DOD HFE TAG Spring 2014
Cognitive Readiness subTAG Report
LCDR Greg Gibson, PhD

1. Cognitive Readiness
2. 22 total attendees – 14 wanted to participate in working group
3. 19 organizations across government, industry, & academia including:
   Navy – NAVSEA, NRL, NAVAIR, NSWC Dalghren, NAWC WD
   Army – Army Institute of Public Health, ARI, ARL-HRED, Yuma Proving Grounds
   Air Force – 711th HPW, AF Institute of Technology
   Other Gov – Brookhaven National Laboratory, US Nuclear Regulatory Comm, TSA, NASA
   Industry, Academia – SA Technologies, MITRE, University of Virginia

4. Cognitive Readiness SubTAG Meeting Agenda
   Chair – LCDR Greg Gibson, Katrina May

   a. Analyzing Visualization Workload through Leverage Points
      Mark A. Livingston[1], Kristen Liggett[2], Paul Havig[2], Jason Moore[2], Jonathan W. Decker[1], Zhuming Ai[1] – [1]Naval Research Laboratory, [2]Air Force Research Laboratory

   b. Improving Team Cognitive Readiness through the Multi-Agent System for Targeting Team Mental Models (MAST-TMM)
      Laura Strater – SA Technologies, Inc

   c. Accelerating Team Development: Unobtrusive Assessments of Team Readiness
      Presented by Arwen DeCostanza - U.S. Army Research Institute
      For Zach Horn – Aptima, Inc

   d. What is Cognitive Readiness? Developing an Operational Definition
      LCDR Greg Gibson – Naval Air Systems Command, Human Systems Department

   e. Cognitive Readiness Business Meeting
      LCDR Greg Gibson & Katrina May

5. Abstracts of Presentations
   a. With the increasing size of data sets and the growing capabilities of graphics processing, it is quite easy to create visual data representations that overwhelm the analyst's ability to make sense of the underlying data. Recently, leverage points were proposed as stages (right) between sensation (perception) of data and cognition of information in data1. In this talk, we will review the proposed leverage point from the standpoint of operator workload, and review whether our quantitative studies3-7 of multivariate visualization (MVV) techniques provide evidence of leverage points.

The first leverage point is the focusing of exogenous attention by salient cues which alert users to changes or important aspects of the data. Examples include varying color and texture, and other pre-attentive cues2. As such, it is of the least concern to workload measures, which focus on cognitive processing. The second leverage point is endogenous attention, which benefits from using appropriate organization of material or interactions. While we did not systematically vary the labels in empirical studies, we alternated the polarity of the task between looking for an increasing and a decreasing trend in successive trials of one study4. Several users made errors that were consistent with searching for the wrong type of trend. Thus one could say that the study design violated the leverage point and yielded bad data from some subjects. The third leverage point is providing strong grouping cues; this also relies on perceptual similarity (e.g. color or shape), but triggers working memory to hold associated groups of data, rather than individual data points. This grouping is a natural feature of MVV techniques (see below), and helps to explains one of our major results. We devised a new task that could only be solved by examining all six variables presented6. This task was the first study that showed a performance advantage (in both error and response time) for MVV over the baseline visualization using separate display of variables. It is easy to see this as an argument for grouping. The fourth leverage point recommends organizing information based on mental models. In studies with novice users for whom tasks may be rather abstract, this is not a hypothesis we can support. But we consider how it might apply to novices. The fifth leverage point recommends that visual structure enable analogy from one part of the data to another. With focused tasks such as in our studies, this is beyond the inferences we can draw from our data. The final leverage point encourages implicit learning via training regimes. This would suggest that a learning effect could be found in our data. There is no statistically significant result; however, users showed a tendency to increase speed over the duration of our studies. This follows from the lack of feedback provided to users.

b. In an increasingly complex operational environment where the participation and collaboration of personnel with disparate capabilities and backgrounds is critical for performance, identifying a priori which teams will be successful is challenging. The Multi Agent System for Targeting Team Mental Models is a tool that was specifically developed to evaluate a teams cognitive readiness, and match that analysis to task or mission characteristics. MAST-TMM combines the latest research from psychology and social sciences on factors that influence team cognitive readiness and performance, a widely accepted model of cognition and decision making, Endsley's model of situation awareness, and integrates them into a Situation Awareness oriented Fuzzy Cognitive Engine which uses a combination of fuzzy logic and concept mapping to represent the relationship among factors. Algorithms combine these factors into a comprehensive model of team cognitive readiness that is predictive of performance. MAST-TMM is an integrated assessment tool designed to evaluate teams across the full spectrum of readiness factors that influence performance. Because team performance is also

dependent, though, on task characteristics, the ultimate objective for MAST development is to synthesize a tool that comprehensively evaluates team characteristics and capabilities, analyzes those inputs through a cognitive model and matches those capabilities to contextual factors such as task and mission demands to predict team performance within the specified context. This presentation will focus on the development of MAST, including the factors that go into the comprehensive assessment, the modeling process of integrating these measures into a cognitively inspired model, and will provide preliminary data from an ongoing validation study.

c. No Abstract Provided

d. Cognitive readiness as an area of studied in the DOD has only been around a little over a decade. Over this short-time frame many definitions have of cognitive readiness have been offered in the literature with little cohesion between those doing the research. However, all are in agreement that cognitive readiness is broad multidimensional problem. What the sub-dimensions of cognitive readiness are is still open for debate. Further complicating this issue is that there is still no standard testing cognitive readiness. Here I suggest the need for a working group to come together for the DOD and develop a standard operational definition of cognitive readiness. What it is, what is it's sub-dimensions, and how do we objectively measures those sub-dimensions in order to provide a single verifiable metric of cognitive readiness. To that end I am proposing the creation of a working group within the Cognitive Readiness subTAG to work this problem over the next 12 months. The conclusion of this working group will be to provide the larger scientific community an operational definition of cognitive readiness which will be open to further comment and refinement with the eventual goal of a generalized agreement of a single operational definition for use within the DOD.

6. Katrina May has left government service and will likely no longer be attending the TAG we are now looking for a co-chair for the Cognitive Readiness SubTAG.

   We developed a working group of 14 individuals who would like to work on developing a standard operational definition of cognitive readiness for use within the DOD.

7. No elections held this session

8. Working group formed – working operational definition to be presented at next TAG May of 2015 for comments and feedback from larger scientific community.

9. SubTAG Chair, LCDR Greg Gibson, gregory.gibson2@navy.mil, 301-342-9284