The Effect of Formal Time Allocations on Learning Trajectories and Performance

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Feb 11, 2022

Acknowledgements. We gratefully acknowledge the thoughtful feedback from Associate Editor Bret Bradley, three exceptional reviewers, Laurie R. Weingart, Anita Woolley, Mary J. Waller, Steven Dow, Denise Rousseau, Kyle Lewis, UCL SoM Reading Group, and GroupsGroup at Harvard University for suggestions to earlier versions of this manuscript. We thank Carnegie Mellon University, Singapore Management University, HEC Paris School of Management, and UCL School of Management for financial support.

Abstract

How do formal time allocations in teams affect team learning trajectories and performance? We argue that allocating more time for transition phases induces steeper learning trajectories that engender a positive group atmosphere, which in turn improves team performance by improving coordination quality. We tested our hypotheses in a laboratory experiment in which teams worked on a creative design task over multiple iterations. Using a latent growth modeling approach, we found that teams with shorter action and longer transition phases during prototyping had lower initial performance but steeper learning trajectories, which indirectly led to better final team performance.

Keywords: time, learning trajectories, group process, performance, latent growth modeling

The Effect of Formal Time Allocations on Learning Trajectories and Team Performance

Teams often have to learn continuously to address important problems. In such situations, solutions may only emerge from multiple iterations of trial-and-error experimentation (Argote & Miron-Spektor, 2011; Eisenhardt & Tabrizi, 1995; Haas & Cummings, 2020; Goh et al., 2013; Lee et al., 2004). For example, software engineering teams cycle between writing code, testing it, and discussing how to correct errors and improve the program. Military teams also routinely conduct after-action reviews following completed simulations or events (Villado & Arthur Jr., 2013). When learning new procedures, surgical teams iterate between off-line practice sessions, trials of the new procedure, and reflecting on lessons learned (Edmondson et al., 2001). Teams like these need to both carefully harvest lessons from prior experiences and experiment with ways to use them to learn and improve their performance over time.

Given the temporal nature of team learning (Cronin, Weingart, & Todorova, 2011; Lehmann-Willenbrock, 2017; Wiese & Burke, 2019), teams face the challenge of how to allocate time to reflection versus hands-on experience to accelerate learning. As much as teams would like to spend time on both reflection and practice, they must make trade-offs because time is a finite resource in organizations. Consider a product development team experimenting with possible solutions by constructing rough prototypes of potential designs: Allocating time for building prototypes means less time for reflecting on their performance (Goh et al., 2013). Figuring out how to balance learning through task performance and reflection is thus a critical decision for teams learning new tasks.

Scholars have recognized that teams need to balance their time and attention between *action phases* and *transition phases* (Ilgen et al., 2005; Marks et al., 2001). Action phases are "periods of time when teams are engaged in acts that contribute directly to goal accomplishment (i.e., task work),” while transition phases are “periods of time when teams focus primarily on evaluation and/or planning activities to guide their accomplishment of a team goal or objective” (Marks et al., 2001, p. 360). Teams often iterate through cycles of action and transition phases, with transitions setting the stage for future action (Ilgen et al., 2005; Marks et al., 2001). When a team is focused on learning, such as in practicing, prototyping, or trial-and-error experimentation, action phases take the form of simulation (i.e., realistic, but less consequential, attempts to perform the task), and transition phases take the form of pauses (i.e., reflecting on lessons learned from a given simulation and planning for future iterations) (Ishak & Ballard, 2012).

Research has shown that teams that devote more attention to reflecting on their objectives, strategies, and processes perform better because they can adapt their strategies and address failures (e.g., Moreland & McMinn, 2010; Schippers et al., 2014; Widmer et al., 2009). In practice, however, teams tend to undervalue transition activities, such as discussing task strategies (Gruenfeld et al., 1996; Hackman et al., 1976; Wittenbaum & Stasser, 1998; Woolley, 1998) and planning for complex tasks (Weingart, 1992). Teams thus tend to show an action bias, in which they naturally favor activities associated with task completion over those associated with reflection and learning (Gurtner et al., 2007). Because teams tend to under-allocate time to reflection and learning, scholars have focused on a variety of interventions to induce teams to engage in them, such as formal debriefs (e.g., Eddy et al., 2013; Keith & Frese, 2005; Okhuysen & Eisenhardt, 2002; Villado & Arthur Jr., 2013) and reflexivity interventions (Gurtner et al., 2007). When teams are given interventions that dictate what to do during reflection, they tend to learn faster and perform better (DeRue et al., 2012; Gurtner et al., 2007; Vashdi et al., 2013). Such interventions are effective because they can help to create shared understandings amongst team members, make use of their diverse perspectives, and help them to learn from the past (Schippers et al., 2013). Thus, interventions to promote effective reflection have the potential to improve team performance.

Although research on interventions to promote and structure transition phases has uncovered insights about what interventions to use, it has yet to address the temporal trade-offs inherent in doing so – devoting more time and attention to transitions means less time and attention for action. Time and temporality are thus crucial to understanding team intervention effectiveness (Fisher, 2017; Hackman & Wageman, 2005). In this research, we examine this temporal trade-off by addressing the question of **how the formal allocation of time to action and transition phases shapes group learning trajectories and performance**.

We build and test a model of how the formal allocation of time to action and transition phases shapes group learning trajectories and performance. We argue that longer transition phases will depress initial performance because they allow less time for action phases. However, this temporal investment in reflection and planning will result in steeper learning trajectories over time (i.e., performance will improve more quickly). These steeper learning trajectories should create a more positive group atmosphere, which reflects the overall quality of relationships among team members (Cronin, Bezrukova, Weingart, & Tinsley, 2011; Jehn et al., 2010). Groups with a more positive atmosphere will coordinate their activities more effectively, improving their performance in subsequent trials.

We tested these hypotheses in a laboratory experiment in which teams designed and built a boat out of Lego blocks. Group members had three practice attempts to (a) build and test prototypes (action phases), and (b) reflect on their performance and plan for the next iteration (transition phases), before building a final product. We manipulated the length of transition phases, randomly assigning groups to shorter transition phases/longer action phases or longer transition phases/shorter action phases, and compared these to a control condition in which groups decided on their own how much time to allocate to transitions. Using a Latent Growth Modeling (LGM) approach, we examined how these different time allocations for action and transition activities affected group performance through learning trajectories, group atmosphere, and coordination. We found that groups assigned longer transition phases demonstrated steeper learning trajectories, which improved their group atmosphere and coordination. Thus, although longer transition phases constrained the initial quality of prototypes, their steeper improvement trajectory created a positive context for group members to work together and coordinate their efforts.

This research contributes to theory on team process and performance in the following ways. First, team learning is typically considered as a post-performance activity and has mostly been considered as an outcome. However, the dynamic and iterative nature of team learning (Bell et al., 2012; Lehmann-Willenbrock, 2017; Wiese & Burke, 2019) means that learning can affect team functioning through both processes and emergent states, i.e., the cognitive, motivational, and affective states of teams (Marks et al., 2001). While often theorized, empirical evidence that accounts for the dynamics of team learning trajectories is scarce (Cronin, Weingart, & Todorova, 2011; Waller et al., 2016), which this research explicitly addresses. Second, our research points to time allocation as a promising intervention for accelerating team learning. Interventions to decrease action bias in groups can catalyze learning and performance. We extend research in the timing of interventions for learning (Fisher, 2017; Hackman & Wageman, 2005; Mathieu et al., 2014; Shuffler et al., 2011) by emphasizing the importance of time allocations between action and transition phases. Our research contributes to the literature by helping to explain how groups that invest early in learning activities can benefit in the long run. More broadly, it emphasizes the importance of planning and routinizing reflection time in team learning. Third, we add to research on team process and performance by examining time allocation between action and transition phases as a type of contextual input that shapes team emergent states and outcomes. Overall, our emphasis on the effect of learning trajectories on team emergent states presents a different way of theorizing about the dynamics of team process and responds to calls for more research on dynamic processes in teams.

Hypothesis Development

Formal Time Allocations and Initial Performance

We propose that devoting more time to transitions is costly in the short term but beneficial in the long term. We take an attention-based view of team processes, which begins with the premise that time and attention are valued, finite resources for teams in organizations (Cummings & Haas, 2012; March & Simon, 1958; Perlow, 1999). At the organizational level, scholars have posited that organizational structures are intended to focus people's attention on essential activities while diverting it from less essential ones (Ocasio, 1997). The same logic can apply to teams (Cummings & Haas, 2012) – formal process structures and interventions orient members' attention toward particular activities at the expense of others.

Formal time allocation interventions for action and transition activities follow the logic above: devoting more time to transition activities, such as planning and reflection, inherently leaves less time for action activities – actual hands-on work on the task. By spending less time on action, groups that devote more time to transitions should have weaker first attempts than groups that spend more time on action for two reasons. First, for new tasks, first-hand experience is necessary to fully learn and understand the demands of the task (Riedl & Seidel, 2018) – it is often futile to forecast what the task is like through planning (e.g., Gino et al., 2010) or instruction (e.g., Fisher, 2017). Thus, action phases will initially be the best way to get familiar with a task. Second, time allocations have a social symbolic meaning – the relative amount of time devoted to an activity conveys its importance (e.,g., Fisher et al., 2018; Zerubavel, 1981). Formally allocating more time to transition phases should signal to team members that these activities are valued, which should make members more learning-oriented (Bunderson & Sutcliffe, 2003). Additionally, formally allocating less time to action phases should make members less performance-oriented, thus making them less concerned with initial performance. This reasoning leads to the following hypothesis:

Hypothesis 1: Longer transition phases will be negatively associated with initial performance.

Formal Time Allocations and Learning Trajectories

Learning is not an isolated event but instead unfolds in multiple episodes over time (Edmondson et al., 2001; Lehmann-Willenbrock, 2017; Rockart & Wilson, 2019; Wiese & Burke, 2019). Although teams that devote more time to transition activities may perform worse initially, devoting more time to transitions should pay dividends in the long run in the form of steeper *learning trajectories*. We define learning trajectories as the rate of performance improvement that team members exhibit over time. For instance, on a task with scores from 1 to 7, a team that scores 1, 4, 7 on successive trials would have a steeper learning trajectory than a team that scores 5, 6, 7, although the final level of performance in the two teams is the same.

Three complementary logics suggest that longer transition phases will lead to steeper learning trajectories. The first reason is purely statistical, following the logic of Hypothesis 1. Assuming that there is a theoretical maximum level of performance, teams that have lower initial performance have more room for improvement. Thus, even simple regression to the mean should allow teams with lower initial improvement to improve more quickly, yielding a steeper learning trajectory.

Second, longer transitions allow more time for team learning behaviors. Team learning behaviors include voicing and reconciling different member perspectives, reflecting on past successes and failures, and challenging assumptions (Edmondson, 1999; Gibson & Vermeulen, 2003; van der Vegt & Bunderson, 2005). Such behaviors are most likely to emerge naturally during transitions that follow significant periods of action. As Hackman and Wageman (2005) note, teams are less likely to engage in learning behaviors during action phases, when their focus is on task performance, but are more likely to reflect immediately following an action cycle. Longer durations should allow more members to share their views and lead to more thorough processing of members' perspectives (e.g., Fisher, 2017; Kelly & Karau, 1999). Thus, teams that spend more time on transitions should have more robust analyses of their prior behavior and form better plans for subsequent performance, leading to greater improvements in performance than teams that devote less time to transitions.

Last, longer transitions should signal to group members that learning is more valued, leading them to become more learning-oriented (Bunderson & Sutcliffe, 2003). As mentioned above, teams can infer the importance of activities from the amount of time allocated to them (Fisher et al., 2018), which should lead teams with longer transition phases to value reflection and planning more than teams with shorter transition phases. Additionally, team members may also be less attached to their initial ideas and plans from the initial action phase when they spend less time on them, thus making them more willing to change. This logic leads to our second hypothesis:

Hypothesis 2: Longer transition phases will be positively associated with steeper learning trajectories.

Learning Trajectories and Group Atmosphere

A steeper learning trajectory is not an end in itself – with better initial performance, a team with a flat learning trajectory can perform just as well as one with a steeper trajectory. The second major facet of our model is that steeper learning trajectories will have effects beyond their absolute levels of performance because they improve *group atmosphere*. Group atmosphere is defined as “positive attitudes and cognitions of group members about their group” (Jehn et al., 2010, p. 603) and describes the positive regard members have for each other in terms of trust, respect, and commitment (Jehn et al., 2010; Mannix & Jehn, 2004). Group atmosphere is a global assessment of the overall positivity of these team emergent states (Marks et al., 2001), developing over time as team members work together (Cronin, Weingart, & Todorova, 2011). Group atmosphere is a predictor of social processes such as conflict (Jehn et al., 2010; Maltarich et al., 2021; Sinha et al., 2016) and, ultimately, team performance (Breugst & Shepherd, 2017; Jehn & Mannix, 2001; Weingart et al., 2005).

Two major theoretical perspectives help explain why steeper learning trajectories should improve group atmosphere. First, research on social judgments and decision-making has shown that people prefer their rewards and outcomes to increase over time, even when the total value of those outcomes may not be higher than flat or decreasing values (e.g., Ariely, 1998; Prelec & Loewenstein, 1991). People tend to weight the ends of sequences and degree of increase more strongly than the total or mean value of the sequence (Kahneman et al., 1993; Loewenstein & Prelec, 1993; Schmitt & Kemper, 1996). Further, people expect trends to continue over time (Ariely, 1998; Ariely & Carmon, 2000; Ariely & Zauberman, 2000), so they will expect more steeply increasing positive trends to continue in the future. For example, Barnes and colleagues (2012) found that performance trends predicted the compensation of professional basketball players when controlling for future performance, suggesting that organizations over-weighted trends in their compensation decisions. Thus, people should exhibit more positive responses to steeper learning trajectories.

Second, research on motivation and subjective experience in organizations make similar predictions that indications of progress and small wins – minor steps towards goal accomplishment – improve workers' motivation and affect (Amabile & Kramer, 2011). Positive learning trajectories reflect progress in accomplishing work outcomes over time. Research has shown that even small indications of progress lead to measurable improvements in people's experiences of the work. For instance, in a diary study of 238 knowledge workers, Amabile and Kramer (2011) found that the experience of progress through small wins had a major impact on people's positive emotions and attitudes towards themselves, their work, their team, their management, and the organization. The energizing effects of small wins have also been found to be crucial in organizational change efforts (Weick, 1984). For example, Reay and colleagues (2017) found that orchestrating small wins about the new roles of nurse practitioners in the Alberta health care system generated confidence and energized continuing work towards legitimizing acceptance of these new roles.

These positive individual responses should lead to groups with more positive group atmospheres. Teams are likely to have a more positive atmosphere when they show more improvement over time (Frese et al., 1991; Ilgen et al., 2005). When teams believe they are performing well, they regard the team and their teammates more positively, leading to increased trust in, respect for, and liking of the team (Bachrach et al., 2001; Downey et al., 1979; Staw, 1975). Conversely, if performance stagnates, members become frustrated and attribute their "poor" performance to their team members (Campbell & Sedikides, 1999), thus harming group atmosphere. This reasoning leads to the following hypothesis:

Hypothesis 3: The slopes of learning trajectories are positively related to group atmosphere.

Group Atmosphere, Coordination, and Team Performance

Our final set of hypotheses argues that, because teams with steeper learning trajectories will have more positive group atmospheres, they will be better able to coordinate their actions and, thus, perform well. Coordination is the process of regulating individual inputs and interactions to achieve a collective performance (Faraj & Xiao, 2006; Okhuysen & Bechky, 2009), such that individual contributions are synchronized to prevent redundancies, oversights, or misunderstandings (Larson & Schaumann, 1993; Tannenbaum et al., 1992). Research has found that strong coordination improves team performance on interdependent tasks (Hoegl & Gemuenden, 2001; Okhuysen & Bechky, 2009; Steiner, 1972; Wageman, 1995). A well-coordinated team will face fewer delays and can spend more time refining the quality of their output and ensuring that it meets requirements. In contrast, poor coordination can result in delays from team members having to wait on one another or having to redo work if one or more components of the team's output are misaligned with the other parts.

Group atmosphere is a critical determinant of coordination for several reasons. First, coordination requires open and timely communication between members (Gittell, 2002). Such open communication is most likely when members trust, respect, and are committed to one another (Edmondson & Lei, 2014), i.e., a positive group atmosphere. Groups with high levels of trust and respect, such as those with many friendship ties between members, tend to solve problems more effectively (Mesmer-Magnus & DeChurch, 2009), integrate information (Cronin, Bezrukova, Weingart, & Tinsley, 2011; Tortoriello & Krackhardt, 2010), and bridge fault lines (Ren et al., 2015). Building on these insights, we can deduce that group members' positive regard for one another can increase communication and the sharing of more accurate information, even when information is difficult to disclose (e.g., it is critical of another member or implies a mistake on one's own part). A positive group atmosphere should therefore promote more frequent and informative communication, providing groups with access to timely information that allows them to mutually adapt their individual work inputs (Hoegl & Gemuenden, 2001; Thompson, 1967; Van de Ven et al., 1976).

A positive group atmosphere may also lessen potential harm from errors and disruptions that are inevitable as groups learn. Research has found that groups with high levels of trust and respect are better able to moderate task conflict (Jehn et al., 2010; Sinha et al., 2016), allowing members to voice errors and problems without fear of blame or retribution (e.g., Edmondson, 1999), and should thus be better able to coordinate their efforts to overcome them. Poor coordination occurs when members' outputs are redundant, late, or misaligned, which can be avoided if early-stage issues are communicated and addressed within the team (Ericksen & Dyer, 2004; Mathieu & Rapp, 2009). In sum, group atmosphere should enable mutual adjustment by encouraging open communication among members, thus providing necessary information about the task and timely updates (both positive and negative) on the state of each member's work. This should enable the coordination that promotes effective team performance in tasks requiring learning and experimentation.

Hypothesis 4a: Group atmosphere is positively associated with coordination quality.

Hypothesis 4b: Group atmosphere is positively associated with team performance.

Hypothesis 4c: Coordination quality mediates the relationship between group atmosphere and team performance.

Method

Participants

Sixty-two three-member teams[1], composed of 186 individuals (56.9% female; M_{age} = 22.6 years old, *SD* = 3.63), were recruited through the study pool of a mid-Atlantic university in the United States. Participants were each paid $15, and each member in the best-performing team earned an additional $50 gift card.

Task and Procedure

An experimenter blind to the hypotheses explained the task and procedure to teams and led them to a private room containing standardized building materials and a timer. Teams were asked to design and build a Lego boat that maximized the performance of their final design based on the client's criteria. They were given instructions to complete the task in two stages: 1.) a "prototyping and design" phase consisting of three trials to design and build prototypes (36 minutes total)[2], and 2.) a "final build" phase consisting of one round to produce a final team product (9 minutes). In the first stage, participants were instructed to individually build three prototypes that will be tested after each round. In the second stage, participants were told that their objective was to build one floating vessel that meets as many point allocation criteria (see Appendix A) as possible and that they would work together to build this vessel. In addition to the $15 received for participating in the study, participants were told that the team with the highest

[1] Three teams were excluded from analyses because of problems with the recording equipment or not following the protocol.
[2] Three rounds of prototyping were selected because pre-tests revealed that prototype scores changed little after that point.

points in the final build phase would win a $150 gift card to be shared equally amongst team members.

During each of the three trials, each member built one boat, yielding three boats per team per round. After participants designed and built their prototypes (i.e., action phases), the experimenter tested each boat on the criteria. Participants then discussed the performance of their prototypes as a team and planned for the next trial (i.e., transition phases). Participants did not communicate during action phases in order to cleanly distinguish transition phases from action phases so the effect of the experimental manipulation was clear. The rationale given for this instruction was that they were in a manufacturing clean room and thus had to put on surgical masks while building their prototypes. During the final round, however, participants were allowed to communicate with one another while working.

Manipulation

Teams were randomly assigned to one of three conditions that varied in the timing of the action-transition phases in the trial stage: 1.) a control condition (n = 20) in which teams were given 36 minutes to complete three trials of building prototypes and discussing the performance of their prototype and its impact on their group's final design, 2.) a short action/long transition condition (LT; n = 21) in which teams were given 12 minutes for each trial, within which 8 minutes was allocated for building a prototype and 4 minutes to discuss the performance of their prototype and its impact on their group's final design, and 3.) a long action/short transition (ST; n = 21) condition in which teams were given 12 minutes for each trial, which which 10 minutes was allocated for building a prototype and 2 minutes to discuss the performance of their prototype and its impact on their group's final design. The time it took the experimenter to test the prototypes was not counted against these totals. All teams were given the same amount of time (9 minutes) to build their final design.

The durations of action-transition phases were determined through pre-tests where teams were instructed to build, test, and then discuss their prototypes over three rounds. In these pretests, participants were not given a fixed duration for each phase. Teams were observed to spend an average of 9 minutes on building one prototype and 2 minutes on discussing the results of the tests. Thus, we decided to set the duration for each transition phase to 2 minutes and four minutes for the ST and LT condition, respectively. To reflect the trade-offs in time that teams face between reflecting and performing, the total time for each round was fixed to 12 minutes which meant that the duration for action phases was set to 10 minutes and 8 minutes for each trial in the ST and LT condition, respectively. Finally, we selected a total of three rounds of action phases because the pre-tests revealed that participants began to become disengaged after three rounds and did not continue to try to improve their prototypes.

Measures

Team Performance[3]

Team performance was measured by scoring the team's final build according to the following four structural characteristics: a.) the height of the boat, b.) the weight of the boat, c.) the amount of weight the boat could hold without sinking (measured with ball bearings placed in the boat when floating in a tub of water), and d.) the height from which the boat could be dropped without breaking (see Appendix A for point allocation). These characteristics were selected so teams would have to make trade-offs between them to perform well (e.g., a heavier boat would get

[3] The final team product was also rated on aesthetic appeal, and teams were told in advance that aesthetic appeal was one of the criteria for final performance. However, prototypes were not assessed on aesthetic appeal. Because including the aesthetic ratings does not alter the pattern of results below, these ratings were dropped from analyses to make prototype scores and final team scores directly comparable.

more points for weight, but might sink more easily). Consequently, a higher total score could not be attained just by maximizing on one dimension and would instead require trial and error to figure out. Furthermore, the criteria and point system were calibrated through pre-testing so that teams were incentivized to consider multiple characteristics to increase their total score.

Experimental Conditions

Two set of dummy variables were used to identify each of the three conditions. The variable LT was coded 1 for the Long Transition condition and 0 for the other conditions, and the variable ST was coded 1 for the Short Transition condition and 0 for the other conditions. Both sets of dummy variables are included in all analyses including experimental conditions.

Learning Trajectory

Learning trajectory was measured by using each team's average individual prototype score in each trial as a latent variable. The learning trajectory for each team was estimated from these latent variables using latent growth modeling (LGM; Duncan et al., 2006; Williams et al., 2009).

Group Atmosphere

Group atmosphere was measured after the third trial but before beginning the final build segment of the experiment. Participants rated group atmosphere using a 10-item scale from Jehn and colleagues (2010) (e.g., "I have a high regard for the other individuals in this team during this exercise"). This scale showed good internal consistency (*Cronbach's α* = .95) and strong within-team agreement (Max rwg_j = 1.0, Min rwg_j = .79, Median rwg_j = .98). While within-team consistency was low (*ICC*(1) = .14, *F* = 1.47, *p* = .04; *ICC*(2) = .32), we justified the lower cutoff for aggregation given the short amount of time that participants had to interact and the small group size which leads to lower ICC values (Kozlowski & Klein, 2000; LeBreton &

Senter, 2008; Glick, 1985). Individual responses for group atmosphere were thus aggregated to the team level.

Coordination Quality

Participants rated coordination quality immediately after the final product was built, but before the product was tested, using a 5-item coordination dimension of Lewis's (2003) scale (e.g., "Our team had very few misunderstandings about what to do"). This scale showed good internal consistency (*Cronbach's* $\alpha = .90$) and high within-team agreement (Max $rwg_j = .99$, Min $rwg_j = .43$, Median $rwg_j = .92$). Within-team consistency was moderate ($ICC(1) = .33$, $F = 2.49$, $p < .001$; $ICC(2) = .60$), which justified aggregating individual responses to the team level.

To test the discriminant validity of the two self-report measures, we conducted a confirmatory factor analysis (CFA) of the items for group atmosphere and coordination quality. While coordination quality loaded onto a single factor as predicted, the items from the group atmosphere scale loaded onto two separate factors ($\chi^2(80) = 123.4$, $AIC = 1188.52$, $CFI = .95$, $SRMR = .06$, $RMSEA = .10$). The three-factor structure demonstrated better fit than a two-factor structure ($\Delta\chi^2(2) = 45.71$, $p < .01$). Since our hypotheses predicated group atmosphere as a unitary construct, and the correlation between the two factors was quite high ($r = .80$), we present our results using an average of the whole scale, consistent with past research (Cronin, Weingart, & Todorova, 2011; Jehn et al., 2010; Jehn & Mannix, 2001).

Data Analysis

We used LGM to model within- and between-team change in performance between the first to third trial using the computer program Mplus, Version 8 (Muthén & Muthén, 1998). LGM is a method for describing changes in a variable's trajectory and capturing differences in trajectories over time. The differences in trajectories are reflected in the slopes and intercepts of the lines (Duncan & Duncan, 2009). In addition to describing and summarizing growth, the slopes and intercepts of these trajectories can become the focus of analysis and can be used to study predictors that explain their differences. Thus, LGM allowed us to use the slopes of the learning trajectory as both an outcome of the time allocation manipulations and a predictor of group atmosphere (see Figure 1).

The modeling task involves identifying an appropriate growth curve form, which will accurately and parsimoniously describe trajectories of teams. The differences in team trajectories between conditions should be reflected as inter-team differences in the slopes and intercepts of those trajectories. Factor loadings from the intercept to performance in each of the three trials were fixed to 1.0 so that their influence on the performance in each trial is equal. Factor loadings from the performance in each of the three trials to the slope were fixed to values of 0, 1, and 2 to represent values of the time metric as an increasing trend (Duncan et al., 2006; Williams et al., 2009).

INSERT FIGURE 1 HERE

Results

Sample means, standard deviations, and correlations of outcomes and predictors are shown in Table 1. Before testing our hypotheses, we compared the time allocations of the experimental groups to those of the control groups. Control groups devoted a total of 7.20 minutes to transition phases (SD = 3.00) and 29.30 minutes to action phases (SD = 2.60), showing a significant difference, $t(18) = -18.16$, $p < .001$. These time allocations differed significantly from groups in the LT condition, who spent exactly 12 minutes on transitions, $t(39) = -7.43$, $p < .001$, and 24 minutes on actions, $t(39) = 8.70$, $p < .001$. However, these time allocations in the control groups did not differ significantly from time allocations in the ST condition, where groups spent exactly 6 minutes on transitions, $t(38) = 1.95$, $p = .06$, and 30 minutes on action, $t(38) = -1.22$, $p = .23$. Thus, the overall time allocations of the LT condition differ from control, but the allocations of the ST condition do not.

INSERT TABLE 1 HERE

We also tested the differences of the key variables between conditions. As shown in Table 2, there were some main effects of conditions: as predicted, LT groups had worse initial prototype scores than control groups and worse scores than both other conditions in the second trial. However, no differences were observed in the third trial. No other significant pairwise differences by condition were found.

INSERT TABLE 2 HERE

Latent Growth Modeling (LGM)

Preparatory Analyses

One of the requirements for LGM is that there is sufficient variance in trajectories to be accounted for by other constructs in the model. To test that our data met this requirement, we first tested an unconditional model (Bollen & Curran, 2006) that excluded covariates. The slope factor mean for group learning trajectory was positive and significant ($p < .01$), suggesting that the mean level of performance increased over time. Intercept factor variances for learning trajectories were statistically significant ($p = .002$), indicating that there were intergroup differences in the initial scores at Time 1. Similarly, slope factor variances for learning trajectories were statistically significant, indicating that there were intergroup differences in the rate of changes in performance over time (p = .01). Figure 2 shows a plot of the learning trajectories across our sample. The correlation between the intercept factor and slope factor was weak (r = .02).

INSERT FIGURE 2 HERE

Hypothesis Tests Using LGM

The hypothesized model that was tested is shown in Figure 1. This model included the effect of both ST and LT conditions on initial scores, group learning trajectory, and group atmosphere. Our hypothesized model had an acceptable fit with the data, $\chi^2(15) = 17.3$, *AIC* = 2467.29, *CFI* = .98, *SRMR* = .04, *RMSEA* = .05. Since the values of the model fit indices meet the criteria proposed by Hu and Bentler (1999), we then examined coefficients to test our hypotheses (see Figure 3). Standardized effect sizes were calculated and reported based on Kelley and Preacher (2012). We also tested a more parsimonious alternative model, which examined whether conditions directly affected group atmosphere instead of through learning trajectories. While this model also showed adequate fit, $\chi^2(16) = 23.33$, *AIC* = 2471.33, *CFI* = .94, *SRMR* = .06, *RMSEA* = .09, the additional path from conditions to learning trajectories in our hypothesized model significantly improved model fit, $\Delta\chi^2(1) = 6.00$, p = .01, indicating that the direct effect of conditions on learning trajectories was critical.

INSERT FIGURE 3 HERE

Hypothesis 1 predicted that longer transition phases will be negatively related to initial performance. We found that the LT condition was negatively related to initial scores (β = -.98, p

< .01) with a standardized effect size of -.40. The ST condition was also negatively related to initial scores (β = -.59, p = .08), but this was not significant. H1 was thus supported.

Hypothesis 2 predicted that longer transition phases will be positively associated with steeper learning trajectories. We found that the LT condition was positively related to learning trajectories (β = .78, p = .02) with a standardized effect size of .31. The ST condition was also positively related to learning trajectories (β = .38, p = .26), but this effect was not significant. H2 was thus supported.

Hypothesis 3 predicted that the slope of learning trajectories will be positively related to group atmosphere. This hypothesis was supported as the slope factor for the learning trajectory was found to be positively related to group atmosphere (β = .36, p < .01) with a standardized effect size of .32.

Hypotheses 4a–b predicted that group atmosphere would be positively related to coordination quality (H4a) and team performance (H4b). The relationship between group atmosphere and coordination quality was found to be positive and significant (β = .48, p < .01), providing support for H4a. Although the total effect of the relationship between group atmosphere and team performance was positive and in the predicted direction, it was not significant (β = .20, p = .08). H4b thus received only marginal support.

Finally, Hypothesis 4c predicted that coordination quality would mediate the relationship between group atmosphere and team performance. This prediction was tested using the bootstrapping approach (5,000 iterations) recommended by Shrout and Bolger (2002) and Preacher and Hayes (2008). Using the 95% confidence interval, the indirect effect of coordination quality on the relationship between group atmosphere and team performance was found to be significant (indirect effect = .16, 95% *CI* [.05, .26]). These results therefore support H4c.

Post-hoc Analysis

We conducted a post-hoc analysis of a model where learning trajectories directly affected coordination quality and team performance through group atmosphere to test for reverse causality between group atmosphere and coordination quality. Compared to our proposed model, this model had an overall poorer model fit, $\chi^2(15) = 19.41$, *AIC* = 1210.25, *CFI* = .93, *SRMR* = .08, *RMSEA* = .10[4]. The relationships between trajectories and coordination (β = .50, p = .06) and from group atmosphere to team performance (β = .01, p = .94) were not significant. Although the relationship between coordination quality and group atmosphere was significant (β = .43, p < .01), it does not justify the causal relationship because the experimental design was such that the measurement of group atmosphere, which was administered after the third trial, preceded the measurement of coordination quality, which was administered after the final build. The results from our post-hoc analysis thus lend further support to our hypothesized model.

We also investigated the indirect effects of the ST and LT conditions, trajectories, and group atmosphere on team performance that was implied by our model using a bootstrapping approach with 5,000 iterations (Preacher & Hayes, 2008; Shrout & Bolger, 2002). As shown in Table 3, only the indirect effect of the LT condition on team performance through initial scores was significant (indirect effect = -.40, 95% *CI* [-.78, -.03]).

To compare the relative effects of ST and LT conditions, we modeled the effect of the ST and control conditions, relative to the LT condition, on initial scores and trajectories. The effects

[4] We also tested an alternative model, which examined whether conditions directly affected group atmosphere. This model also fit adequately, $\chi 2(27) = 134.12$, AIC = 2339.78, CFI=.97, SRMR = .05, but was not a significant improvement over our hypothesized model, $\Delta\chi 2(2) = .58$, p = .25, indicating that the direct effect between conditions and group atmosphere was not critical.

of ST on initial scores and trajectories were not significant (initial scores: β = 0.38, p = .25, trajectories: β = -0.32, p = .33), while the effect of control on initial scores and trajectories were significant (initial scores: β = 0.96, p = .002, trajectories: β = -0.74, p = .02). Finally, we explored whether formalizing time allocations had a positive effect on learning trajectories by comparing the control condition to the other two in combination. We found that groups with formal time allocations tended to have steeper learning trajectories than groups without (β = .58, p = .046).

INSERT TABLE 3 HERE

Discussion

Team learning is a temporal process (Cronin, Weingart, & Todorova, 2011; Lehmann-Willenbrock, 2017; Wiese & Burke, 2019) that occurs through iterative cycles of action and transition phases (Haas & Cummings, 2020; Goh et al., 2013; Argote & Miron-Spektor, 2011). In organizations, time is a finite resource so teams have to address trade-offs between action and transition phases - devoting more time and attention to transitions means less time and attention for action. Figuring out how to balance task performance in action phases, and reflection in transition phases is thus a critical decision for teams learning new tasks and can enhance our understanding of team intervention effectiveness (Fisher, 2017; Hackman & Wageman, 2005).

In this research, we examine this temporal trade-off by addressing the question of how the formal allocation of time to action and transition phases shapes group learning trajectories and performance. We found that teams with longer transition phases depressed initial performance but resulted in steeper learning trajectories over time. These steeper learning trajectories created a more positive group atmosphere, which improved coordination and performance in subsequent trials. In the following section, we discuss the theoretical implications of our findings for models of team performance and team learning.

Theoretical Contributions

Time allocations of action and transition phases create rhythms of activity for teams (Ancona & Waller, 2007; Goh et al., 2013; Mathieu et al., 2014; Zellmer-Bruhn et al., 2004). Such rhythms of interactions have their own unique social meanings (Fisher et al., 2018; Zerubavel, 1981), yet time allocation is an understudied antecedent of team emergent states and outcomes. In focusing on time allocation as an input, we draw attention to a pervasive contextual feature that teams are simultaneously embedded in and shaped by (Orlikowski & Yates, 2002). Extant work that has examined characteristics of the temporal context includes work on shifting deadlines (Waller et al., 2002), time pressure (Karau & Kelly, 1992), and mid-points (Gersick, 1988; Okhuysen & Waller, 2002). We add to the literature on team processes and performance by examining time allocation between action and transition phases as a type of contextual input that shapes team emergent states and outcomes. Although scholars have acknowledged that group processes bear distinct temporal characteristics based on the time allocation of action and transitions (Ancona et al., 2001; Marks et al., 2001), there has been little research into how their relative balance affects team processes and outcomes.

Our findings suggest that changing time allocations is a promising intervention for promoting team learning by countering the action bias in teams. The main body of research on interventions to enhance learning has focused on the content of interventions (Eddy et al., 2013; Gurtner et al., 2007; Keith & Frese, 2005; Okhuysen & Eisenhardt, 2002; Villado & Arthur Jr., 2013), but issues of time and timing are only starting to be considered. For example, drawing on theories of group development (e.g., Gersick, 1988; Marks et al., 2001), an emerging stream of research has investigated opportune moments for intervention (Fisher, 2017; Hackman & Wageman, 2005; Mathieu et al., 2014; Shuffler et al., 2011). By emphasizing time allocations between action and transition phases, we extend the temporal perspective of interventions by demonstrating that the relative allocation of time between these phases can also shape team processes and outcomes in important ways.

Findings from the present study also have implications for models of team learning and performance (e.g., Edmondson, 1999; O'Leary et al., 2011). In prior research, learning is typically the outcome of interest (Edmondson, 2002; Edmondson et al., 2007). Because learning is often conceptualized as a cognitive activity that occurs after a performance episode (e.g., Levine and Argote, 2020), it is rarely studied as an experiential input into team dynamics. In other words, previous theoretical models of teams rarely treat learning as an independent variable that influences team functioning, even though learning is often iterative and occurs in-process (Bell et al., 2012). Thus, we add to theoretical models of team learning by articulating how learning trajectories shape emergent states and processes. Focusing on learning trajectories as the independent variable allows scholars to draw on new literature (e.g., people's tendencies to form summary judgments about whether things are getting better or worse; Ariely & Carmon, 2000) to develop new theories about the consequences of team learning on team functioning in general.

Practical Implications

Our finding about the positive steeper learning trajectories improving team coordination and performance through a more positive group atmosphere has several practical implications for the allocation of time between action and transition phases. First, our findings suggest that teams that engage in trial-and-error experimentation can enhance learning by blocking off sufficient time for transition activities. Although allocating more time for transition activities means less time for task performance, our findings suggest that teams benefit from the correspondingly steeper learning trajectories.

Another implication is that teams with flatter trajectories could be supported by encouraging them to consider allocating more time for transition activities to increase their trajectory. Also, organizations could celebrate teams with steep trajectories to acknowledge their learning and performance and be an example for other teams to create a learning community. Overall, our results suggest that new teams must balance time for action with sufficient time for transitions: As the saying goes, “Fail often and fail early”, but *do not* fail to learn.

Limitations and Future Directions

Like all research, this study has limitations that suggest directions for future investigation. Importantly, like many laboratory studies, the benefit of control limits some of the generalizability of our results. For instance, to test the effect of time allocation between action and transition phases, these phases had to be clearly delineated in the experimental task. While Bernstein and colleagues (2018) found that individual work punctuated by intermittent group interaction is the optimal strategy for groups, the distinction between phases may be less clear in some teams and organizations (Marks et al., 2001; Miner et al., 2001). Further, our procedure restricted communication between individuals to transition phases, but reflection and communication may also occur in small bursts during action phases. Future research could investigate the effects of formal time allocations in settings where the distinction between action and transition is less clear, such as in knowledge-work tasks.

An intriguing, but inconclusive, aspect of our results is the effects of formalizing durations of action and transition phases. In our post-hoc analyses, we found that the control groups, which had unstructured phase lengths, had higher initial performance and a flatter trajectory than the two conditions with structured phase lengths. This raises the question of whether formal temporal structuring has an effect independent of phase length, possibly because of decreased autonomy. While our results are inconclusive on this front, future research should seek to separate the effects of phase duration from the formal temporal structuring interventions.

Since this was a laboratory study, ad-hoc teams assembled for relatively short durations. Thus, it is unclear to which extent teams existing for longer durations would experience the same dynamics. Because the teams in our study faced the heavy load of dealing with the difficulties of initial team formation (Kozlowski & Bell, 2003; Tuckman, 1965), as well as dealing with an unfamiliar task, they may have had more problems performing well initially than a team that had worked together for longer periods. Teams engaged in longer-term projects might experience different relationships between time allocation, learning trajectories, emergent states, and team performance (Waller et al., 2016).

Another important boundary condition is the ability of teams to use trial-and-error experimentation. Teams in high-reliability organizations such as fire crews (Ishak & Williams, 2017), military units (Knight, 2015), nuclear power control room crews (Stachowski et al., 2009), or police SWAT teams (Okhuysen & Bechky, 2009) have little room for making mistakes during their performance phase. For such teams, learning trajectories may occur both within cycles of simulation and pauses during a preparatory transition phase (e.g., through training simulations) and in cycles of real task performance and reflection (Ishak & Ballard, 2012). How learning trajectories affect emergent states in preparatory versus actual task performance in action teams is an area requiring further research.

Our study also leaves room for future research on what aspects of trajectories lead to effects on team performance. Trajectories might mediate the relationship between condition and team performance, but our post-hoc analysis did not support this prediction. A possible explanation is that the negative effect of condition on initial scores was offset by the positive effects of trajectories on performance (via group atmosphere and coordination; see Figure 3)—longer transitions have both positive and negative effects on performance. Longer transitions leave less time for action. When starting a new task, less time for action means less initial opportunity to optimize a prototype (i.e., worse initial scores). But, over time, groups spending more time on transitions should learn more quickly (i.e., steeper trajectories), improving group atmosphere, coordination, and, thus, performance. However, it leaves open theoretical and practical questions of the conditions under which longer transitions do or do not lead to increased team performance. While our research presents initial evidence of the relationship between formalized transition times on learning trajectories and team performance, future research is needed to separate the effects of initial scores, time allocation, and learning trajectories on performance.

Our findings also raises the question of whether lower initial performance causes steeper trajectories by leaving more room for improvement. The theory that steeper learning trajectories predict group atmosphere raises the question of whether strong initial performance can harm group atmosphere in the long run because it leaves less room for improvement in tasks with a “ceiling” for optimal performance. While the weak correlation between initial scores and group atmosphere do not support this explanation, future research should investigate the conditions under which strong initial performance may lead to slower rates of improvement, thus harming group atmosphere.

Conclusion

In conclusion, our study is a first step into studying formal time allocation between action and transition phases as an essential aspect of team processes. We found that more time allocated to transition phases counters the action bias in teams and leads to beneficial effects on team learning and performance. Our findings add to an emerging stream of research focused on the timing of interventions. We hope that these findings encourage future research into other ways that the temporality of group processes shapes team learning, emergent states, and team outcomes.

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Table 1

Descriptive Statistics and Correlation Matrix of Variables (n = 62)

		M	SD	1	2	3	4	5
1	Prototype $Score_1$	34.93	17.85	--				
2	Prototype $Score_2$	56.61	23.46	.57**	--			
3	Prototype $Score_3$	71.50	26.70	.44**	.66**	--		
4	Group Atmosphere	5.23	.56	-.03	.02	.26*		
5	Coordination Quality	3.65	.64	.07	.10	.09	.48**	--
6	Team Performance	83.78	40.42	.37**	.45**	.46**	.27*	.38**

Note. * $p < .05$. ** $p < .01$. Prototype Score = Average Member Scores [subscript denotes measurement period].

Table 2

Descriptive Statistics and ANOVAs by Condition

Condition	Prototype $Score_1$	Prototype $Score_2$	Prototype $Score_3$	Group Atmosphere	Coordination Quality	Team Performance
	M (SE)	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*	*M (SE)*
Control	42.63 (4.97)[b]	66.74 (6.14)[b]	70.68 (6.67)	5.17 (0.16)	3.67 (0.13)	83.68 (9.13)
Long Transition	28.71 (2.80)[a]	49.06 (6.14)[a, c]	72.57 (5.23)	5.19 (0.12)	3.55 (0.13)	82.57 (7.00)
Short Transition	34.44 (3.77)	54.83 (3.35)[b]	71.33 (6.20)	5.34 (0.11)	3.75 (0.17)	81.38 (10.48)
Model Summary						
$F(2, 58)$	3.18^{*}	3.03^{+}	0.03	0.53	0.52	0.02
η_p^2	0.10	0.09	< 0.01	0.02	0.02	< 0.01

$^{+}p < .10$; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

[a] Pairwise difference from Control, $p < .05$

[b] Pairwise difference from Long Transition, $p < .05$

[c] Pairwise difference from Short Transition, $p < .05$

Table 3

Tests of Indirect Effects

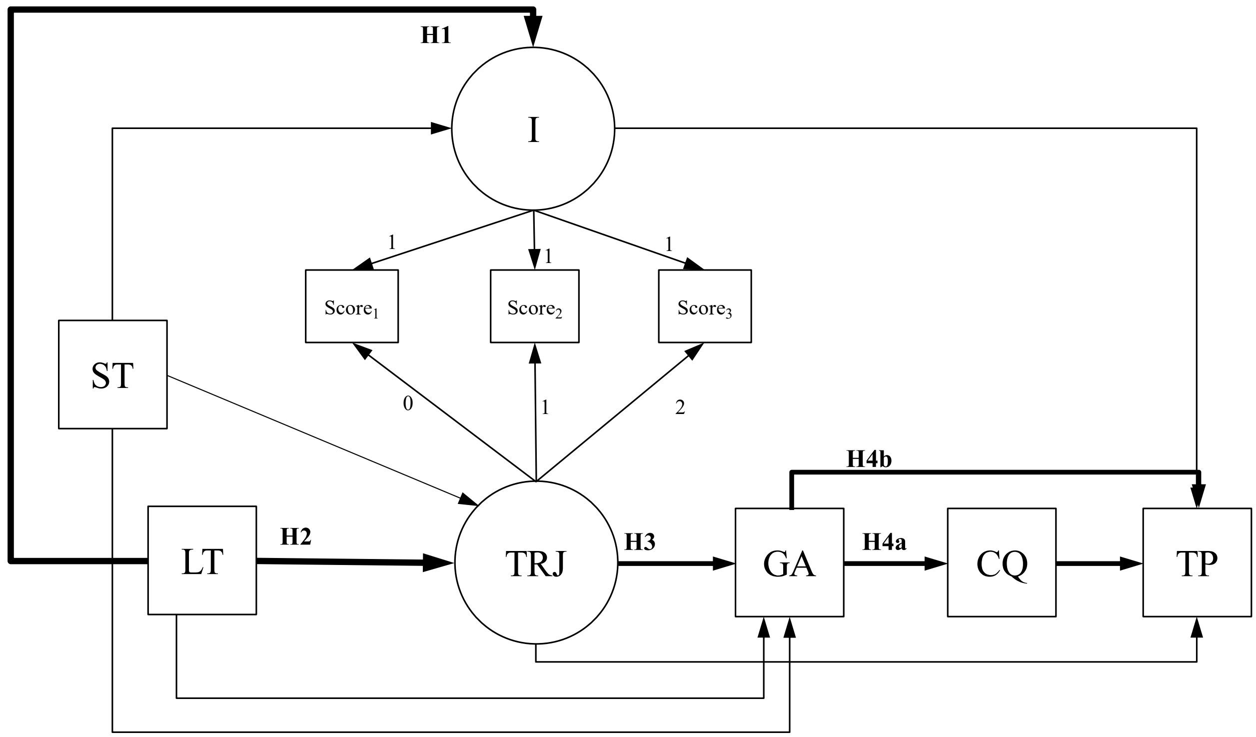
	Bootstrapped Effects and Confidence Intervals (95% C.I.)		
	Effect (SE)	*LL*	*UL*
1. LT → I → TP	-.40 (.19)	-.78	-.03
2. LT → TRJ → TP	.23 (.23)	-.21	.67
3. LT → TRJ → GA	.28 (.52)	-.74	1.30
4. LT → TRJ → GA → CQ	.14 (.30)	-.45	.71
5. LT → TRJ → GA → CQ → TP	.04 (.14)	-.24	.32
6. TRJ → GA → CQ	.17 (.39)	-.13	.48
7. TRJ → GA → CQ → TP	.06 (.16)	-.07	.18
8. GA → CQ → TP	.16 (.07)	.05	.26

Note. Chains beginning with "LT" also control for "ST", following Hayes and Preacher's (2014) recommendation to control for other categorical variables, such that k – 1 categories are represented in the analysis.

LT= Long Transition Condition; TRJ = Learning Trajectory; I = Intercept; GA = Group Atmosphere; CQ = Coordination Quality; TP = Team Performance.

Figure 1

Structural Latent Growth Model



Note. Score = Average Score [subscript denotes measurement period]; LT= Long Transition Condition; ST = Short Transition Condition; TRJ = Learning Trajectory; I = Intercept; GA = Group Atmosphere; CQ = Coordination Quality; TP = Team Performance. Arrows in bold are hypothesized effects.

Figure 2

Learning trajectories by condition

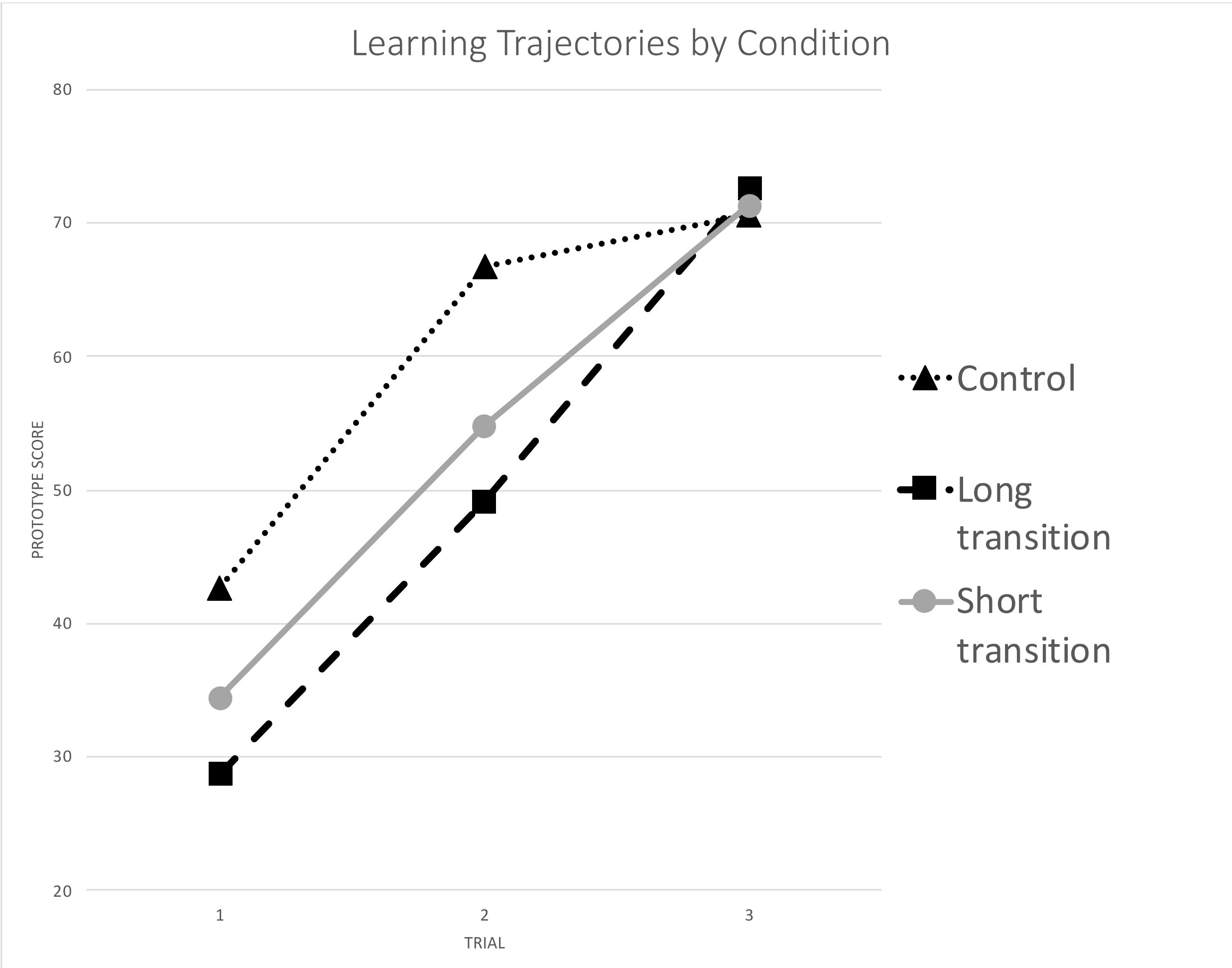
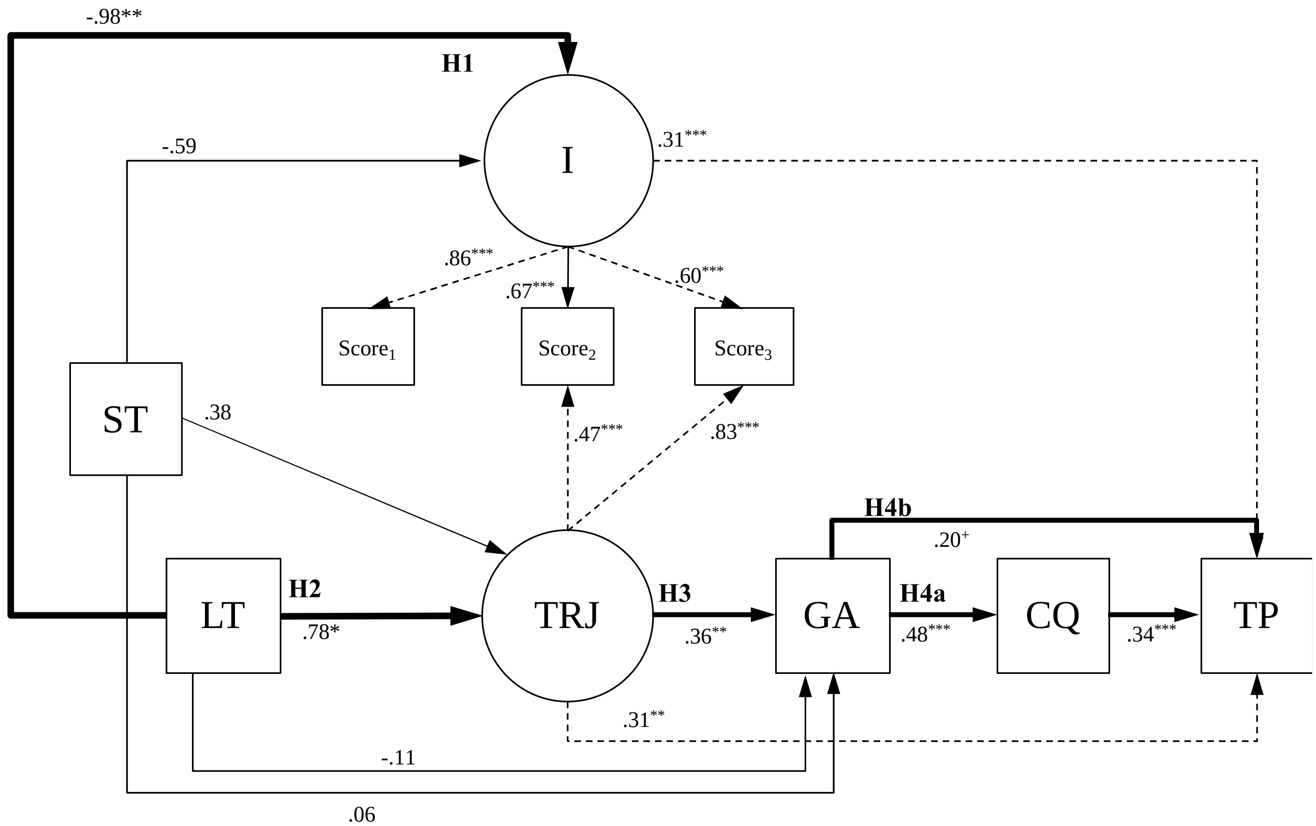


Figure 3

Standardized parameter estimates of Model 1



Note. Score = Average Score [subscript denotes measurement period]; ST = Short Transition Condition; LT= Long Transition Condition; TRJ = Learning Trajectory; I = Intercept; GA = Group Atmosphere; CQ = Coordination Quality; TP = Team Performance. Arrows in bold are hypothesized effects. Dotted arrows are other significant effects that were not involved in hypotheses tests.

$^{+}p < .10$, * $p < .05$; ** $p < .01$, *** $p < .001$.

Appendix A

Point Allocations for Lego Boats

1) Height: +4 points for every .5 inches, up to 5 inches.
2) Weight: 10 points deducted if vessel is under 100g. +1 point for every gram over 100g, up to 140g.
3) Buoyancy: 5 points deducted if vessel sinks. +10 points for each steel ball carried.
4) Durability: 5 points deducted if vessel breaks from a 1-foot drop. +10 points for each additional 1ft it is able to remain intact when dropped.

Author Bios

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