perspective. *Proceedings of the 52nd Hawaii International Conference on System Sciences*, 1466-1475.
<https://doi.org/10.24251/HICSS.2019.178>
- Klein, C., DiazGranados, D., Salas, E., Le, H., Burke, C. S., Lyons, R., & Goodwin, G. F. (2009). Does team building work? *Small Group Research*, 40(2), 181-222.
<https://doi.org/10.1177/1046496408328821>

- Kleingeld, A., van Mierlo, H., & Arends, L. (2011). The effect of goal setting on group performance: A meta-analysis. *Journal of Applied Psychology, 96*(6), 1289-1304. <https://doi.org/10.1037/a0024315>
- Kolar, T. (2017). Conceptualising tourist experiences with new attractions: The case of escape rooms. *International Journal of Contemporary Hospitality Management, 29*(5), 1322-1339. <https://doi.org/10.1108/IJCHM-12-2015-0687>
- Kormos, C., & Gifford, R. (2014). The validity of self-report measures of proenvironmental behavior: A meta-analytic review. *Journal of Environmental Psychology, 40*, 359-371. <https://doi.org/10.1016/j.jenvp.2014.09.003>
- Kutzin, J. M. (2019). Escape the room: Innovative approaches to interprofessional education. *Journal of Nursing Education, 58*(8), 474-480. <https://doi.org/10.3928/01484834-20190719-07>
- Lacerenza, C. N., Marlow, S. L., Tannenbaum, S. I., & Salas, E. (2018). Team development interventions: Evidence-based approaches for improving teamwork. *American Psychologist, 73*(4), 517-531. <https://doi.org/10.1037/amp0000295>
- Laerd Statistics (2015). *Multiple regression using SPSS Statistics*. <https://statistics.laerd.com/>
- Laerd Statistics (2015). *One-way MANOVA using SPSS Statistics*. <https://statistics.laerd.com/>
- Laerd Statistics (2015). *Paired-samples t-test using SPSS Statistics*. <https://statistics.laerd.com/>
- Laerd Statistics (2017). *Simple linear regression using SPSS Statistics*. <https://statistics.laerd.com/>
- Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159-174. <https://doi.org/10.2307/2529310>

- Lazzara, E. H., Benishek, L. E., Hughes, A. M., Zajac, S., Spencers, K. B., Rogers, J. E., & Salas, E. (2021). Enhancing the organizations workforce: Guidance for effective training sustainment. *Consulting Psychology Journal: Practice and Research*, 73(1).
<https://doi.org/10.1037/cpb0000185>
- LePine, J. A., Piccolo, R. F., Jackson, C. L., Mathieu, J. E., & Saul, J. R. (2008). A meta-analysis of teamwork processes: Tests of a multidimensional model and relationships with team effectiveness criteria. *Personnel Psychology*, 61(2), 273-307.
<https://doi.org/10.1111/j.1744-6570.2008.00114.x>
- Marks, M. A., Mathieu, J. E., & Zaccaro, S. J. (2001). A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26(3), 356-376.
<https://doi.org/10.5465/amr.2001.4845785>
- Marks, M. A., & Panzer, F. J. (2004). The influence of team monitoring on team processes and performance. *Human Performance*, 17(1), 25-41.
https://doi.org/10.1207/S15327043HUP1701_2
- Mathieu, J. E., Luciano, M. M., D’Innocenzo, L., Klock, E. A., & LePine, J. A. (2020). The development and construct validity of a team processes survey measure. *Organizational Research Methods*, 23(3), 399-431. <https://doi.org/10.1177/1094428119840801>
- McGrath, J. E. (1964). *Social psychology: A brief introduction*. Holt, Rinehart and Winston.
- Mullan, B. A., & Kothe, E. J. (2010). Evaluating a nursing communication skills training course: The relationships between self-rated ability, satisfaction, and actual performance. *Nurse Education in Practice*, 10(6), 374-378. <https://doi.org/10.1016/j.nepr.2010.05.007>
- Nicholson, S. (2015). *Peeking behind the locked door: A survey of escape room facilities* [White paper]. Wilfrid Laurier University. <http://scottnicholson.com/pubs/erfacwhite.pdf>

- Nicholson, S. (2018). Creating engaging escape rooms for the classroom. *Childhood Education*, 94(1), 44-49. <https://doi.org/10.1080/00094056.2018.1420363>
- O'Boyle C. A., Henly S. J., Larson E. (2001). Understanding adherence to hand hygiene recommendations: The theory of planned behaviour. *American Journal of Infection Control*, 29(6), 352-360. <https://doi.org/10.1067/mic.2001.18405>
- Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (6th ed.). Routledge.
- Pan, R., Lo, H., & Neustaedter, C. (2017). Collaboration, awareness, and communication in real-life escape rooms. *Proceedings of the 2017 Conference on Designing Interactive Systems*, 1353-1364. <https://doi.org/10.1145/3064663.3064767>
- Patineau, A., Leonowics, N., & Mlynarek, C. (2019). Escape room: An innovative approach to teaching disaster preparedness to emergency medicine residents and medical students. *The Western Journal of Emergency Medicine*, 20(4), S48.
- Rapee, R. M., & Lim, L. (1992). Discrepancy between self-and observer ratings of performance in social phobics. *Journal of Abnormal Psychology*, 101(4), 728-731. <https://doi.org/10.1037//0021-843x.101.4.728>
- Rosen, M. A., DiazGranados, D., Dietz, A. S., Benishek, L. E., Thompson, D., Pronovost, P. J., & Weaver, S. J. (2018). Teamwork in healthcare: Key discoveries enabling safer, high-quality care. *American Psychologist*, 73(4), 433-450. <https://doi.org/10.1037/amp0000298>
- Rosen, M. A., Salas, E., Tannenbaum, S. I., Pronovost, P. J., & King, H. B. (2016). Simulation based training for teams in health care: Designing scenarios, measuring performance, and

- providing feedback. In P. Carayon (Ed.), *Handbook of human factors and ergonomics in health care and patient safety* (pp. 602–625). CRC Press. <https://doi.org/10.1201/b11219>
- Ross, R., & Bell, C. (2019). Turning the classroom into an escape room with decoder hardware to increase student engagement. *Proceedings of the 2019 IEEE Conference on Games*. <https://doi.org/10.1109/CIG.2019.8848020>
- Salas, E., & Cannon-Bowers, J. A. (2000). Design training systematically. In E. A. Locke, (Ed.), *The Blackwell handbook of principles of organizational behavior* (pp. 43-59). Wiley-Blackwell. <https://doi.org/10.1002/9781405164047.ch4>
- Salas, E., Reyes, D. L., & McDaniel, S. H. (2018). The science of teamwork: Progress, reflections, and the road ahead. *American Psychologist*, 73(4), 593-600. <https://doi.org/10.1037/amp0000334>
- Salas, E., Rozell, D., Mullen, B., & Driskell, J. E. (1999). The effect of team building on performance: An integration. *Small Group Research*, 30(3), 309-329. <https://doi.org/10.1177/104649649903000303>
- SCRAP. (2007, July 7). *Real Escape Game project first series*. SCRAP. <http://realdgame.jp/event/nazotokinoutage.html>
- Shakeri, H., Singhal, S., Pan, R., Neustaedter, C., & Tang, A. (2017). Escaping together: The design and evaluation of a distributed real-life escape room. *Proceedings of the 2017 Annual Symposium on Computer-Human Interaction in Play*, 115-128. <https://doi.org/10.1145/3116595.3116601>
- Shuffler, M. L., DiazGranados, D., & Salas, E. (2011). There's a science for that: Team development interventions in organizations. *Current Directions in Psychological Science*, 20(6), 365-372. <https://doi.org/10.1177/0963721411422054>

- Tibballs J. (1996). Teaching hospital medical staff to handwash. *Medical Journal of Australia*, 164(7), 395-398. <https://doi.org/10.5694/j.1326-5377.1996.tb122084.x>
- Veldkamp, A., Daemen, J., Teekens, S., Koelewijn, S., Knippels, M. C. P., & van Joolingen, W. R. (2020). Escape boxes: Bringing escape room experience into the classroom. *British Journal of Educational Technology*, 51(4), 1220-1239. <https://doi.org/10.1111/bjet.12935>
- Warmelink, H., Mayer, I., Weber, J., Heijligers, B., Haggis, M., Peters, E., & Louwense, M. (2017). AMELIO: Evaluating the team-building potential of a mixed reality escape room game. *Proceedings of the 2017 Annual Symposium on Computer-Human Interaction in Play*, 111-123. <https://doi.org/10.1145/3130859.3131436>
- Webb, S. D., & Soh, S. (2007). Cheating in networked computer games: A review. *Proceedings of the 2nd International Conference on Digital Interactive Media in Entertainment and Arts*, 105-112. <https://doi.org/10.1145/1306813.1306839>
- Williams, P. (2018). Using escape room-like puzzles to teach undergraduate students effective and efficient group process skills. *Proceedings of the 2018 IEEE Integrated STEM Education Conference*, 254-257). <https://doi.org/10.1109/ISECon.2018.8340495>
- Wu, C., Wagenschutz, H., & Hein, J. (2018). Promoting leadership and teamwork development through escape rooms. *Medical Education*, 52(5), 561-562. <https://doi.org/10.1111/medu.13557>
- Zapf, A., Castell, S., Morawietz, L., & Karch, A. (2016). Measuring inter-rater reliability for nominal data – Which coefficients and confidence intervals are appropriate? *BMC Medical Research Methodology*, 16(1). <https://doi.org/10.1186/s12874-016-0200-9>
- Zhang, X. C., Diemer, G., Lee, H., Jaffe, R., & Papanagnou, D. (2019). Finding the ‘QR’ to patient safety: Applying gamification to incorporate patient safety priorities through a

simulated 'escape room' experience. *Cureus*, 11(2).

<https://doi.org/10.7759%2Fcureus.4014>

Zhang, X. C., Lee, H., Rodriguez, C., Rudner, J., Chan, T. M., & Papanagnou, D. (2018).

Trapped as a group, escape as a team: applying gamification to incorporate team-building skills through an 'escape room' experience. *Cureus*, 10(3).

<https://doi.org/10.7759/cureus.2256>

Appendices

Appendix A

Operational Definitions of Terms

Term	Definition	Citation
<i>Escape Room</i>	A recreational, team-based activity wherein multiple individuals must work together to solve a series of challenges or puzzles in a limited amount of time	Nicholson, S. (2015)
<i>Work Teams</i>	Teams composed of two or more interdependent members with a shared goal	Benishek, L. E., & Lazzara, E. H. (2019)
<i>Teamwork</i>	The ability to work together with others to achieve a shared goal	Mathieu et al., (2001)
<i>IPO</i>	Framework of team effectiveness composed of inputs, processes, and outcomes	Ilggen et al., (2005)
<i>IMOI</i>	Iterative framework of team effectiveness using inputs, mediators, and outcomes, which then function as new inputs	Ilggen et al., (2005)
<i>Team Training</i>	Team development intervention that seeks to provide team members with specific knowledge, skills, and attitudes required for optimal team performance	Shuffler et al., (2011)
<i>Team Building</i>	Team development intervention that seeks to provide opportunities to improve interpersonal relationships and social interactions between team members	Shuffler et al., (2011)
<i>Team Processes</i>	The mechanisms by which a team coordinates their efforts to work together during a task	Marks et al., (2001)
<i>Goal Specification</i>	Communicating goal(s) or subgoals required for task completion	Marks et al., (2001)
<i>Monitoring Progress Towards Goals</i>	Communicating progress towards task completion	Marks et al., (2001)
<i>Motivating and Confidence Building</i>	Verbal or non-verbal affirmation to teammates concerning task completion	Marks et al., (2001)
<i>Perceived Team Effectiveness (PTE)</i>	Self-reported perceptions concerning the extent to which a team was able to meet the demands that were placed upon it and are valued by their organization	Essens et al., (2005)
<i>Task Completion</i>	The number of steps completed by a team to solve puzzles during the escape room intervention	-

Appendix B

Demographic Items Utilized in Archival Sample

Item	Response Format/Response Options
Age	Open String Response
Gender	<ul style="list-style-type: none"> <input type="radio"/> Male <input type="radio"/> Female <input type="radio"/> Other (If Yes, Specify Below)
If you answered "Other", enter "Other Type" here	Open String Response
What is your current job role?	<ul style="list-style-type: none"> <input type="radio"/> Clinical - Nursing - CAN <input type="radio"/> Clinical - Nursing - BSN <input type="radio"/> Clinical - Nursing - MSN <input type="radio"/> Clinical - Nursing - NP <input type="radio"/> Clinical - Nursing - Other - If Yes, Please SPECIFY BELOW ("Other Nursing: Your Role") <input type="radio"/> Clinical - Surgeon - If Yes, Please SPECIFY BELOW ("Surgeon: Your Role") <input type="radio"/> Clinical - Anesthesiologist <input type="radio"/> Clinical - Other MD - If Yes, Please SPECIFY BELOW ("Other MD: Your Role") <input type="radio"/> Clinical - Other Clinical role - If Yes, Please SPECIFY BELOW ("Other Clinical role: Your Role") <input type="radio"/> Non-Clinical - Administrative – If Yes, Please SPECIFY BELOW ("Administrative: Your Role") <input type="radio"/> Non-Clinical - Research <input type="radio"/> Non-Clinical - Executive Leadership <input type="radio"/> Non-Clinical - Technology/IT/EIS <input type="radio"/> Non-Clinical – HR <input type="radio"/> Non-Clinical - Facilities <input type="radio"/> Non-Clinical - Other - If Yes, Please SPECIFY BELOW ("Other: Your Role")
If you answered "Other", enter "Other Type" here	Open String Response
Highest education attained:	<ul style="list-style-type: none"> <input type="radio"/> High school diploma <input type="radio"/> Associates degree (AA) <input type="radio"/> Bachelor's degree (BA, BS, BSN) <input type="radio"/> Master's degree (MA, MS, MBA, etc.) <input type="radio"/> MD PhD or other doctorate <input type="radio"/> Other - If Yes, Please SPECIFY BELOW ("Other: Your Degree")
If you answered "Other", enter "Other Type" here	Open String Response

- How long have you been in your current role? Open String Response
- How long have you been working with the team of individuals that you are doing the escape room with? Open String Response
- Have you ever participated in an escape room before?
- No
 - Yes (If Yes, please SPECIFY BELOW how many you have done)
- Number of escape rooms done previously Open String Response
- How many days per week do you interact with the team members who will be participating in the escape room with you?
- 0
 - 1
 - 2
 - 3
 - 4
 - 5
- Have you completed any team building exercises with this team before?
- No
 - Yes (If Yes, Explain BELOW)
- If you answered Yes, EXPLAIN HERE Open String Response
-

Appendix C

Demographic Items Utilized in 1 Year Follow Up Survey

Item	Response Format/Response Options
Please enter your Cedars-Sinai email address:	Open String Response
What is your current age in years? (ex: 42)	Open Numerical Response
Please indicate your gender below:	<ul style="list-style-type: none"> <input type="radio"/> Male <input type="radio"/> Female <input type="radio"/> Other
If you answered "other" for the previous question, please describe your gender below:	Open String Response
What is the highest level of education you have attained?	<ul style="list-style-type: none"> <input type="radio"/> High school diploma <input type="radio"/> Associates degree (AA) <input type="radio"/> Bachelor's degree (BA, BS, BSN) <input type="radio"/> Master's degree (MA, MS, MBA, etc.) <input type="radio"/> MD <input type="radio"/> PhD or other doctorate <input type="radio"/> Other
If you selected "Other" please specify your highest attained education below:	Open String Response
What is your current job role?	<ul style="list-style-type: none"> <input type="radio"/> Clinical - Nursing - CAN <input type="radio"/> Clinical - Nursing - BSN <input type="radio"/> Clinical - Nursing - MSN <input type="radio"/> Clinical - Nursing - NP <input type="radio"/> Clinical - Nursing - Other <input type="radio"/> Clinical - Surgeon <input type="radio"/> Clinical - Anesthesiologist <input type="radio"/> Clinical - Other MD <input type="radio"/> Clinical - Other Clinical Role <input type="radio"/> Non-Clinical - Administrative <input type="radio"/> Non-Clinical - Research <input type="radio"/> Non-Clinical - Executive Leadership <input type="radio"/> Non-Clinical - Technology/IT/EIS <input type="radio"/> Non-Clinical – HR <input type="radio"/> Non-Clinical - Facilities <input type="radio"/> Non-Clinical - Other
If you selected "Clinical - Nursing - Other" please specify your role below:	Open String Response
If you selected "Clinical - Surgeon" please specify your role below:	Open String Response
If you selected "Clinical - Other MD" please specify your role below:	Open String Response
If you selected "Clinical - Other Clinical Role" please specify your role below:	Open String Response

If you selected "Non-clinical - Administrative" please specify your role below:	Open String Response
If you selected "Non-clinical - Other" please specify your role below:	Open String Response
How long have you been in your current role? (ex: 1 year, 3 months)	Years: Open Numerical Response Months: Open Numerical Response
Have you participated in any <i>additional</i> escape room activities with the team of individuals you completed the escape room with at Cedars-Sinai?	<input type="radio"/> Yes <input type="radio"/> No
How many escape rooms have you completed previously (including the escape room activity at Cedars-Sinai)?	Open Numerical Response
Have you participated in any other additional team building exercises with the team of individuals you completed the escape room with at Cedars-Sinai?	<input type="radio"/> Yes <input type="radio"/> No
If you selected "Yes" to the previous question, please describe the team building exercise(s) you have completed with this team below:	Open String Response
Do you still work with the same team of individuals that you completed the escape room at Cedars-Sinai with?	<input type="radio"/> I work with <i>all</i> of the same teammates <input type="radio"/> I work with <i>some</i> of the same teammates <input type="radio"/> I work with <i>only one</i> of the same teammates <input type="radio"/> I work with <i>none</i> of the same teammates
How many days per week do you interact with the team members that you participated with in the escape room at Cedars-Sinai?	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input type="radio"/> 5
How long have you been working with the team of individuals that you completed the escape room with? (ex: 2 years, 11 months)	Years: Open Numerical Response Months: Open Numerical Response

Appendix D

Team Processes Survey Items

Prompt:

Read each item carefully and select the most accurate response. As you read each item, think about your current team at Cedars-Sinai and consider the following prompt:

To what extent does our team actively work to do each of the following...

Item	Response Format/Response Options
Identify the key challenges that we expect to face? Ensure that everyone on our team clearly understands our goals? Develop an overall strategy to guide our team activities? Seek timely feedback from stakeholders (e.g., customers, top management, other organizational units) about how well we are meeting our goals? Monitor important aspects of our work environment (e.g., inventories, equipment and process operations, information flows)? Assist each other when help is needed? Coordinate our activities with one another? Deal with personal conflicts in fair and equitable ways? Encourage each other to perform our very best? Keep a good emotional balance in the team?	<ul style="list-style-type: none">○ Not at all○ Very little○ To some extent○ To a great extent○ To a very great extent

Appendix E

Training Document Provided to Research Assistants

Overview for Reviewers

Thank you for agreeing to be a video reviewer for this project dealing with team processes and escape rooms. The purpose of this document is to prepare you to review videos of teams completing an escape room activity and to assess varying behaviors that team members exhibit during the activity using a digital form.

Escape rooms are a recreational, team-based activity wherein multiple participants work together to solve puzzles or complete different challenges to 'escape the room' in a limited amount of time. Escape rooms are beginning to receive attention as a team-building intervention, but more research is needed to understand their efficacy towards this end.

Teamwork, the ability to work together with others to achieve a shared goal, is often viewed through the lens of team processes. Team processes refer to the specific behavioral functions that enable a team to work together towards a shared goal and can be organized into three groups depending on their relationship to a task being performed by a group: 1) transition phase processes, which take place between episodes of task completion, 2) action phases processes, which take place during task completion, and 3) interpersonal processes, which can take place at any time. Action processes are associated with *completing tasks*, transition processes *set the stage* for task completion, and interpersonal processes are associated with the *management of social relationships* that can influence the effectiveness of action and transition processes.

This project aims to better understand the nature of teamwork in an escape room activity and how teamwork can influence team performance as well as other team-building outcomes. This will be achieved by reviewing multiple videos of teams completing an escape room activity and assessing three specific team processes hypothesized to influence performance in the escape room as well as other team-building outcomes.

These three team processes are: 1) *goal specification*, 2) *monitoring progress towards goals*, and 3) *motivating and confidence building*.

- ***Goal specification*** is a *transition* process that refers to actions that seek to denote, clarify, or prioritize goals that are needed to ensure successful task completion.
 - This will be measured as verbal statements from one team member to the rest of their team that seek to denote, clarify, or prioritize goals related to puzzle completion in the escape room such as "We will have to solve all 4 of these puzzles before we can progress," or "We should focus on this puzzle before moving to another."
- ***Monitoring progress towards goals*** is an *action* process that refers to attempts by team members to attend to, interpret, and communicate information needed to assess the team's progress towards a shared goal.
 - This will be measured as verbal statements which announce the completion of a puzzle to the rest of the group or clarifying if a current strategy is ineffective in contributing towards a puzzle's completion such as "We just solved another puzzle," or "We'll have to work faster if we want to complete this puzzle in time."
- ***Motivation and confidence building*** is an *interpersonal* process and refers to attempts to both build or maintain motivation and confidence within the team concerning their ability to effectively complete their shared task(s).
 - This will be measured as verbal statements that attempt to foster motivation and confidence within the team such as "We're doing great, let's keep it up!" or "We can do this!"

Instructions for Reviewers

Your Role as a Reviewer:

You will be provided with a digital form containing a list of timestamps that refer to behaviors exhibited by team members at different times during the escape room activity. By using this digital form and reviewing videos of participants during the activity, **you will sort these behavioral events into one of the three above categories (goal specification, monitoring progress towards goals, or motivation and confidence building)**. The way that you sort these behavioral events will be compared against other raters to assess the inter-rater reliability of this process.

As a video reviewer in this project, you will be expected to dedicate some time to familiarize yourself with these instructions and to review multiple videos of teams completing the escape room activity. The escape room that participants are completing in these videos was designed to last approximately 45 minutes. Some teams may escape the room in less than 45 minutes, and some teams may take the entire time. You will be assigned a sample of these videos to review to serve as training, then you will be assigned another sample of videos to review once training is completed.

What to Expect in the Videos:

This escape room was initially designed and developed by employees of Cedars-Sinai Medical Center, a large hospital in Los Angeles. Teams of up to six employees of Cedars-Sinai were invited to participate in the activity and completed multiple surveys before and after participating. The participants have backgrounds in many different areas of healthcare, including surgery, nursing, or administration. Videos of these teams completing the activity were recorded for the current behavioral analysis. These videos were recorded before the COVID-19 pandemic began and social distancing was not commonplace.

Each participant is identifiable by a number written on a sign that is hanging from their clothes. These participant numbers on their clothes will correspond to the participant numbers in the digital form.

Two cameras at opposite points in the room were set up to capture videos of participants as they completed the activity. The video files that you will be reviewing show both of these camera feeds simultaneously, with one camera displayed in the left half of the video, and another camera displayed in the right half of the video. Please note that these video feeds may pan to different locations in the room throughout a recording.

Two microphones were hung near the center of the room to capture audio and verbal statements of participants as they completed the activity. Please note that the audio may be unclear at times and that it may be difficult to determine who is speaking if they are off-screen or if their mouth is not visible.

Reviewer Training:

The video review process will begin with training. There will be a meeting held with all video raters where these instructions will be discussed and you will have the opportunity to ask any questions you may have. Following this meeting, you will be assigned a sample of videos to review. The way that you sort each behavior event will be compared against other raters to assess inter-rater reliability. A second meeting will be held to discuss inter-rater reliability and if all video raters are consistently sorting each behavioral event into one of three categories you will be assigned another larger sample of videos to review. Additional meetings may be held as necessary to bolster inter-rater reliability before you are assigned your remaining videos to review.

Using the Digital Form:

You will be provided with multiple excel files which will act as the digital form used in this process. Each Excel file will feature three sheets:

- Sheet title: Behavior Legend
 - This sheet contains each team process being analyzed (goal specification, monitoring progress towards goals, and motivating and confidence building).
 - This sheet also contains a definition of each team process, an operational definition for its measurement in the escape room activity, as well as examples of each within the context of the escape room.
- Sheet title: Instructions for RAs
 - This sheet contains an abbreviated set of instructions for this procedure.
 - You are to use the behavior legend sheet as a guide when sorting the behaviors listed in the TP selection sheet.
- Sheet title: Form – TP Selection
 - This sheet will be used to sort behavior events into the three team process categories.
 - Each participant in a video will have a row denoted by each participant's number (1-6).
 - Each participant will have a list of behavior events, timestamps for those events, and a comment field.
 - The timestamps will denote where a behavior can be found in a video.
 - You are welcome to leave a comment on any individual behavior as desired.
 - The “associated team process” columns are where you will sort each behavior event.
 - Each cell will have a drop down menu where you can select the appropriate category for each behavior event

You will complete this form multiple times (one for each video you are assigned to review). The procedure for using the form is listed below:

1. Open the digital form/Excel file associated with the video you are reviewing (these will be provided via email ahead of time)
2. Open the video file you are reviewing.
3. Navigate to a timestamp in the video using the timestamps provided in the form for each behavior event.
4. Review the actions and verbal statements of the team member in the video for that behavior event at the provided timestamp.
 - Note: You can review the video for as long as needed and fast-forward or rewind the video from the provided timestamp as needed to acquire additional context.
5. Select the appropriate team process for the behavioral event using the drop-down options provided in the digital form.
 - Note: Each behavior event will only be associated with one team process and you are *not* allowed to skip any behavior events.
6. Repeat this process for each behavioral event noted in the form.

Video Access:

The videos being reviewed in this project can be found at this link: [Link Redacted]. You will be assigned a sample of these videos to review during training and during the full-video review proper via email. Recordings of teams completing the escape room activity each have their own folder (*example folder name:* “Study Group ID 1 (7-17-19) – 6 participants”). These folders will contain video files that you will use during this process. The group ID listed in the folder name will be used when referring to video assignments (example: Reviewer one will be assigned to group ID 1, 3, 5, & 7).

Appendix F

Statistical Assumptions Related to H1-H3

Assumptions of MANOVA

- 1) There are two or more continuous dependent variables measured at the interval or ratio level
 - 2) There is one independent variable that is composed of two or more categorical, independent groups
 - 3) Observations of each group are independent
 - 4) There are more cases in each group than there are dependent variables
 - 5) There are no univariate or multivariate outliers in the data
 - 6) Data are normally distributed in each independent variable group
 - 7) Dependent variables are linearly related for each group of the independent variable
 - 8) There is homogeneity of variances in the data (there are equal variances between each group of the independent variable)
 - 9) Dependent variables do not exhibit multicollinearity (correlations between dependent variables are moderate)
-

Appendix G

Statistical Assumptions Related to H4-H9

Assumptions of Multiple Regression

- 1) There is one continuous dependent variable measured at the interval or ratio level
 - 2) There are at least two or more continuous independent variables measured at the nominal, interval, or ratio level
 - 3) There is a linear relationship between the dependent variable and each independent variable individually, as well as collectively
 - 4) There are at least 15 cases per predictor in the regression equation
 - 5) The data does not contain any significant outliers
 - 6) The variance of residuals (differences between obtained and predicted scores) exhibits homoscedasticity (variance in residuals is the same for all values of the predicted dependent variables)
 - 7) There is no multicollinearity or singularity in values of the independent variables (independent variables are not highly correlated with each other and no independent variable is a combination of other independent variables in the regression equation)
 - 8) Residuals of the predicted dependent variable are linearly related to predicted values of the dependent variable
 - 9) Residuals (differences between obtained and predicted scores) of the predicted dependent variable are normally distributed
-

Appendix H

Statistical Assumptions Related to H10-H11

Assumptions of Paired-Samples T-Test

- 1) There is one continuous dependent variable measured at the interval or ratio level
 - 2) There is one categorical independent variable that consists of two related groups or matched pairs
 - 3) There are no significant outliers in the differences between each of the two related groups
 - 4) Scores for each group of the independent variable are normally distributed
-

Appendix I

Statistical Assumptions Related to H12

Assumptions of Bivariate Regression

- 1) There is one continuous dependent variable measured at the interval or ratio level
 - 2) There is one continuous independent variable measured at the interval or ratio level
 - 3) There is a linear relationship between the independent and dependent variables
 - 4) There are at least 15 cases per predictor in the regression equation
 - 5) There are no significant outliers in measures of the independent or dependent variable
 - 6) There is independence of observations
 - 7) The variance of residuals (differences between obtained and predicted scores) exhibits homoscedasticity (variance in residuals is the same for all values of the independent variable)
 - 8) Residuals of the predicted dependent variable are normally distributed
-

Appendix J

Overview of Job Roles Reported by Participants in Archival Sample

Category	Frequency Count (Percentage)	Specific String Responses (If Provided)
Clinical - Nursing - BSN	25 (17.2%)	n/a
Clinical - Nursing - MSN	17 (11.7%)	n/a
Clinical - Nursing - NP	3 (2.1%)	n/a
Clinical - Nursing - Other	1 (0.7%)	1 "MHDS"
Clinical - Surgeon	7 (4.8%)	1 "Otolaryngology" 1 "Resident" 1 "Urologist"
Clinical - Other MD	31 (21.4%)	4 Blanks/No Response 1 "ED" 1 "emergency physician" 1 "Emergency room attending" 1 "Hematologist, Bone Marrow Transplant Program" 1 "IM intern" 1 "Int. medicine" 1 "Intern" 1 "internal medicine" 1 "Internal medicine" 3 "Internal Medicine" 1 "Internal Medicine PG4-1" 1 "Internal Medicine Resident" 1 "Medical student" 1 "Medicine" 10 "Resident" 1 "Resident intern" 4 Blanks/No Response
Clinical - Other Clinical Role	19 (13.1%)	1 "Associate Director Clinical Nutrition" 2 "Clinical Dietitian" 1 "Clinical Research Coordinator" 5 "Dietitian" 1 "Med student" 2 "pharmacist" 2 "Pharmacist" 1 "Pharmacy manager" 1 "Pharmacy Manager" 1 "PSR" 1 "Registered Dietitian" 1 "Visiting Medical Student"
Non-Clinical - Administrative	11 (7.6%)	1 "Administrative: Patient Service Representative" 1 "Administrative: Pharmacy Manager" 1 "ANM" 1 "Associate Director" 1 "Senior Administrative Assistant" 1 "Supervisor" 1 "trauma program manager" 4 Blanks/No Response
Non-Clinical - Research	16 (11%)	n/a
Non-Clinical - Executive Leadership	2 (1.4%)	n/a
Non-Clinical - HR	5 (3.4%)	n/a
Non-Clinical - Other	5 (3.4%)	1 "MA II" 1 "Manager" 1 "medical student" 1 "Program Manager CCTO Regulatory" 1 "Program/Project Coordinator"
Missing Data	3 (2.1%)	n/a

Appendix K

Overview of Job Roles Reported by Participants in Prospective Sample

Category	Frequency Count (Percentage)	Specific String Responses (If Provided)
Clinical - Nursing - BSN	6 (12.24%)	n/a
Clinical - Nursing - MSN	6 (12.24%)	n/a
Clinical - Nursing - NP	2 (4.08%)	n/a
Clinical - Nursing - Other	2 (4.08%)	1 "Assistant nurse manager"
		1 Blank/No Response
Clinical - Surgeon	3 (6.12%)	1 "Professor"
		1 "resident"
		1 "Resident"
Clinical - Other MD	8 (16.33%)	1 "Attending- Emergency"
		1 "emergency physician"
		1 "IM"
		1 "Internal medicine"
		2 "Internal medicine resident"
		1 "Internal Medicine Resident"
		1 "Resident"
Clinical - Other Clinical Role	4 (8.16%)	1 "Clinical Dietitian"
		2 "Dietitian"
		1 "Research Dietitian"
Non-Clinical - Administrative	5 (10.20%)	1 "Associate Director"
		1 "Education Program Coordinator for OR"
		1 "Executive Director"
		1 "Manager, Clinical Operations"
		1 "patient service representative"
Non-Clinical - Research	10 (20.41%)	n/a
Non-Clinical - HR	2 (4.08%)	n/a
Non-Clinical - Other	1 (2.04%)	1 "Manager"

Appendix L

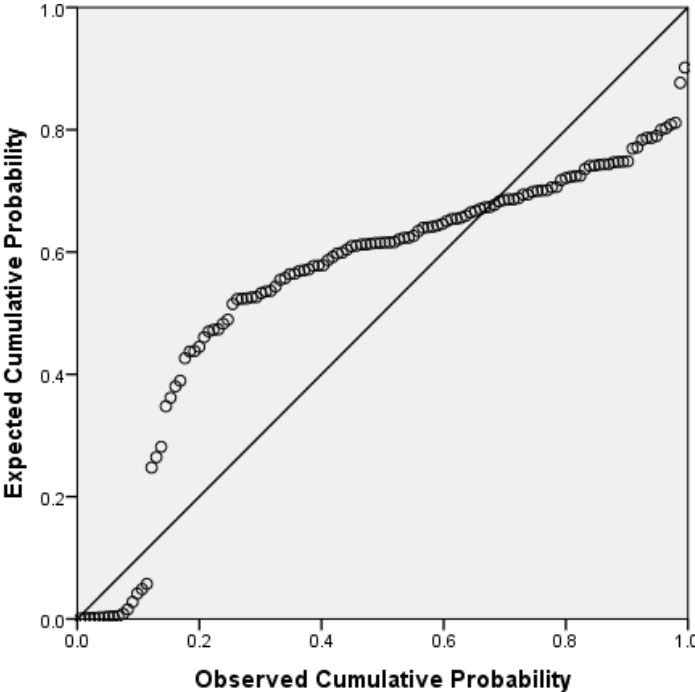
Inter-Item Correlations

Variable		1	2	3	4	5	6	7	8	9	10
1. Age	Pearson Correlation										
	Sig. (2-tailed)	-									
	N										
2. Gender	Pearson Correlation	.115									
	Sig. (2-tailed)	.172	-								
	N	142									
3. Education	Pearson Correlation	-.036	-.239**								
	Sig. (2-tailed)	.673	.005	-							
	N	140	140								
4. Job Role	Pearson Correlation	-.249**	-.078	.031							
	Sig. (2-tailed)	.003	.357	.715	-						
	N	142	142	140							
5. Prior TB Experience	Pearson Correlation	.156	-.036	.069	-.031						
	Sig. (2-tailed)	.066	.671	.421	.715	-					
	N	140	140	140	140						
6. Prior Escape Room Experience	Pearson Correlation	-.016	.008	.102	.098	.321**					
	Sig. (2-tailed)	.846	.925	.230	.246	.000	-				
	N	142	142	140	142	140					
7. Number of Prior Escape Rooms	Pearson Correlation	-.028	.090	.230*	.023	.158	. ^c				
	Sig. (2-tailed)	.804	.431	.044	.839	.169	.000	-			
	N	79	79	77	79	77	79				
8. Days of Weekly Interaction	Pearson Correlation	.091	.155	-.223**	.004	.162	.119	.102			
	Sig. (2-tailed)	.279	.065	.008	.960	.055	.160	.369	-		
	N	142	142	140	142	140	142	79			
9. Time to Escape	Pearson Correlation	.023	-.018	-.148	-.171*	-.215*	-.395**	-.294**	-.107		
	Sig. (2-tailed)	.788	.835	.080	.042	.011	.000	.009	.205	-	
	N	142	142	140	142	140	142	79	142		
10. Task Completion	Pearson Correlation	-.031	.010	.164	-.005	.215*	.287**	.068	-.051	-.410**	
	Sig. (2-tailed)	.726	.913	.066	.954	.015	.001	.567	.564	.000	-
	N	128	128	127	128	127	128	74	128	131	
11. PTE (Pre)	Pearson Correlation	.194*	.208*	-.166	-.187*	.119	.199*	.132	.393**	-.065	.065
	Sig. (2-tailed)	.021	.013	.050	.026	.162	.018	.250	.000	.441	.470
	N	141	141	139	141	139	141	78	141	141	127
12. PTE (Post)	Pearson Correlation	.277**	.118	-.096	-.129	.116	.179*	.109	.238**	-.225**	.420**
	Sig. (2-tailed)	.001	.163	.264	.129	.177	.035	.340	.005	.007	.000
	N	140	140	138	140	138	140	79	140	143	130
13. PTE (1 Year)	Pearson Correlation	.225	.162	.006	-.176	.132	.187	-.081	.262	-.154	.155
	Sig. (2-tailed)	.119	.266	.970	.227	.372	.199	.654	.069	.291	.311
	N	49	49	48	49	48	49	33	49	49	45
14. Transition Items Average (Pre)	Pearson Correlation	.171*	.062	-.167*	-.137	-.062	.031	.032	.161	.123	-.100
	Sig. (2-tailed)	.042	.466	.049	.105	.464	.715	.778	.057	.147	.262
	N	141	141	140	141	140	141	78	141	141	128
15. Action Items Average (Pre)	Pearson Correlation	.146	.053	-.103	-.070	.023	.098	.073	.240**	.014	-.107
	Sig. (2-tailed)	.085	.533	.228	.409	.791	.247	.524	.004	.870	.228
	N	141	141	140	141	140	141	78	141	141	128
16. Interpersonal Items Average (Pre)	Pearson Correlation	.114	.022	-.035	-.055	.048	.014	.119	.252**	.071	-.136
	Sig. (2-tailed)	.177	.795	.683	.518	.572	.869	.299	.003	.405	.126
	N	141	141	140	141	140	141	78	141	141	128
17. Transition Items Average (1 Year)	Pearson Correlation	.108	-.005	-.045	-.097	.075	-.061	-.011	.187	.201	.041
	Sig. (2-tailed)	.468	.973	.767	.517	.618	.685	.954	.207	.176	.794
	N	47	47	46	47	46	47	32	47	47	43
18. Action Items Average (1 Year)	Pearson Correlation	-.013	-.048	.096	-.025	.068	-.046	-.099	.200	.149	.188
	Sig. (2-tailed)	.930	.747	.525	.868	.655	.757	.588	.178	.317	.227
	N	47	47	46	47	46	47	32	47	47	43
19. Interpersonal Items Average (1 Year)	Pearson Correlation	.093	.110	.108	-.151	.100	.052	-.213	.146	-.028	.176
	Sig. (2-tailed)	.533	.463	.475	.309	.507	.730	.241	.327	.851	.258
	N	47	47	46	47	46	47	32	47	47	43
20. Goal Specification Behavior	Pearson Correlation	-.006	.003	.076	-.167	-.023	-.091	-.080	-.115	.505**	-.087
	Sig. (2-tailed)	.947	.974	.393	.060	.795	.309	.496	.197	.000	.324
	N	128	128	127	128	127	128	74	128	131	131
21. Monitoring Progress Towards Goals Behavior	Pearson Correlation	.040	.014	.083	-.230**	-.035	-.252**	-.158	-.144	.569**	-.201*
	Sig. (2-tailed)	.656	.873	.355	.009	.699	.004	.179	.106	.000	.021
	N	128	128	127	128	127	128	74	128	131	131
22. Motivating/ Confidence Building Behavior	Pearson Correlation	.029	-.004	-.022	-.089	.067	-.052	.080	-.074	.157	.008
	Sig. (2-tailed)	.742	.965	.803	.318	.451	.563	.499	.405	.073	.930
	N	128	128	127	128	127	128	74	128	131	131

Variable		11	12	13	14	15	16	17	18	19	20	21	22
11. PTE (Pre)	Pearson Correlation												
	Sig. (2-tailed)	-											
	N												
12. PTE (Post)	Pearson Correlation	.546**											
	Sig. (2-tailed)	.000	-										
	N	139											
13. PTE (1 Year)	Pearson Correlation	.686**	.519**										
	Sig. (2-tailed)	.000	.000	-									
	N	49	49										
14. Transition Items Average (Pre)	Pearson Correlation	.515**	.259**	.331*									
	Sig. (2-tailed)	.000	.002	.021	-								
	N	140	139	48									
15. Action Items Average (Pre)	Pearson Correlation	.624**	.351**	.533**	.742**								
	Sig. (2-tailed)	.000	.000	.000	.000	-							
	N	140	139	48	141								
16. Interpersonal Items Average (Pre)	Pearson Correlation	.579**	.240**	.402**	.633**	.802**							
	Sig. (2-tailed)	.000	.004	.005	.000	.000	-						
	N	140	139	48	141	141							
17. Transition Items Average (1 Year)	Pearson Correlation	.370*	.310*	.355*	.107	.358*	.258						
	Sig. (2-tailed)	.010	.034	.014	.478	.015	.083	-					
	N	47	47	47	46	46	46						
18. Action Items Average (1 Year)	Pearson Correlation	.261	.222	.351*	.056	.211	.190	.881**					
	Sig. (2-tailed)	.076	.133	.016	.710	.160	.205	.000	-				
	N	47	47	47	46	46	46	47					
19. Interpersonal Items Average (1 Year)	Pearson Correlation	.357*	.343*	.484**	.200	.343*	.291*	.680**	.747**				
	Sig. (2-tailed)	.014	.018	.001	.183	.019	.050	.000	.000	-			
	N	47	47	47	46	46	46	47	47				
20. Goal Specification Behavior	Pearson Correlation	-.102	-.108	-.121	.009	-.037	-.021	-.064	.063	-.078			
	Sig. (2-tailed)	.255	.223	.427	.921	.678	.814	.686	.687	.620	-		
	N	127	130	45	128	128	128	43	43	43			
21. Monitoring Progress Towards Goals Behavior	Pearson Correlation	-.075	-.187*	.133	-.013	-.113	-.047	.184	.189	.014	.704**		
	Sig. (2-tailed)	.404	.033	.385	.882	.203	.595	.238	.226	.929	.000	-	
	N	127	130	45	128	128	128	43	43	43	131		
22. Motivating/Confidence Building Behavior	Pearson Correlation	.117	.116	.252	.134	.089	-.016	.067	.108	.019	.439**	.349**	
	Sig. (2-tailed)	.190	.187	.095	.130	.317	.858	.671	.489	.902	.000	.000	-
	N	127	130	45	128	128	128	43	43	43	131	131	

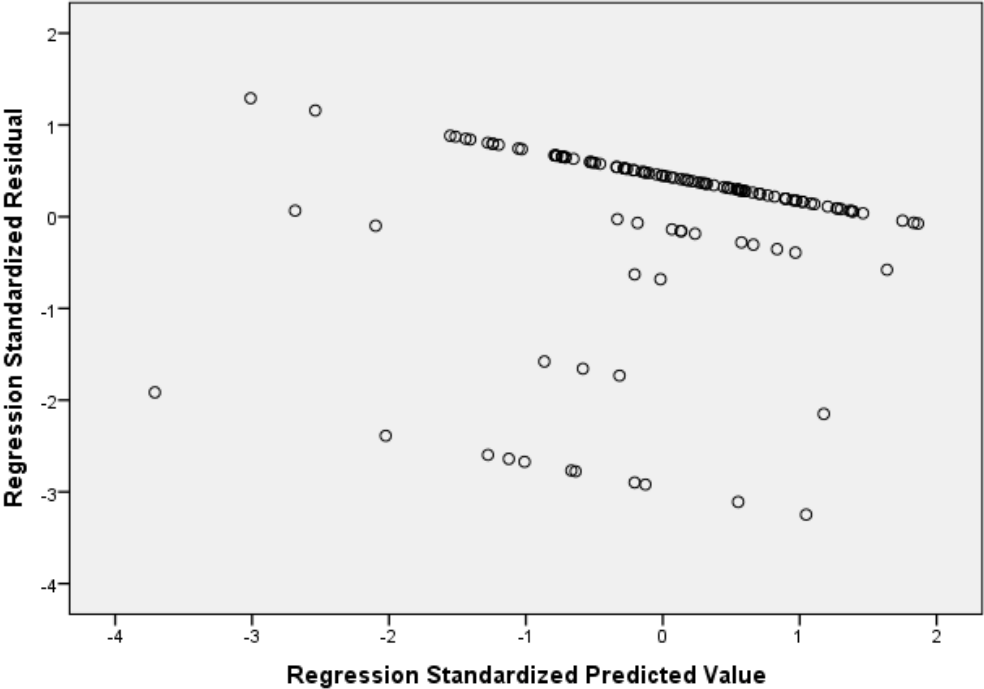
Appendix M

H4-H9: P-P Output Generated by SPSS



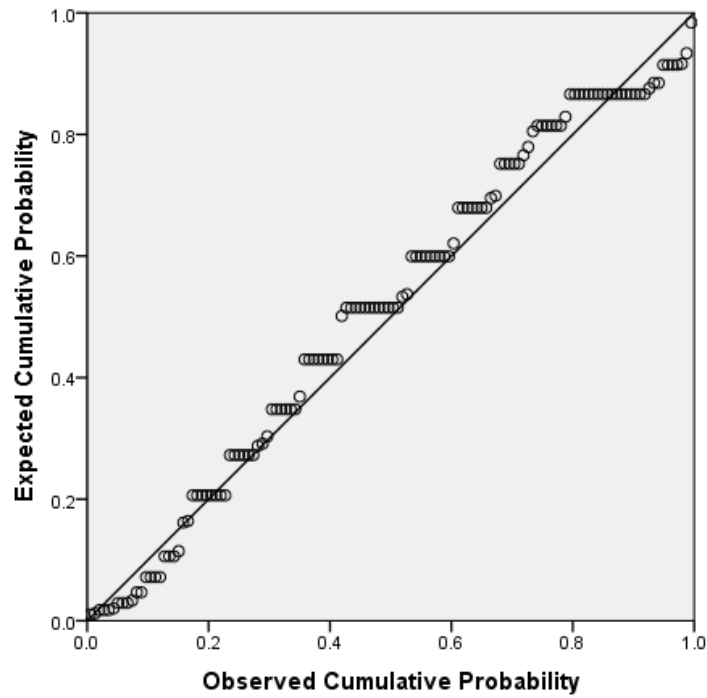
Appendix N

H4-H9: Scatterplot Output Generated by SPSS



Appendix O

H12: P-P Output Generated by SPSS



Appendix P

H12: Scatterplot Output Generated by SPSS

