##### **Hypothesis Preregistration: ASIST**

**Study 3 (April 2022)**

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## **Hypothesis** 1**:** Team Skill and Mission Knowledge Predict Performance

1. **Hypothesis Title:** Team member skill and mission knowledge will be associated with performance
2. **Hypothesis Description**
   1. We hypothesize that individual team members' video game experience, minecraft skill, mission knowledge, and spatial ability will be significant predictors of performance. These predictions are based on our analyses of data from ASIST study 2, which indicated a significant relationship between these variables and performance.
3. **Constructs / Indices** 
   1. **Gaming Experience**: Mean team (or min or max) response to two self-report items asking participants about their prior video gaming experience (MC\_Prof\_6, MC\_Prof\_7 OR QID870, QID869)
   2. **Minecraft Skill** is captured by the speed at which players navigate through the pre-mission competency test. Lower scores on this test indicate higher speed which is interpreted as higher skill.
   3. **Mission Knowledge** is based on the mean (or min or max) number of questions administered after participants receive task instructions, focusing on the number of correct answers in response to 8 questions (10 points per correct answer; variable sc0 variable OR SC\_0dFvjllRXQzBoYR)
   4. **Spatial Ability**: Multi-item self-report scale based on the Santa Barbara Sense of Direction Scale. Team means (or min or max) are collected from the 15 item composite, with reverse scoring as necessary (QID13\_1, QID13\_2r, QID13\_3, QID13\_4, QID13\_5, QID13\_6r, QID13\_7, QID13\_8r, QID13\_9, QID13\_10r, QID13\_11r, QID13\_12r, QID13\_13r, QID13\_14, QID13\_15r).
   5. **Performance** is defined as the total number of points teams score during both missions. Alternatively, number of critical victims saved will also serve as an indicator of the quality of collaborative performance
4. **Hypothesis Formalization**
   1. We predict higher levels of team member gaming experience, minecraft skill, mission knowledge, and spatial ability will be positively associated with team performance during both missions.
5. **Dependent (output) variables** 
   1. **Performance** is defined as the total number of points teams score during both missions. Alternatively, number of critical victims saved will also serve as an indicator of the quality of collaborative performance
6. **Independent (input/consumed) variables**
   1. Gaming Experience, Minecraft Skill, Mission Knowledge, and Spatial Ability
7. **Covariates & Nuisance Variables (optional)**
   1. Map order, team mean level of self-reported anger, anxiety and social perceptiveness, and ASI condition
8. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
9. **Sample size rationale (required)**
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.60, power at 0.90, and our alpha criterion at p < 0.05 results in an estimated 119 teams needed to achieve sufficient power to conduct analyses.
10. **Analysis plan: Multiple Linear Regression**
    * 1. **DV1:** Team performance (score on missions)
      2. **DV2**: Critical victims saved
      3. **IVs:** Individual member mission knowledge, minecraft skill, spatial ability, and gaming experience
      4. **Covariates**: team mean level of anger, anxiety, and social perceptiveness; map order, ASI condition
11. **Inference Criteria** (required)
    1. Significant assessed at p < 0.05

## **Hypothesis** 2: Negative Emotions Are Associated with Performance

1. **Hypothesis Title**: Negative emotions are predictive of performance
2. **Hypothesis Description**
   1. Based on our findings from ASIST Study 2 along with other studies by our team (Eadeh et al., 2021; 2022),we hypothesize that negative emotions will be associated with changes in performance. Specifically, we hypothesize that the team 's mean level of pre-task anger will be associated with better performance. Specifically, anger is linked to increased goal-focus, energy, and persistence (Carver and Harmon-Jones [2009](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR11); Maglio et al. [2014](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR50); Seckler et al. [201](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR63)7; Rucker & Petty, 2004; Carver, 2006; Harris et al. [2003](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR34); Pekrun et al. [2006](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR57); Seo et al. [2004](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR64)). and increased persistence is positively correlated with goal achievement and performance (Frese and Fay [2001](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR20); Kanfer et al. [2008](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR40); Locke and Latham [1990](https://link.springer.com/article/10.1007/s11031-018-9720-4#ref-CR47)).

We hypothesize that higher team mean levels of pre-mission anxiety will be associated with lower performance. Extant work demonstrates that anxiety leads to a variety of cognitive deficits. These include (a) decreased activation of prefrontal control mechanisms (Bishop, Duncan, & Lawrence, [2004a](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR13), Kim, Somerville, Johnstone, Polis, & Alexander, [2004](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR40); Somerville, Kim, Johnstone, Alexander, & Whalen, [2004](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR72)), (b) increased risk aversion and satisficing behavior (Oh-Descher, H., Tanaka, H., LaBar, K. S., Ferrari, S., Sommer, M. A., & Egner, T.; 2019; Lam, Ng, Sim, & Song, 2016; see also Ketelaar, T., & Goodie, A., 2011; Lerner & Keltner, 2000; 2001), (c) less concentration and processing efficiency (Eysenck & Calvo, [1992](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR23); Eysenck et al., [2007](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR24)), (d) less reward-focus ( Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & IJzendoorn, [2007](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR2); Bishop, [2007](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR12), (e) less precise motor movements (Behan & Wilson, [2008](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR3); Causer, Holmes, Smith, & Williams, [2011](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR18); Nieuwenhuys, Pijpers, Oudejans, & Bakker, [2008](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR55); Nieuwenhuys & Oudejans, [2011](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR54); Vickers & Williams, [2007](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR77); Wilson, Vine, & Wood, [2009](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470682/#CR86)), (f) reduced working memory capacity (Darke, 1988; Shackman, A. J., Sarinopoulos, I., Maxwell, J. S., Pizzagalli, D. A., Lavric, A., & Davidson, R. J, 2008; Spalding et al., 2020; see Moran, 2016 for a meta-analysis), and (g) increases in false memory rates (Kaplan et al., 2016).

1. **Constructs / Indices**
   1. **Anger**: team mean (or min or max) on 2 item composite from the Positive and Negative Affect Schedule (PANAS\_8, PANAS\_11 OR QID1021\_8, QID1021\_11).
   2. **Anxiety**: team mean (or min or max) on 4 item composite from PANAS (PANAS\_7, PANAS\_15, PANAS\_18, PANAS\_20 OR 1021\_7, 1021\_15, 1021\_18, 1021\_20).
   3. **Performance** is defined as the total number of points teams score during both missions. Alternatively, number of critical victims saved will also serve as an indicator of the quality of collaborative performance
2. **Hypothesis Formalization**
   1. **Hypothesis 2A:** We predict that higher team mean (or min or max)levels of pre-mission anger will be associated with improved performance
   2. **Hypothesis 2B:** We hypothesize that higher team mean (or min or max) levels of pre-mission anxiety will be associated with reduced performance.
3. **Dependent (output) variables (required)**
   1. Performance is defined as the total number of points scored during both missions or the number of critical victims saved
4. **Independent (input/consumed) variables (optional)**
   1. Anger
   2. Anxiety
5. **Covariates & Nuisance Variables (optional)**
   1. Individual member mission knowledge, gaming experience, Minecraft skill, and spatial ability, map order, ASI team condition, social perceptiveness
6. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.50.
7. **Sample size rationale (required)**
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.50, power at 0.80, and our alpha criterion at p < 0.05, we estimated needing 128 teams.
8. **Analysis plan (required)**
   1. **Multiple Linear Regression**
      1. **DV1:** Points scored during both missions
      2. **DV2:** Number of critical victims saved during both missions
      3. **IVs:** team mean (or min or max) levels of anger, anxiety, and social perceptiveness
      4. **Covariates**: team mean level of mission knowledge, minecraft skill, spatial ability and gaming experience; ASI Condition, map order
9. **Inference Criteria (required)**
   1. Significance assessed at p < 0.05

## **Hypothesis** 3: Negative Emotions and Social Perceptiveness Are Predictive of the Quality of Team Processes

1. **Hypothesis Title:** Negative emotions and social perceptiveness are predictive of the quality of team processes
2. **Hypothesis Description** 
   1. See Hypothesis description from H2
3. **Constructs / Indices (optional**)
   1. **Anger**: Team mean (or min or max) level of 2 item composite from the Positive and Negative Affect Schedule (PANAS\_8, PANAS\_11 OR QID1021\_8, QID1021\_11).
   2. **Anxiety**: Team mean (or min or max) level of 4 item composite from PANAS (PANAS\_7, PANAS\_15, PANAS\_18, PANAS\_20 OR 1021\_7, 1021\_15, 1021\_18, 1021\_20)
   3. **Social Perceptiveness**: Team mean (or min or max) number of correct answers (or proportion of correct answers) from the Reading the Mind in the Eyes Task (RMIE\_1 to RMIE\_72 OR QIDs 751-821).
   4. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
   5. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
   6. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
      1. Amount of space covered/total space
      2. Rate of victim saving during the mission
4. **Hypothesis Formalization**
   1. **Hypothesis 3A:** We predict that higher levels of team pre-mission anger will be associated with improved team processes.
   2. **Hypothesis 3B:** We predict that higher levels of pre-mission anger will be associated with less communication in the first quarter of the first mission.
   3. **Hypothesis 3C:** We hypothesize that higher team levels of pre-mission anxiety will be associated with weaker team processes.
   4. **Hypothesis 3D:** We hypothesize that higher team levels of social perceptiveness will be associated with improved team processes.
   5. **Hypothesis 3E**: We hypothesize that the lowest team member social perceptiveness score will be associated with appropriate skill use and efficient team strategy. Specifically, a higher minimum team member social perceptiveness scores will be positively correlated with skill use and task strategy efficiency.
5. **Dependent (output) variables (required)**
   1. Effort
   2. Skill use
   3. Task strategy efficiency
6. **Independent (input/consumed) variables (optional)**
   1. Anger, anxiety, and social Perceptiveness
7. **Covariates & Nuisance Variables (optional)**
   1. Mission knowledge, gaming experience, minecraft skill, and spatial ability, map order, ASI team condition,
8. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.50.
9. **Sample size rationale (required)**
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.50, power at 0.80, and our alpha criterion at p < 0.05, we estimated needing 128 teams.
10. **Analysis plan (required):** 
    1. **Multiple Linear Regression**
       1. **DV1:** Effort
       2. **DV2**: Appropriate skill use
       3. **DV3**: Task strategy efficiency
       4. **IVs:** mean individual level anger, anxiety, social perceptiveness
       5. **Covariates**: individual mission knowledge, minecraft skill, spatial ability, gaming experience, ASI Team Condition, map order
11. **Inference Criteria**
    1. Significance assessed at p < 0.05

## **Hypothesis** 4**:** Team Skill and Mission Knowledge will predict the quality of team processes

1. **Hypothesis title:** Team member skill and mission knowledge will predict the quality of team process
2. **Hypothesis Description** 
   1. Based on our findings from ASIST Study 2,we hypothesize that individual team members' minecraft skill and mission knowledge will be a significant predictor of the quality of team processes — collective effort, skill use, and task strategy efficiency.
3. **Constructs / Indices** 
   1. **Minecraft skill** is defined as the speed at which players navigate through the pre-mission competency test. Lower scores on this test indicate higher speed which is interpreted as higher skill.
   2. **Mission Knowledge** (sc0 variable OR SC\_0dFvjllRXQzBoYR): Number of correct answers out of 8 (10 points per answer). Mean (or min or max) levels are computed for each team.
   3. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
   4. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
   5. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
      1. Amount of space covered/total space
      2. Rate of victim saving during the mission
4. **Hypothesis Formalization**
   1. We predict that higher levels of team member mission knowledge and lower scores on minecraft skill (walking speed, where lower values signify faster speed) will be positively associated with effort, appropriate skill use, and task strategy efficiency during both missions.
5. **Dependent (output) variables** 
   1. Effort
   2. Appropriate skill use
   3. Task strategy efficiency
6. **Independent (input/consumed) variables** 
   1. Team mean level Minecraft skill, mission knowledge
7. **Covariates & Nuisance Variables**
   1. Map order, along with team mean (or min or max) anger, gaming experience, anxiety and social perceptiveness, and ASI condition
8. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
9. **Sample size rationale** 
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.60, power at 0.90, and our alpha criterion at p < 0.05, we estimated needing 119 teams.
10. **Analysis plan** 
    1. **Multiple Linear Regression**
       1. **DV1:** Effort
       2. **DV2**: Appropriate Skill Use
       3. **DV3**: Task Strategy Efficiency
       4. **IVs:** Mission knowledge, minecraft skill, spatial ability, gaming experience
       5. **Covariates**: anger, anxiety, social perceptiveness, map order, ASI condition, gaming experience
11. **Inference Criteria (required)**
    1. Significance assessed at p < 0.05

## Hypothesis 5: Mean individual member Skill and Anxiety predict team processes

1. **Hypothesis Title:** Mean individual member skill and anxiety predict team process
2. **Hypothesis Description** 
   1. Based on our findings from ASIST Study 2,we hypothesize that individual team members' minecraft skill and their levels of anxiety will be a significant predictor of team processes. More specifically, we expect an interaction, such that teams with higher mean levels of anxiety and lower mean individual member skill will show the biggest drop in team processes relative to anxious teams with average or high levels of team member skill.
3. **Constructs / Indices** 
   1. **Minecraft skill** is defined as the mean (or min or max) speed at which players navigate through the pre-mission competency test. Lower values indicate greater skill.
   2. **Anxiety**: Team min (or min or max) of 4 item composite of PANAS (PANAS\_7, PANAS\_15, PANAS\_18, PANAS\_20 OR 1021\_7, 1021\_15, 1021\_18, 1021\_20)
   3. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
   4. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
   5. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
      1. Amount of space covered/total space
      2. Rate of victim saving during the mission
4. **Hypothesis Formalization**
   1. We predict that the statistical interaction between walking skill and pre-measured anxiety will predict team processes. Specifically, teams with high mean anxiety and low mean individual minecraft skill will show the lowest quality team processes relative to all other combinations of anxiety and skill.
5. **Dependent (output) variables** 
   1. Effort
   2. Appropriate skill use
   3. Task strategy efficiency
6. **Independent (input/consumed) variables** 
   1. Individual member mean Minecraft Skill (mean centered) and mean individual anxiety (mean centered)
7. **Covariates & Nuisance Variables**
   1. Map order, along with measures of team-based anger anger and social perceptiveness, ASI condition, gaming experience, mission knowledge, spatial ability
8. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
9. **Sample size rationale**
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with a fixed model R2 increase (see below) effect size of Cohen's d = 0.60 (equivalent to an f2 of 0.09), power at 0.90, and our alpha criterion at p < 0.05, we estimated needing 119 teams.
10. **Analysis plan**
    1. **Multiple Linear Regression**
       1. **DV1:** Effort
       2. **DV2**: Appropriate skill use
       3. **DV3**: Task strategy efficiency
       4. **IVs:** Minecraft skill (mean-centered main effect), anxiety (mean-centered main effect), minecraft skill\*anxiety (interaction)
       5. **Covariates**: Map order, along with measures of team-based anger anger and social perceptiveness, ASI condition, gaming experience, mission knowledge, spatial ability
11. **Inference Criteria**

Significance assessed at p < 0.05

## Hypothesis 6: Quality of Team Processes Predict Performance

1. **Hypothesis Title:** Quality of team processes predict performance
2. **Hypothesis Description** 
   1. Recent research illustrates that collective intelligence is strongly predicted by particular classes of team collaborative process behaviors [(Riedl et al., 2021)](https://www.zotero.org/google-docs/?lWwlsZ). These categories of collaborative process include selecting the right task coordination strategy, making good use of members’ knowledge and skill, and eliciting high levels of collective effort across the team [(Hackman, 1987)](https://www.zotero.org/google-docs/?lxJlw0). Many of these team process behaviors can be encouraged via interventions and activities in teams that help develop the right norms and routines early in work (Mathieu & Rapp, 2009; [Woolley et al](https://www.zotero.org/google-docs/?CsF8oj)., [2008](https://www.zotero.org/google-docs/?CsF8oj)[)](https://www.zotero.org/google-docs/?HyMCRZ). The current study examines whether a pre-mission team planning intervention can reliably improve the quality of these collaborative team process behaviors, as well as improved performance in the context of a USAR task.

Based on the literature, we propose three hypotheses. First, we hypothesize group collaboration process behaviors, including collective effort, task strategy efficiency, and appropriate skill use will improve team performance on an Urban Search and Rescue (USAR) task.

1. **Constructs / Indices** 
   1. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
   2. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
   3. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
      1. Amount of space covered/total space
      2. Rate of victim saving during the mission
   4. **Performance** is defined as the total number of points scored and the number of critical victims saved
2. **Hypothesis Formalization**
   1. We predict that higher levels of mission knowledge and individual member skill will be positively associated with effort, appropriate skill use, and task strategy efficiency during both missions.
3. **Dependent (output) variables**
   1. **Performance** is defined as the total number of points scored during both missions. Alternatively, number of critical victims saved is an additional predictor of performance
4. **Independent (input/consumed) variables**
   1. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
   2. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
   3. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
      1. Amount of space covered/total space
      2. Rate of victim saving during the mission
5. **Covariates & Nuisance Variables** 
   1. Map order, ASI condition
6. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
7. **Sample size rationale** 
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.60, power at 0.90, and our alpha criterion at p < 0.05, we estimated needing 119 teams.
8. **Analysis plan**
   1. **Multiple Linear Regression**
      1. **DV1:** Points scored
      2. **DV2**: Critical victims saved
      3. **IVs:** Effort, appropriate skill use, task strategy efficiency
      4. **Covariates**: Map order, ASI condition
9. **Inference Criteria** 
   1. Significance assessed at p < 0.05

## Hypothesis 7: Collaborative fluency predicts performance

1. **Hypothesis Title:** Collaborative fluency predicts performance
2. **Hypothesis Description** 
   1. Collaborative fluency (Hoffman 2019) is the coordination of joint activities by members in a team. Collaborative fluency includes measures of idle time, concurrent activity, and functional delay. Concurrent activity is the amount of time in which all members of a team were acting or performing tasks at the same time. Functional delay is the time from when a teammate immediately completes an activity that requires another member to follow up to when the second teammate begins their segment of the interdependent task.

Based on the literature, we propose four hypotheses. First, we hypothesize team collaborative fluency measures of team idle time, team concurrent activity, functional delay, and inverse functional delay will improve team performance on an Urban Search and Rescue (USAR) task.

1. **Constructs / Indices** 
   1. **Collaborative Fluency (CF).** CF measures will be measured in post-mission analyses.
      1. **Team Idle Time** is defined as the amount of time in which 1 or more players in the team are not moving or performing a task.

**Team Idle Time = Total time (seconds) in which 1 or more players in the team are not moving nor using a tool to perform a task.**

* + 1. **Team Concurrent Activity** is defined as the amount of time in which 1 or more players in the team are moving or performing a task.

**Team Concurrent Activity = Total time (seconds) in which 1 or more players in the team are moving or using a tool to perform a task.**

* + 1. **Functional Delay** is defined as the time from when a teammate A performs a task requiring action by another teammate to when the second teammate B performs the required action. One example of this is the time from when a rubble-remover moves the rubble blocking a victim to the time a medic saves the victim.

**Functional Delay = Time at which medic saves victim i - Time in which rubbler removes blockage to victim i)**

* + 1. **Inverse Functional Delay** is defined as the time a player A aiming to perform a task that is dependent on the actions of another teammate B must wait for the dependent task to be completed by player B. One example of this is when a medic arrives at a victim, but must wait for the rubble around the victim to be cleared by a teammate.

**Inverse Functional Delay = Total time (seconds) in which a medic stands by a victim (in FOV) but is unable to save the victim due to its being blocked by rubble.**

* 1. **Performance** is defined as the total number of points scored or the number of critical victims saved

1. **Hypothesis Formalization**
   1. We predict that higher levels of collaborative fluency (lower team idle time, higher team concurrent activity, lower functional delay, lower inverse functional delay) will be positively correlated with higher score on the USAR task.
2. **Dependent (output) variables**
   1. Performance
3. **Independent (input/consumed) variables**
   1. Collaborative fluency
      1. Team Idle Time
      2. Team Concurrent Activity
      3. Functional Delay
      4. Inverse Functional Delay
4. **Covariates & Nuisance Variables** 
   1. Map order, ASI Condition, walking skill, anger, anxiety, mission knowledge, social perceptiveness, spatial ability
5. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
6. **Sample size rationale** 
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.60, power at 0.90, and our alpha criterion at p < 0.05, we estimated needing 119 teams.
7. **Analysis plan**
   1. **Multiple Linear Regression**
      1. **DV1:** Total points scored
      2. **DV2**: Number of critical victims saved
      3. **IVs:** Team Idle Time, Team Concurrent Activity, Functional Delay, Inverse functional delay
      4. **Covariates**: map order, ASI Condition, walking skill, anger, anxiety, mission knowledge, social perceptiveness, spatial ability
8. **Inference Criteria** 
   1. Significance assessed at p < 0.05

## Hypothesis 8: Communication predicts team collaborative fluency, performance, and team processes

1. **Hypothesis Title:** Communication predicts team collaborative fluency and performance
2. **Hypothesis Description** 
   1. Past research demonstrates the importance of a high level and equality of communication among team members for team decision making (Bartlett & Cooke, 2015) and collective intelligence (Engel et al., 2014; Woolley et al., 2010).

Here, we look at more specific patterns in communication based on the literature, and propose three hypotheses. First, we hypothesize that more frequent communication will be a significant predictor of teams’ performance. Third, higher communication frequency and consistency will be positively correlated with higher levels of collaborative fluency. We also predict that higher communication frequency will be positively correlated with higher levels of skill use and task strategy efficiency

1. **Constructs / Indices** 
   1. **Team Frequency of Communication** = Average Communication Frequency Per Minute Over all Players
      1. One communication instance is a single logged audio message in the Zoom Audio transcripts.
   2. **Team Consistency of Communication** = 1/[Variance of the Team’s Communication Frequency Per Minute]
   3. **Collaborative Fluency**
      1. **Team Idle Time** is defined as the amount of time in which 1 or more players in the team are not moving or performing a task.
      2. **Team Concurrent Activity** is defined as the amount of time in which 1 or more players in the team are not moving or performing a task.
      3. **Functional Delay** is defined as the time from when a teammate A performs a task requiring action by another teammate to when the second teammate B performs the required action. One example of this is the time from when a rubble-remover moves the rubble blocking a victim to the time a medic saves the victim.
      4. **Inverse Functional Delay** is defined as the time a player A aiming to perform a task that is dependent on the actions of another teammate B must wait for the dependent task to be completed by player B. One example of this is when a medic arrives at a victim, but must wait for the rubble around the victim to be cleared by a teammate.
   4. **Team processes**
      1. **Effort** is defined as the activity level of team members during the mission. We calculate it as [1 - (time inactive\*) / (time window)]
      2. **Skill Use** is defined as the average percentage of time spent by all members engaged in role-congruent (specialist) actions.
      3. **Task Strategy Efficiency** is defined as a weighted combination of 2 component measures
         1. Amount of space covered/total space
         2. Rate of victim saving during the mission
   5. **Performance** is defined as the total number of points scored or the number of critical victims saved
2. **Hypothesis Formalization**
   1. We predict that higher levels of communication frequency will be positively correlated with higher scores on the USAR task.
   2. We also predict that higher communication frequency and consistency will be positively correlated with higher levels of collaborative fluency.
   3. We also predict that higher communication frequency will be positively correlated with higher levels of skill use and task strategy efficiency
3. **Dependent (output) variables**
   1. Team Processes
      1. Skill use
      2. Task strategy efficiency
   2. Performance
   3. Collaborative Fluency
4. **Independent (input/consumed) variables**
   1. Communication frequency
   2. Communication consistency
5. **Covariates & Nuisance Variables** 
   1. map order, ASI Condition, walking skill, anger, anxiety, mission knowledge, social perceptiveness, spatial ability
6. **Effect size (required for hypotheses)**
   1. We expect the average effect size of any given coefficient to be a Cohen’s d of 0.60.
7. **Sample size rationale** 
   1. An a priori power analysis was conducted to determine the number of teams needed using G\*Power3 (Faul et al., 2007). Using a two-tailed test for linear multiple regression with an effect size of Cohen's d = 0.60, power at 0.90, and our alpha criterion at p < 0.05, we estimated needing 119 teams.
8. **Analysis plan**
   1. **Multiple Linear Regression**
      1. **DV1:** Points scored
      2. **DV2**: Critical victims saved
      3. **DV3**: Skill use
      4. **DV4**: Task strategy efficiency
      5. **DV5:** Team Idle Time
      6. **DV6:** Team Concurrent Activity
      7. **DV7:** Functional Delay
      8. **DV8**: Inverse functional delay
      9. **IVs:** Communication frequency (number of messages spoken by the team), consistency (standard deviation of messages spoken by the team over each minute)
      10. **Covariates**: map order, ASI Condition, walking skill, anger, anxiety, mission knowledge, social perceptiveness, spatial ability
9. **Inference Criteria** 
   1. Significance assessed at p < 0.05

**Authors:** Jared Freeman, David Mellor, Lesley Markham

**Purpose:** Enable ASIST performers to preregister hypotheses and capability claims prior to experimentation.

**Instructions:** Please create one, uniquely named copy of this file in which you’ll enter your hypotheses. Please describe each distinct hypothesis in a separate section of this document.Please **do not write in this file**

Background and some instructions [concerning this form are here](https://docs.google.com/document/d/16Ajv-zcr9s3fJX6ztK8Pl5ac6r_4HdnKRqPOTSf8W6Q/edit?usp=sharing).

Once your preregistration is complete, please sign up to review one of your colleagues registrations by using this form[Study 3 Peer Review Sign-up](https://docs.google.com/spreadsheets/d/15EDnbETgi_L9HPuZtryrTnxLGctZm36xYn9dsLptj-U/edit?usp=sharing)

**\*\*To be included in our pre-registration hypotheses form\***

**CMU-TA2 Hypothesis Brainstorming**

Please list your hypothesis ideas below, put your initials at the end of each, and as the list grows let’s try to make categories and group them.

1. BEARD-related hypotheses on Performance (e.g. points scored)
   1. ~~Individual team member video game experience, minecraft skill, mission knowledge and spatial ability (average, min and/or max) will be a significant predictor of team points scored (AW)~~
   2. ~~Emotions predict performance~~
      1. ~~Teams with higher than average anger on pre-mission measures will be a significant predictor of team points scored. Specifically, higher levels of anger are hypothesized to be positively correlated with points scored (FE).~~
      2. ~~Teams with higher than average anxiety on pre-mission measures will be a significant predictor of team points scored. Specifically, higher levels of anxiety are hypothesized to be inversely correlated with points scored (FE).~~
   3. ~~Teams with higher than average walking skill will be a significant predictor of the number of critical victims saved (FE).~~
   4. ~~Teams with higher than average anger on pre-mission measures will be a significant predictor of the number of critical victims saved (FE).~~
2. BEARD-related hypotheses on TED metric Outcome measures:
   1. ~~Negative Emotions will be predictive of our TED Variables~~
      1. ~~Teams with higher than average anxiety on pre-mission measures will be a significant predictor of appropriate skill use, task strategy efficiency, and effort, such that higher levels of this emotion will be predictive of~~ *~~worse~~* ~~TED outcomes (FE)~~
      2. ~~Teams with higher than average anger on pre-mission measures will be a significant predictor of appropriate skill use, effort, and task strategy efficiency, such that higher levels of this emotion will be predictive of~~ *~~better~~* ~~TED outcomes (FE)~~
   2. ~~Teams with higher than average social perceptiveness will predict appropriate skill use and task strategy efficiency (FE)~~
   3. ~~Teams with higher than average walking skill as measured by the pre-mission competency test will predict all of our TED metrics, such that higher-skilled teams will outperform lower-skilled on these team process metrics. (FE)~~
   4. ~~Teams with higher than average mission knowledge as measured by the pre-mission test will predict all of our TED metrics, such that higher-knowledge teams will outperform lower-knowledge teams on these team process metrics. (FE)~~
   5. ~~We predict an interaction of walking skill and anxiety on team skill use. Specifically, teams with higher than average anxiety teams and lower than average walking skill will be less likely to engage in appropriate skill use. (FE)~~
   6. ~~Teams with higher than average anger on pre-mission measures will exhibit reduced communication in the first quarter of the mission.(AW)~~
3. TED-related hypotheses
   1. Early team “states” on TED metrics will predict later team states in teams not receiving interventions (AW)
   2. ~~Higher collective effort will be a significant predictor of team points scored (PG)~~
   3. ~~Higher skill use will be a significant predictor of team points scored (PG)~~
   4. ~~Faster workload burndown (appropriate strategy) will be a significant predictor of team points scored (PG)~~
   5. ~~Equal communication be a significant predictor of team points scored (PG)~~
   6. ~~Less communication will be a significant predictor of teams’ collective effort (PG)~~
   7. ~~More communication will be a significant predictor of teams’ skill use (PG)~~
   8. ~~More communication will be a significant predictor of teams’ workload burndown (PG)~~
4. TED x BEARD hypotheses
   1. ~~Lowest team member RME score will predict TED metrics of use of member skill and quality of team strategy (AW)~~
   2. Teams with higher than average anger on pre-mission measures will exhibit reduced communication following ASI intervention (AW).
5. ~~Collaborative Fluency Hypothesis (Do hypotheses need to be TED/BEARD related?)~~
   1. ~~Higher collaborative fluency (individual and team idle time, functional delay) will be predictive of team performance.(MZ)~~

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**Feedback**

* Feedback about the hypothesis
  + [your comments…]
* Feedback about this form
  + [your comments…]