

Cognitive Science Applications to International Nuclear Safeguards Inspections

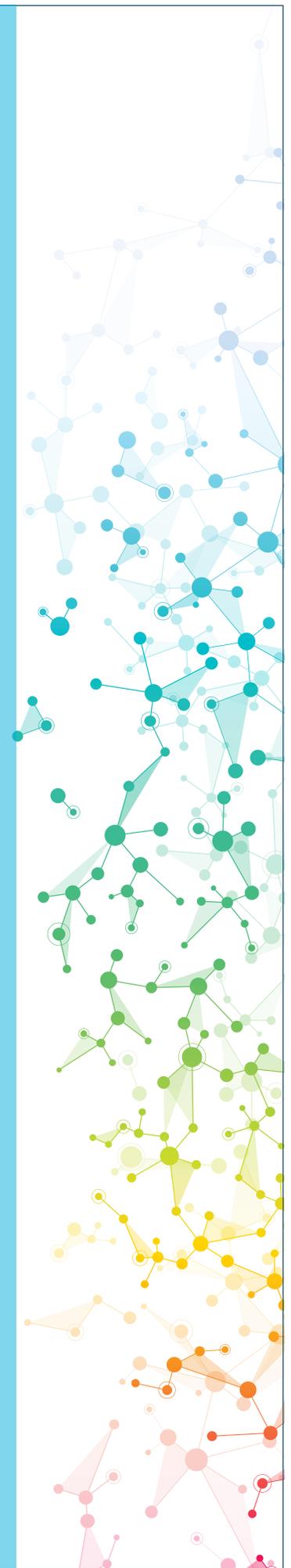


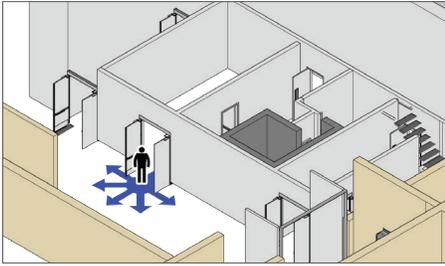
In today's Information Age, more data is being created, shared, and analyzed than any other time in history. Some of that data is potentially relevant for international nuclear safeguards – the collection of measures and methods used to verify that states are using their nuclear programs only for their declared, peaceful purpose – but providing even a small portion of this emerging information could result in massive amounts of data for International Atomic Energy Agency (IAEA) safeguards inspectors.

Cognitive science research shows that excessive access to information can be confusing, frustrating, or distracting. For international nuclear safeguards inspectors conducting in-field verification activities, too much information, or information presented in a confusing way may lead to inspection errors or omissions. Sandia's multidisciplinary team of experts is applying fundamental principles of cognitive neuroscience to the field of international nuclear safeguards, specifically by evaluating the type and quantity of safeguards information used by inspectors and how to most effectively convey that information. By conducting human performance tests using safeguards-like activities, Sandia can make recommendations that could improve the accuracy, timeliness, and situational awareness of safeguards inspectors working in the field.

What it Means

Human observers tend to miss changes that occur right in front of them. Known as **Inattentional Blindness**, this concept demonstrates that a change to stimuli considered to be in plain sight can be missed by an observer who is focused on one demanding task. Recent research has focused on humans in real-world contexts (rather than laboratories) and is showing that inattentional blindness occurs often and in many circumstances for even the most diligent people. For international nuclear safeguards, inattentional blindness principles indicate that even highly focused safeguards inspectors may miss key information from their environment.





Wayfinding is a form of spatial cognition in which people determine where they are in an environment and how to navigate to where they want to go. Wayfinding can include navigation by map, landmarks, or verbal/written directions outdoors or indoors. When safeguards inspectors are escorted from one part of a nuclear facility to another, they must rely on their wayfinding skills to determine if they have been led to the correct location, or if the route taken was circuitous or avoided certain areas.

Knowledge Transfer refers to sharing information and experience across different teams or parts of an organization. When one team hands off work to another, or when people move in or out of an organization, transferring knowledge is crucially important for maintaining continuity. Knowledge transfer is a critical component of international safeguards inspection activities. Facility expertise must be passed from experienced to newer inspectors and information obtained from in-field inspection activities must be passed from one inspector (or inspection team) to another over extended time periods as well as to IAEA Headquarters. The time frame of knowledge transfer for IAEA activities is much longer than for domains that have been studied in the past, such as shift changes for medical workers, making effective knowledge transfer more challenging.

What We Do

We design and execute novel human performance tests to measure the accuracy, timeliness, and situational awareness of participants in experiments that simulate in-field safeguards inspection scenarios. Our experiments are intended to determine the impact of how information is provided to, or recorded by, international safeguards inspectors working in the field so we can make recommendations on information visualizations, information provision mechanisms, record keeping, and training. We incorporate assessment techniques from across the field of cognitive science, including eye tracking, behavioral observations, memory tests, measures of situational awareness, and self-assessments.



Example screen from an eyetracking test in which we test how participants' performance on a list-matching activity changes with different presentations of the list. In this case, the list on the left is in random order, but each entry is color-coded depending on its expected location in the list on the right

The Team

Our research is a collaborative effort between subject matter experts on international nuclear safeguards and inspections and cognitive research scientists with expertise in experimental design, data science, and human visual perception and comprehension. This unique cooperation allows us to develop scientifically-based recommendations on training and information provision for international nuclear safeguards inspectors, and add significant new work to the cognitive science corpus encompassing information visualization, cognitive load, and memory.

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