OFFICE OF THE DIRECTOR OF NATIONAL INTELLIGENCE

Sirius Proposers' Day
Office of Incisive Analysis

LEADING INTELLIGENCE INTEGRATION

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INTELLIGENCE ADVANCED RESEARCH PROJECTS ACTIVITY (IARPA)

Disclaimer

- This presentation is provided solely for information and planning purposes
- The Proposers' Day Conference does not constitute a formal solicitation for proposals or proposal abstracts
- Nothing said at Proposers' Day changes the requirements set forth in a BAA.
- BAA supersedes anything presented or said at the Proposers' Day by IARPA

Today's Goals

- Familiarize participants with IARPA's interest in Sirius – Please ask questions & provide feedback; this is your chance to alter the course of events.
- Foster discussion of synergistic capabilities among potential program participants, AKA teaming. Take a chance, someone might have a missing piece of your puzzle.

Schedule

- Full Proposals will be due 60 days after the BAA is published
- Once BAA is released, questions can only be answered in writing on the program website

Today's Topics

- Program Overview
- Program Metrics and Milestones
- Award Information
- Eligibility Information
- Application Review Information

Program Overview

Research Objectives

- Experimentally manipulate variables in Virtual Learning Environments (VLE) to determine if any such variables enable user recognition and persistent mitigation of Real World (RW) cognitive biases

Definitions

Problem Background

- Broad consensus that human decision making relies on a repertoire of simple, fast, heuristic decision rules that are used in specific situations
- These decision rules can bias general problem-solving in ways that produce erroneous results
- When an intelligence problem invokes these biases, analysts may draw inferences or adopt beliefs that are logically unsound or not supported by evidence
- Cognitive biases in analysis tend to:
  - increase with the level of uncertainty
  - lead to systematic errors
  - filter perceptions
  - shape assumptions and
  - constrain alternatives

Who Does It? How Is It Done Now?

- Cognitive biases cannot be eliminated, but research suggests they may be mitigated by awareness, collaboration, and critical or procedural thinking processes
- Cognitive bias problems are seen in many professions (e.g., medical, aviation)
- Mitigation efforts have generally met with mixed success
  - Mindfulness of biases is difficult to cultivate with traditional "training course" methods
  - The cost of extra effort required to use sophisticated strategies and structured techniques to mitigate bias problems is often perceived to outweigh the potential benefits
  - Experimental evidence of bias blind spot: We are unaware that our biases are at work influencing our decision-making

Who Does It? How Is It Done Now?

- IC analyst training curricula already includes:
  - Overview of cognitive, cultural and group biases
  - Consequences of logical and procedural error
  - Knowledge and application of structured analytic techniques (SAT)
- Examples of SATs:
  - Hypothesis Generation and Analysis of Assumptions
  - Analysis of Competing Hypothesis
  - Devil's Advocacy
  - Brainstorming
  - "What If?" Analysis
  - Delphi
  - Decomposition and Visualization of Complex Data
  - Alternative Futures Analysis

Who Does It? How Is It Done Now?

- Training occurs at:
  - Formal IC schools
  - Formal short courses and seminars
  - Workshops and conferences
- Principal training methods:
  - Lecture and Power Point Briefs
  - Table top exercises
  - Demonstration and familiarization with software aids
- Mentors responsible for monitoring and ensuring proficiency after initial training
- Mitigation via peer review

Limitations of Current Training Approach

- General research consensus is that factual knowledge about cognitive biases is ineffective in mitigating them—experiential training is necessary

- New analysts get a few days of knowledge-based instruction and minimal experience in applying knowledge, with limited opportunities to maintain and improve basic skills

- Effectiveness and persistence of learning are rarely measured

Why Games?

Serious Games provide…

- Experiential learning – “learning by doing”
- A safe environment where learning from failure is OK
- Repetition, repetition, repetition

Serious Games are..

- Videogames developed for educational, therapeutic, or other serious purposes
- Serious games may employ entertainment game-play to achieve their purpose, but reward systems and game-play are structured and internally constrained to focus the user on the concepts or material to be internalized and learned

Summary of Serious Games R&D

Other communities have successfully addressed similar training challenges:

✓**US and foreign military** (e.g., aircraft and weapon simulators, combat medical aid, security)
✓**Educational institutions** (primary, secondary, and university)
✓**Health care** (e.g., surgery, pain management, PTSD therapy, Public Health)
✓**Industry, public safety & security** (e.g. customs, airlines, explosives manufacture, power generation)

Summary of Serious Games R&D

- Research is fairly consistent in finding that Virtual Environments can have a positive experiential-learning transfer to specific RW skills (e.g., surgery) or for specific behavior changes (e.g., drug treatment protocol compliance)

Summary of Serious Games R&D in the IC

- IC generally (with a few exceptions) does not currently research, develop or use computer-based serious games for analytic training
- No one (inside or outside the IC) has attempted to create a serious game for exposing and mitigating cognitive bias

Limitations of Current Approach to Serious Games R&D

- Most educational computer game research does not account for how learning activity is influenced by factors of game content
  - Tendency to take a “black box” approach to VE design & research
  - Usually focus on gross effects
  - Non-standard definitions of Engagement, Presence, and Immersion make it difficult to compare results
  - Just beginning to tease apart the mechanisms that make game play so powerful for persistent learning
- Need understanding of the critical design variables that affect motivation, sense of presence, engagement, training transfer, and persistence of learning over time

Definitions

The Sirius program will…

- Identify and quantitatively characterize the important VLE and player variables that control the strength and persistence of training and learning effects for the recognition and mitigation of cognitive biases
- Provide a basis for experimental repeatability and independent validation of effects
- Identify critical elements of design for effective analytic training in VLEs

Game design goals

- The overall game design should create an experience that drives the player to acquire new **skills for mitigating cognitive biases**
- These skills should have **high perceived value to the player**.

Sirius Program Requirements

- Cognitive biases that will be examined by all teams are different in each phase of the program:
  - Phase 1
    - Confirmation Bias
    - Fundamental Attribution Error
    - Bias Blind Spot
  - Phase 2
    - Anchoring Bias
    - Representativeness Bias
    - Projection Bias

Definitions

Sirius Program Requirements

Research teams will be required to include the following, at a minimum, in their human subjects experimental protocols:

- Pre-tests for:
  - Demographics, game experience, etc
  - Knowledge of cognitive biases
  - Measurement of cognitive bias
- Experimental Intervention:
  - Control Group: intervention using traditional lecture training method. IARPA will provide a training video that will be used by all research teams.
  - Two or more Treatment Groups: intervention using a Serious Game to elicit, expose, and mitigate cognitive biases, that manipulates a game variable (see slide 24) at a minimum of 2 levels.

Sirius Program Requirements

Research teams will be required to include the following, at a minimum, in their human subjects experimental protocols:

- Game instrumentation measures variables such as engagement and achievement during game-play
- Immediate post-test for:
  - Knowledge of cognitive biases
  - Measurement of cognitive bias (outside of game)
- Follow-up test at 8 weeks (Phase 1) and 12 weeks (Phase 2) to test for persistence of effect. These are minimum requirements. Researchers may conduct additional follow-up tests if desired. Both control and treatment groups should be tested each time.

Candidate Variables for Manipulation and Study

Game Independent Variables	
•Session Duration & Repetition *(required)*	•Fidelity/Level of Abstraction of task, social, visual, audio
•Fantasy elements	•Type of Narrative
•Single Player vs Multi Player	•Communication Type, Frequency, Style
•First vs Third Person View	•Game Mechanics
•Reward Structure	•Real Time Feedback
•Priming of participants	

Dependent Variables ***(all required)***	
•Recognition of Cognitive Biases	•Mitigation of Cognitive Biases
•Engagement	•% of game/quest completed
	•Persistence of Effect

Moderating Variables	
•Demographics *(required)*	•Personality *(required)*
•Experience with: computers, games *(required)*	•Perception of “immersion”, “presence” or “flow state”
•Psycho physiological Arousal	•Affective State
•Motivation	•Cognitive abilities
•Analytic Experience: Novice, Journeyman, Expert	

Sirius Technology Constraints

In Scope:

- Personal Computer-based (standalone)
- Web-based games with browser, thin or thick client interfaces (which would optionally allow for multi-player games)
- Gaming consoles
- Tablet computers

Wireless and camera capabilities may be used in experiments. But, both capabilities are problematic for general deployment within the IC.

Not in Scope:

- CAVES, “Virtual Reality”, Head-Mounted Displays
- Other Hand-Held Mobile Devices (phones, hand-held games)
- Board games or Table-top games

Other Sirius Requirements

- Each performer must test a minimum of 3 game variables in Phase 1, in addition to the variable of session duration & repetition
- Each performer must test a minimum of 3 additional game variables in Phase 2, in addition to the variable of session duration & repetition
- Choice of game variables must be driven by theory*. A "shotgun approach" is not acceptable
- The game must elicit and teach the player how to mitigate the 3 specified cognitive biases in Phase 1 and the 3 specified cognitive biases in Phase 2.

*Theory must direct the research: e.g., learning theory, social influence, neuroscience, etc

Other Sirius Requirements, continued

- Game in Phase 1 is an “Alpha” version, not a full game:
  - Player must succeed in an activity within 5 minutes
  - Player must experience a “teachable moment” within 10 minutes
  - Game play should provide a significant training experience in 30 minutes or less
  - Player must be able to log off/log on and resume at same point in game
  - Self-taught – no instruction manual required
- A single, or multiple Alpha games may be produced by a single research team in Phase 1. All cognitive biases being researched may be elicited & mitigated in one or more games.
- Game play must be instrumented
- Play-testing should be conducted and feedback incorporated by research teams prior to formal human subjects experimentation. In addition, independent play-testing will be conducted by the government team. Note that both play-testing and experiments will require Institutional Review Board (IRB) approvals.
- Number of subjects in each treatment/control condition must be sufficiently large to allow for valid statistical analysis and demonstrate desired effect size
- The same requirements apply for Phase 2 Alpha games

A Notional Use Case

- Used as an adjunct to traditional classroom training
- Available game play time in class will be about 30 minutes
- Game must be playable at home: "Games as Homework"
- The game may employ a user model, i.e., in the use case, we know who the player is…demographics, previous training, etc
  - If research demonstrates that these moderating variables have an impact on effectiveness of the game, then performers may leverage this in the design or customization of the game

Why now?

- Gaming and Virtual Environments are emerging as a new teaching approach
- Multiple vendor platforms and tools provide the means to develop compelling Virtual Environments relatively quickly
- Extensive COTS game building tools and environments available will allow researchers to focus on the mechanics and controlling the variables
- New generation of analysts has grown up playing videogames and will be primed for learning via this method

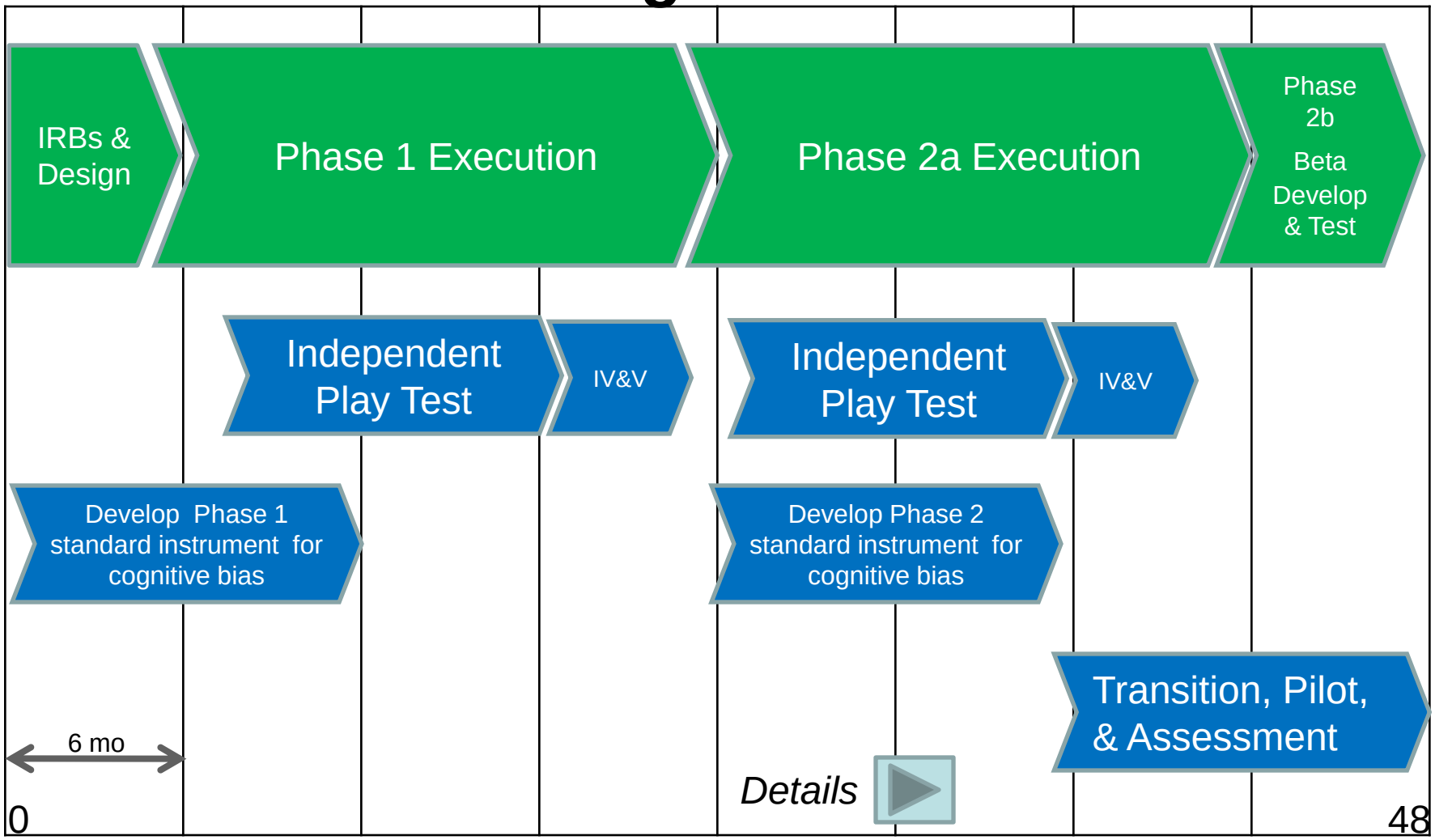
What Difference Will It Make?

- Training organizations will be able to:
  - Evaluate students' ability to recognize cognitive biases and mitigate their effects
  - Measure learning persistence
  - Maintain student proficiency
- Well-characterized design variables can be used to drive requirements for future VLE analytic training systems
- Training will be less expensive with scaling up, available on-demand, engaging, and measureable
- Training effects will persist longer
- Use of serious games can be expanded to areas of…
  - Skill in choosing and applying structured analytic techniques
  - Skill in critical thinking
  - Skill in managing complex data
- **Reduced analytic bias in IC products**

Sirius Program Structure

- 4 years:
  - Phase 1 – 24 months
  - Phase 2a – 18 months
  - Phase 2b – 6 months

Sirius Program Structure



Sirius Program Structure

- Iterative Development and Experiment Strategy
- Phase 1 (24 mo)
  - Research & development conducted by several independent research teams
  - Allow 6 months up-front for IRB approvals during game design and development. No IARPA funding can be used towards human subjects research until ALL approvals are granted
  - Teams develop alpha versions, not full games
  - Reviews of experiments every 3 months (i.e., 3 reviews over 9 months)
  - Independent experimental replication by government and/or FFRDC and/or UARC, using analysts or analyst surrogates
  - Down-select performers based on achievement of metrics
- Phase 2 (24 mo)
  - Leverage results from Phase 1, extend alpha game-play to 3 more cognitive biases, and continue experimentation
  - Reviews of experiments every 3 months (i.e., 3 reviews over 9 months)
  - Independent experimental replication by government and/or FFRDC and/or UARC, using analysts or analyst surrogates
  - For games shown to be effective, teams will develop, test, and deliver a beta version of games (last 6 months)

Sirius Program Structure

- The Government will develop and test a standardized instrument to measure cognitive biases, that will be used by the Independent Validation & Verification (IV&V) team
- Pre-Phase 1
  - Identify FFRDC or UARC partners with expertise
  - Begin research into preliminary instrument design
- Phase 1 (first 12 to18 months)
  - Determine instantiations of cognitive biases being studied by the research teams
  - Begin instrument design
    - Must fairly test the different instantiations of the same bias being studied by the different teams
    - Must test generalization to new instances of the cognitive bias
  - Obtain IRB approvals
  - Pilot test
  - Test instrument with human subjects
  - Refine, retest, validate
  - Use of validated instrument by IV&V team starting at month 18
- Repeat for Phase 2
- **Research teams will be responsible for their own test methods and instruments for their experiments for both Phases**

Program Milestones & Metrics

Milestones & Metrics – Phase 1

- Programmatic Midterms (Phase 1):
  - IRB approvals
  - Verification & Validation Team reviews of research design & test instruments
  - Successful demonstration of game at site visits
  - Delivery of alpha game, documentation, and Phase 1 report
- Technical Midterms (Phase 1):
  - Play-testing prior to experimentation (pass/fail)
  - Demonstrated engagement (individual minimums >50% of play session & average over all subjects >75% of play session)
  - Prove/disprove the null hypothesis that games have no effect on recognition and mitigation of cognitive biases via statistically significant post-test compared to pre-test
  - Game treatment demonstrates practical significance via a minimum **50**% reduction (averaged across subjects, across all biases) in observed cognitive bias compared to pre-test. Researchers should also report the average reduction (across subjects) for each bias.
  - At **8** weeks after initial treatment, the game treatment group demonstrates a minimum **35**% reduction (averaged across subjects, across all biases) in observed cognitive bias compared to pre-test
  - Game treatment effects are better than the control group, at immediate post test and at 8 weeks
  - Verification & Validation Team replicates results
- Continuation review at end of Phase 1 (“Leveling Up”)

Milestones & Metrics – Phase 2a

- Programmatic Final Exams (Phase 2a):
  - IRB approvals
  - Verification & Validation Team reviews of research design & test instruments
  - Successful demonstration of all planned game capabilities
  - Delivery of alpha game, documentation, and Phase 2a report
- Technical Final Exams (Phase 2a):
  - Play-testing prior to experimentation (pass/fail)
  - Demonstrated engagement (individual minimums >75% of play session & average over all subjects >90% of play session)
  - Prove/disprove the null hypothesis that games have no effect on recognition and mitigation of cognitive biases via statistically significant post-test compared to control group and pre-test
  - Game treatment demonstrates practical significance via a minimum **75**% reduction (averaged across subjects, across all biases) in observed cognitive bias compared to pre-test. Researchers should also report the average reduction (across subjects) for each bias.
  - At 12 weeks after initial treatment, the game treatment group demonstrates a minimum **65**% reduction (averaged across subjects, across all biases) in observed cognitive bias compared to pre-test
  - Game treatment effects are better than the control group, at immediate post test and at 12 weeks
  - Verification & Validation Team replicates results

Milestones & Metrics – Phase 2b

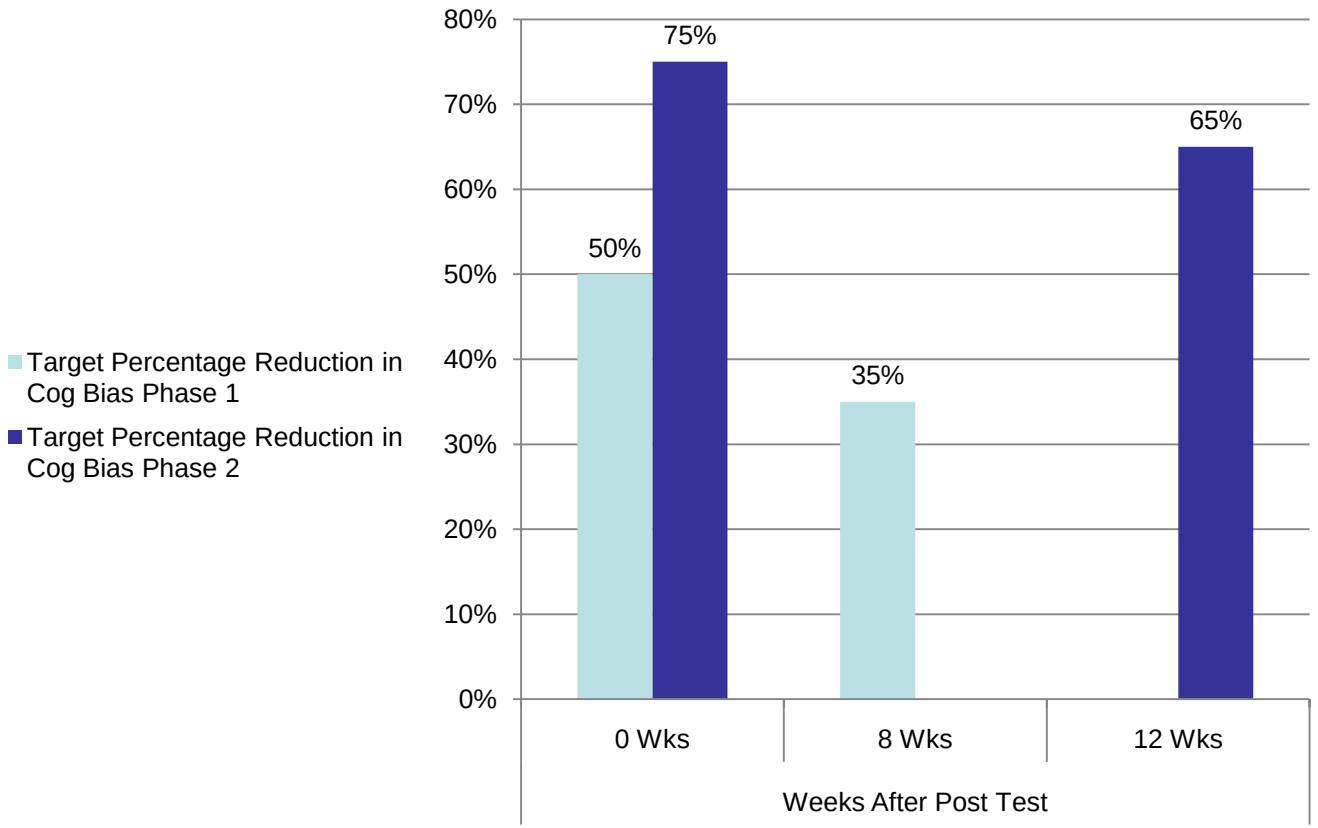
- Programmatic Final Exams (Phase 2b):
  - Successful demonstration of all planned game capabilities
  - Delivery of beta game, documentation, and Phase 2b report
- Technical Final Exams (Phase 2b):
  - Play-testing of beta game (pass/fail)
  - Pilot testing of beta games by the government team demonstrates cognitive bias reductions equivalent to Phase 2a results (pass/fail)

Note that the BAA will contain detailed information on required milestones for all Phases. These various milestones will occur at approximately 3-month intervals

More on Metrics

- Researchers will create their own measurement scales, crafted to fit the particular biases that they are studying and the bias elicitation protocol that they are using
- The standard measurement instrument will be developed by a Government/FFRDC/UARC team and used by the IV&V team
- Target average reductions (across all subjects, across all biases) must be achieved using a statistically significant N
  - it is not sufficient to demonstrate an average 50% reduction with N=2, for example
  - reduction in just 2 individuals is a case study, not a valid experiment

Target Metrics



QUESTIONS?

Award Information

Award Plan

- 4 year Program starting FY4Q2011
  - Phase 1 – Base Period - 24 months
  - Phase 2a – Option Period - 18 months
  - Phase 2b – Option Period – 6 months
- Phase 1 performance is critical to participation in Phase 2
- Multiple awards anticipated, depending upon
  - Quality of the proposals received
  - Availability of funds

Eligibility Information

Eligible Applicants

- Collaborative efforts/teaming strongly encouraged
  - Content, communications, networking, and team formation -responsibility of proposers
- Foreign organizations and/or individuals may participate
  - Must comply with Non-Disclosure Agreements, Security Regulations, Export Control Laws, etc, as appropriate

Ineligible Organizations

- Other Government Agencies, Federally Funded Research and Development Centers (FFRDCs), University Affiliated Research Centers (UARCs), and any organizations that have a special relationship with the Government, including access to privileged and/or proprietary information, or access to Government equipment or real property, are not eligible to submit proposals under this BAA or participate as team members under proposals submitted by eligible entities

Organizational Conflict of Interest

- If a prospective offeror, or any of its proposed subcontractor teammates, believes that a potential conflict of interest exists or may exist (whether organizational or otherwise), the offeror should promptly raise the issue with IARPA and submit a waiver request by e-mail to the mailbox address for this BAA at dni-iarpa-baa-11-03@ugov.gov. A potential conflict of interest includes but is not limited to any instance where an offeror, or any of its proposed subcontractor teammates, is providing either scientific, engineering and technical assistance (SETA) or technical consultation to IARPA. In all cases, the offeror shall identify the contract under which the SETA or consultant support is being provided. Without a waiver from the IARPA Director, neither an offeror, nor its proposed subcontractor teammates, can simultaneously provide SETA support or technical consultation to IARPA and compete or perform as a Performer under this solicitation.

Application Review Information

Evaluation Criteria

Evaluation criteria in descending order of importance are:

- Overall Scientific and Technical Merit
- Effectiveness of Proposed Work Plan
- Relevance to IARPA Mission and Sirius Program Goals
- Relevant Experience and Expertise
- Cost Realism

Relevant Experience & Expertise Criteria

- Successful teams must be multidisciplinary, with a variety of scientific and game development job titles, such as:
  - Project Manager
  - Social/Behavioral Science/Ed Psych Researcher
  - Statistician
  - Instructional Designer/Researcher
  - Game Designer
  - Game Developer
  - Game Artist
  - Game Tester
  - Intelligence Community SME

Publication

- Publication of results of the research project in appropriate professional journals is encouraged as an important method of recording and reporting scientific information.
- One courtesy copy of all papers and/or charts to be presented in any public forum must be submitted to the IARPA Program Manager at least two calendar weeks prior to publication.
- Following publication, final copies of published papers and charts must be submitted to the IARPA Program Manager and Contracting Officer's Representative

Point of Contact

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Thank You!
Any Final Questions?

BACK UPS

Definition of Terms

Definitions

- **Serious Games**: Serious games are designed for the purpose of solving a problem. Whereas entertainment video games are classified by genre of gameplay, serious games are categorized by their purpose such as: education, training, policy, or strategy. Although serious games may employ entertainment gameplay to achieve their purpose, reward systems and gameplay are structured and internally constrained to focus the user on the concepts or material to be internalized and learned. Serious games may also incorporate elements of structured techniques or simulation.
- **Simulations:** In general, simulations are designed to train users in specific physical procedures or structured thought processes. They generally model the training domain with as much fidelity as possible and are internally constrained by physics or technology. Constraints on the user are typically externally supplied by the procedures or techniques to be learned.
- **Virtual Learning Environments** are Serious Games, or Simulations that provide an interactive, digital model of the training or learning domain of interest. The objective of VLEs is “learning by doing” and helping the student internalize new knowledge and integrate it with their existing knowledge. VLEs are designed to provide users with rewards and consequences for their behavior. The fidelity of VLEs depends on their purpose. For many games the simplest fidelity may be sufficient to maintain engagement and learning. Simulations on the other hand generally require higher levels of fidelity and verisimilitude to stimulate desired learning and training effects.

Definitions

- **Immersion:** For Sirius research, immersion is the extent to which the computer system delivers a surrounding environment that is more salient than the RW , that accommodates multiple sensory modalities, and that has a rich representational capability
- **Engagement:** When a player is interested in the game, attends to events, and wants to keep playing, that player is engaged. Engagement can be qualitatively observed and coded, or quantitatively measured (e.g., eye tracking). Overall engagement can be expressed as a percentage of total play time. To get to the point of engagement players must like the content, have some type of emotional connection, be motivated to succeed, and not be distracted. Engagement can be enhanced or disrupted by the design of the game and the learning task.
- **Presence:** The player's awareness of the game environment and whether or not the expected perceptions are consistent with sensory inputs. In this respect, presence has three main components:
  - Sense of "being there" in the game environment
  - Inclination to respond to events in the game environment rather than the RW environment (i.e., events precipitated by the computer and game generated environment dominate over those in the RW)
  - The learner's memory of the virtual components of the environment as being part of the whole environment, rather than distinguishing "virtual" parts from "real" parts. This particularly applies to augmented reality games (ARGs)

Definitions

- **Cognitive Bias**: Cognitive biases are the result of heuristic processes humans have evolved to quickly make sense of the world. These biases in thinking are both innate and learned. The tendency to form heuristics from our perceptions is a primary function of normal human cognition and enables us to process ambiguous or uncertain situations. Cognitive biases cannot be eliminated, but may be mitigated by awareness, collaboration, and critical or procedural thinking processes.
- **Structured Analytic Techniques:** Step-by-step processes designed to mitigate potential cognitive biases and externalize the analyst's thinking in a manner that promotes review, critique, collaboration and structured analysis by groups.

Definitions

Phase 1:

- **Confirmation Bias:** The tendency to search for or interpret information in a way that confirms one's preconceptions. Often preceded by priming.
- **Fundamental Attribution Error:** The tendency for people to over-emphasize personality-based explanations for behaviors observed in others while under-emphasizing the role and power of situational influences on the same behavior (also called attribution bias)
- **Bias blind spot:** We do not have conscious access to our own cognitive biases. Knowledge of particular biases in human judgment and inference, the ability to recognize the impact of those biases on others and the ability to recognize those biases in others does not prevent an individual from succumbing to cognitive biases or have awareness of doing so.

Definitions

Phase 2:

- **Anchoring Bias:** the common human tendency to rely too heavily, or "anchor," on one trait or piece of information when making decisions (related to focalism or focusing illusion)
- **Representativeness Bias:** The tendency for people to judge the probability or frequency of a hypothesis by considering how much the hypothesis resembles available data. Also sometimes referred to as the “small numbers” bias
- **Projection Bias**: the tendency to unconsciously assume that others (or one's future selves) share one's current emotional states, thoughts and values.