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The Role of Maps in Site Knowledge and Wayfinding: A Human Performance Evaluation for International Nuclear Safeguards Inspections

PRESENTED BY

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Overview

Background

Research Question

Experimental Conditions

Tasks

Results

Additional Experiments

Discussion


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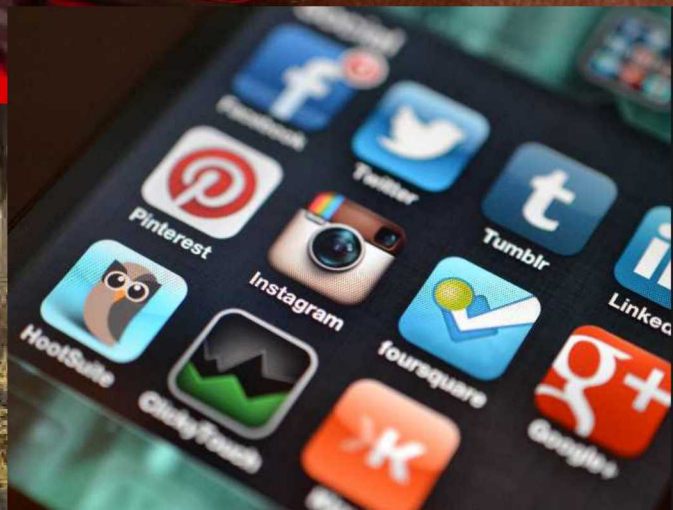
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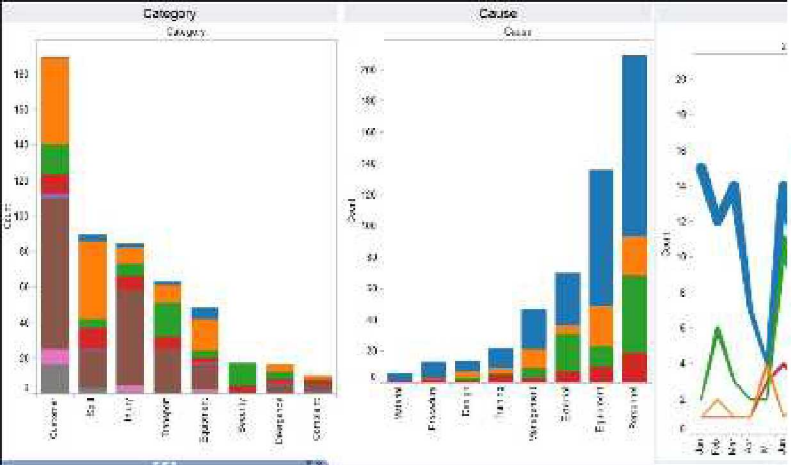
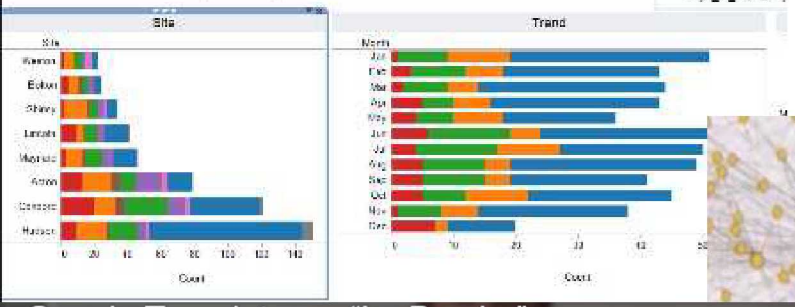
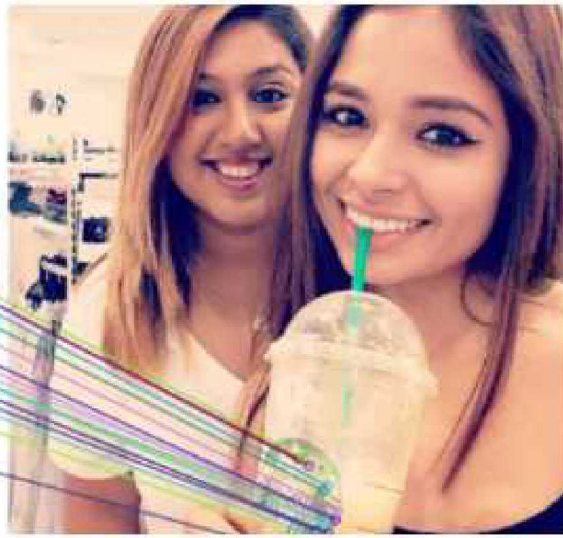
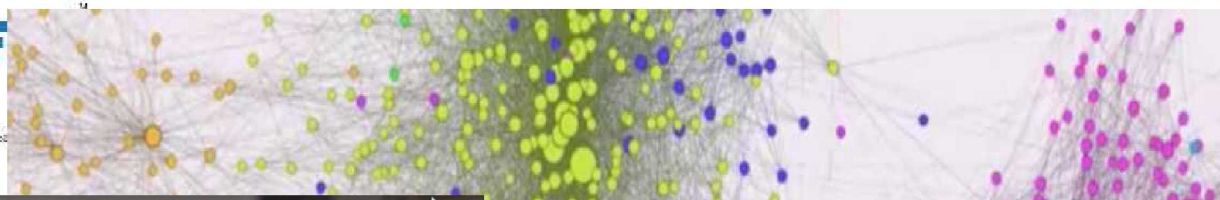

Category
Cause


Site
Trend


STARBUCKS
COFFEE



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UNA POCA
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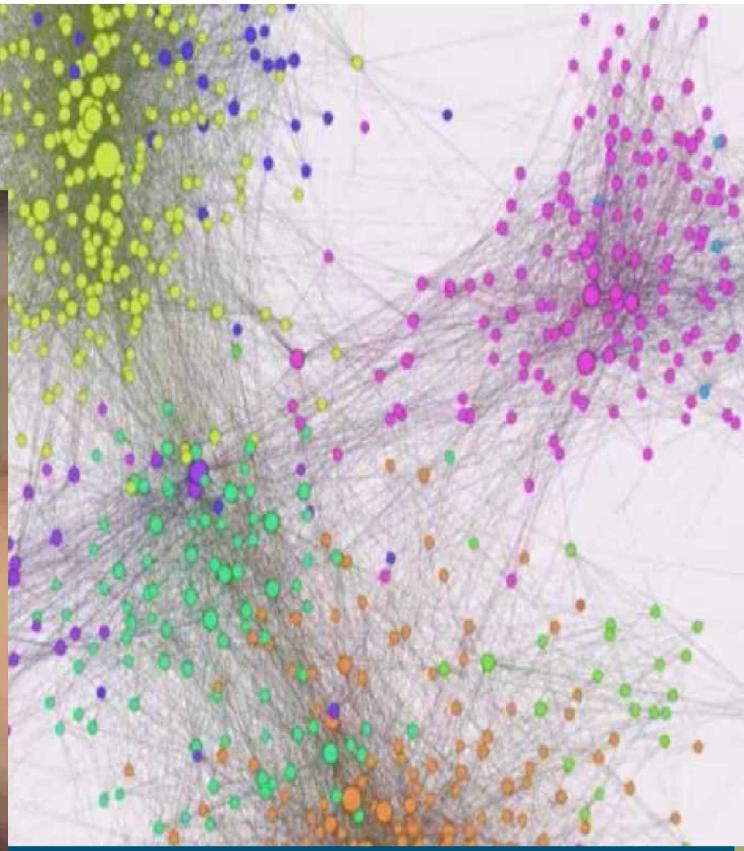
A LITTLE BIT
OF GRACE
0:33 / 1:40

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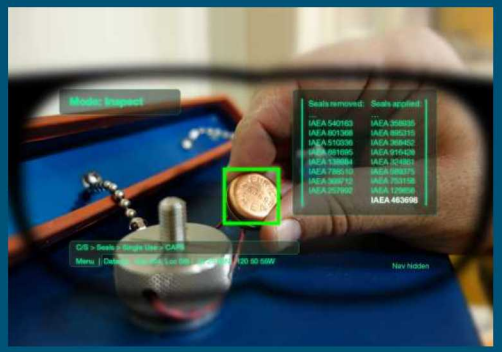
Background

Safeguards Information Model

Human Performance Testing

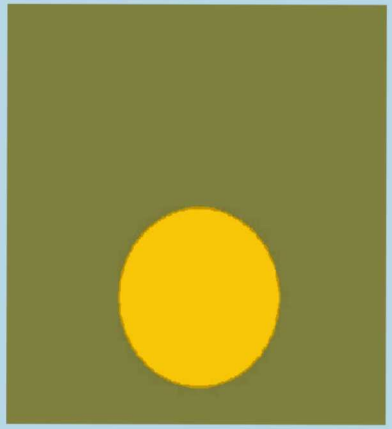
Theoretical Foundation



Cognitive Information System for international safeguards

Background: Focus Areas

Seal/Container		Room	Seal/Container		Room
845432	EF-36	A	894320	AB-41	B
864704	LM-80	A	881092	GI-89	B
847186	GI-82	A	827614	NP-12	C
884277	EF-39	A	858592	NP-09	C
864413	VZ-97	A	814835	HK-28	C
892115	LM-79	B	878348	HK-29	C
821045	NP-14	B	863497	HK-21	D
835983	EF-34	B	899508	VZ-55	D
835893	EF-38	B	863479	VZ-96	D



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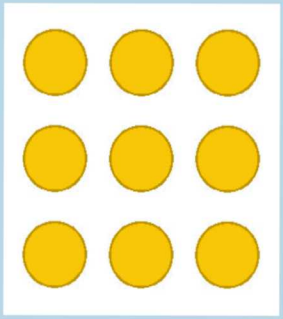
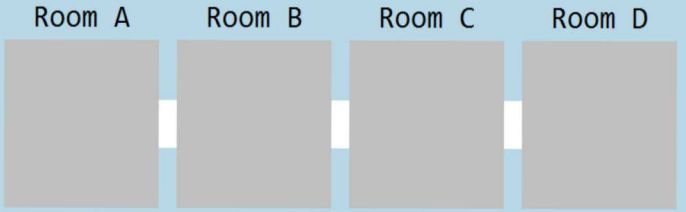
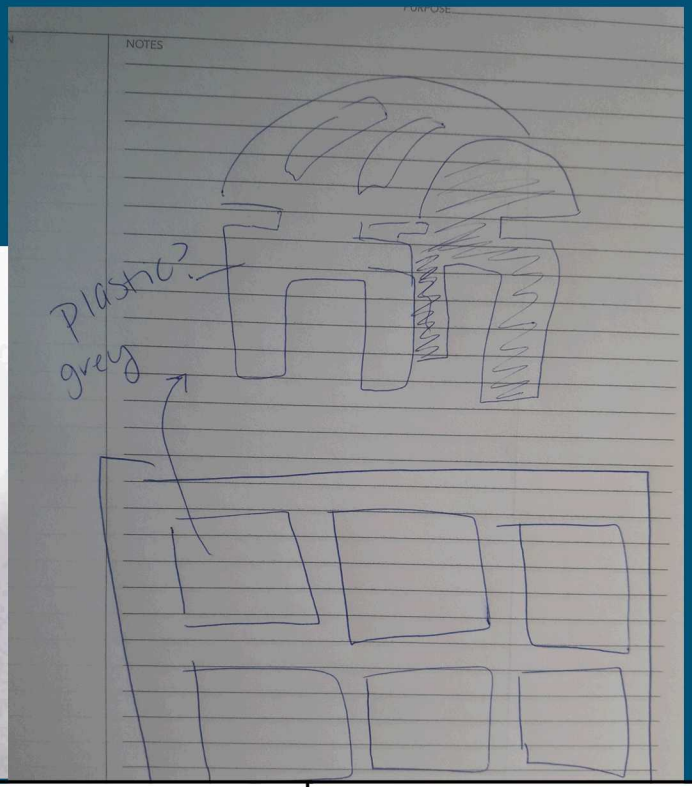




Inspection Complete

Color Change

Background: Focus Areas

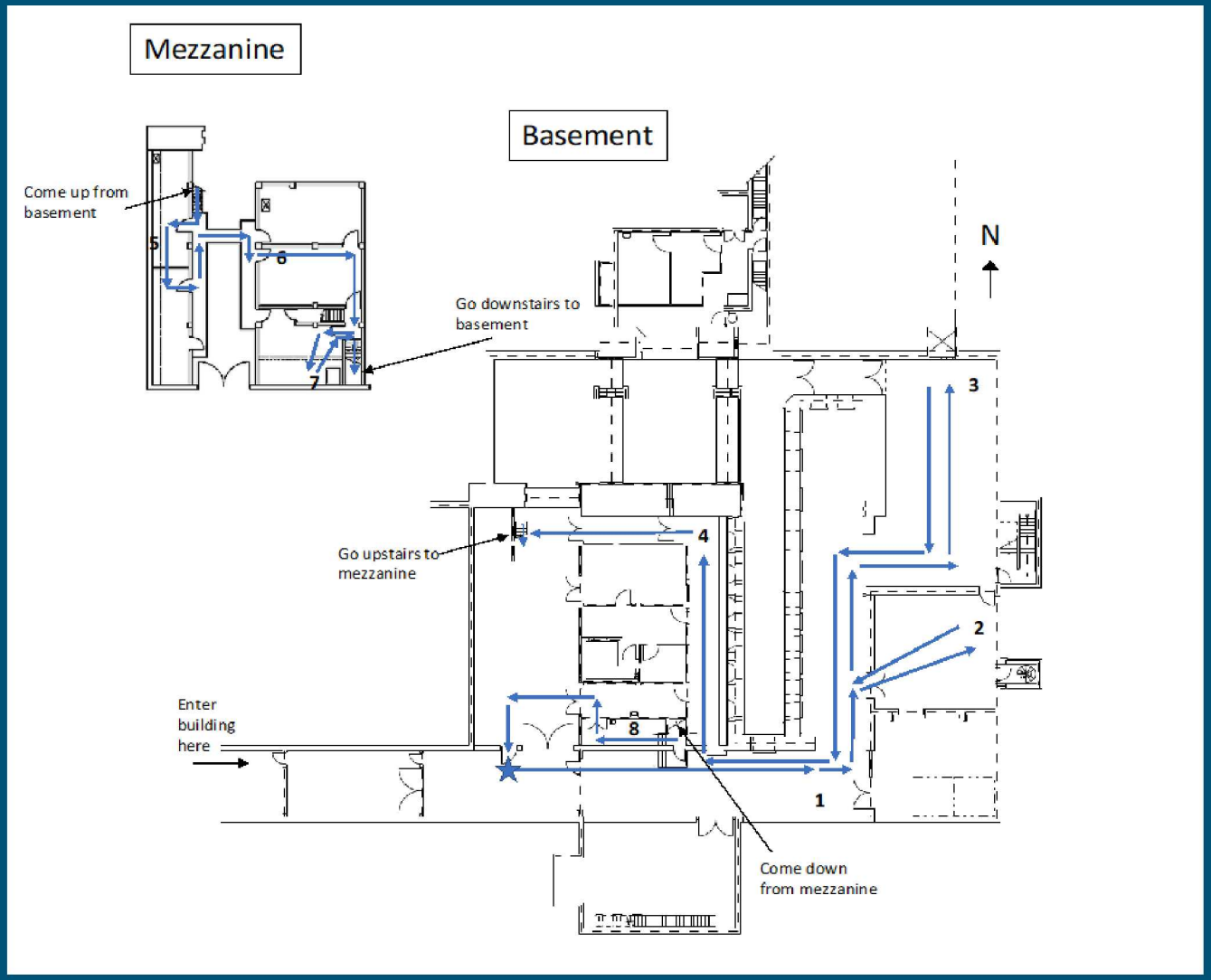


A

B

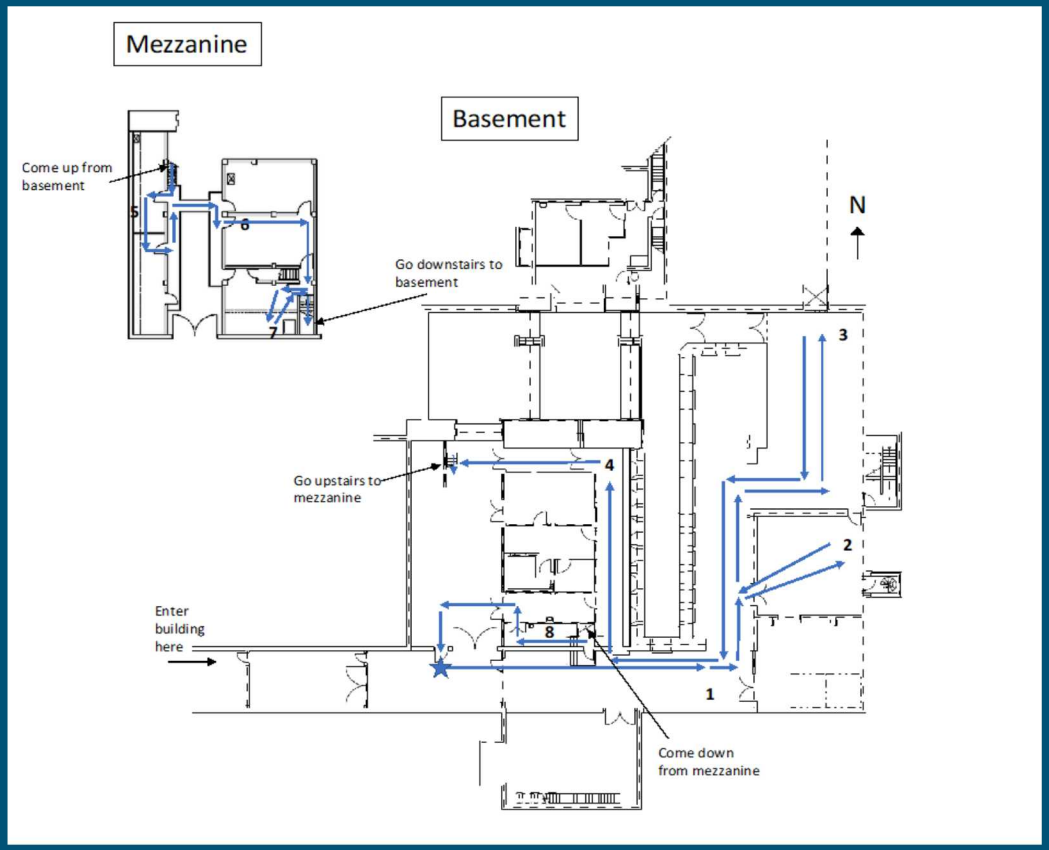
C

Background: Focus Areas



Wayfinding Research Question

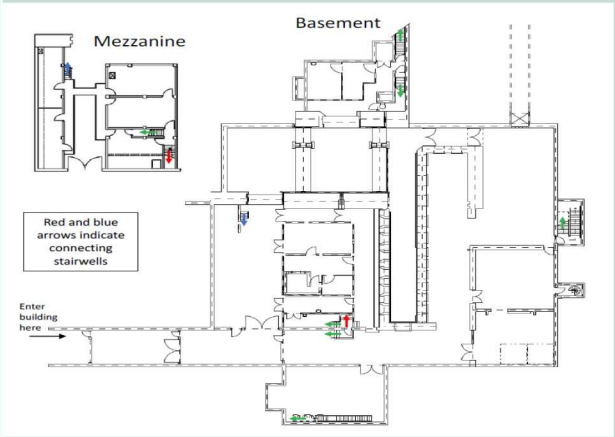
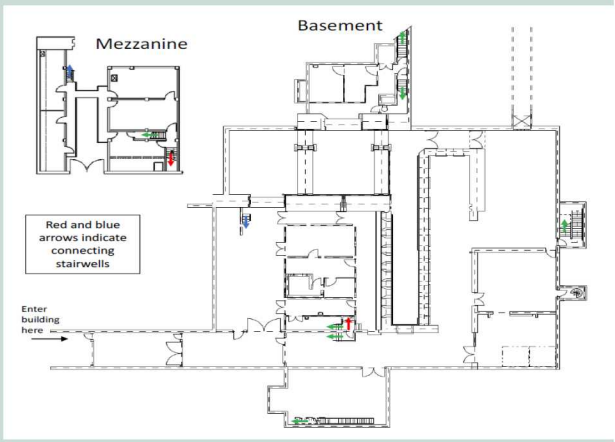
How does the presence and use of **map information** change a user's **understanding** of a complex industrial facility?



Landmarks

1. Manipulator mockup
2. Glove box
3. Overhead crane
4. Instrument cabinet
5. Atom art
6. Capped Pipe
7. Water meter
8. Dosimeter charger

Experimental Conditions

Study	Study + Carry	No Map
		

International Nuclear Safeguards and Inspections

International nuclear safeguards (hereafter "safeguards" or "international safeguards") are activities or agreements that provide assurance to the global community that States are using nuclear technologies for peaceful purposes. The technical objective of international safeguards is three-fold:

1) The detection of diversion of nuclear material from known (safeguarded) facilities
2) The misuse of safeguarded facilities for undeclared nuclear purposes
3) The development of undeclared nuclear facilities for undeclared nuclear activities

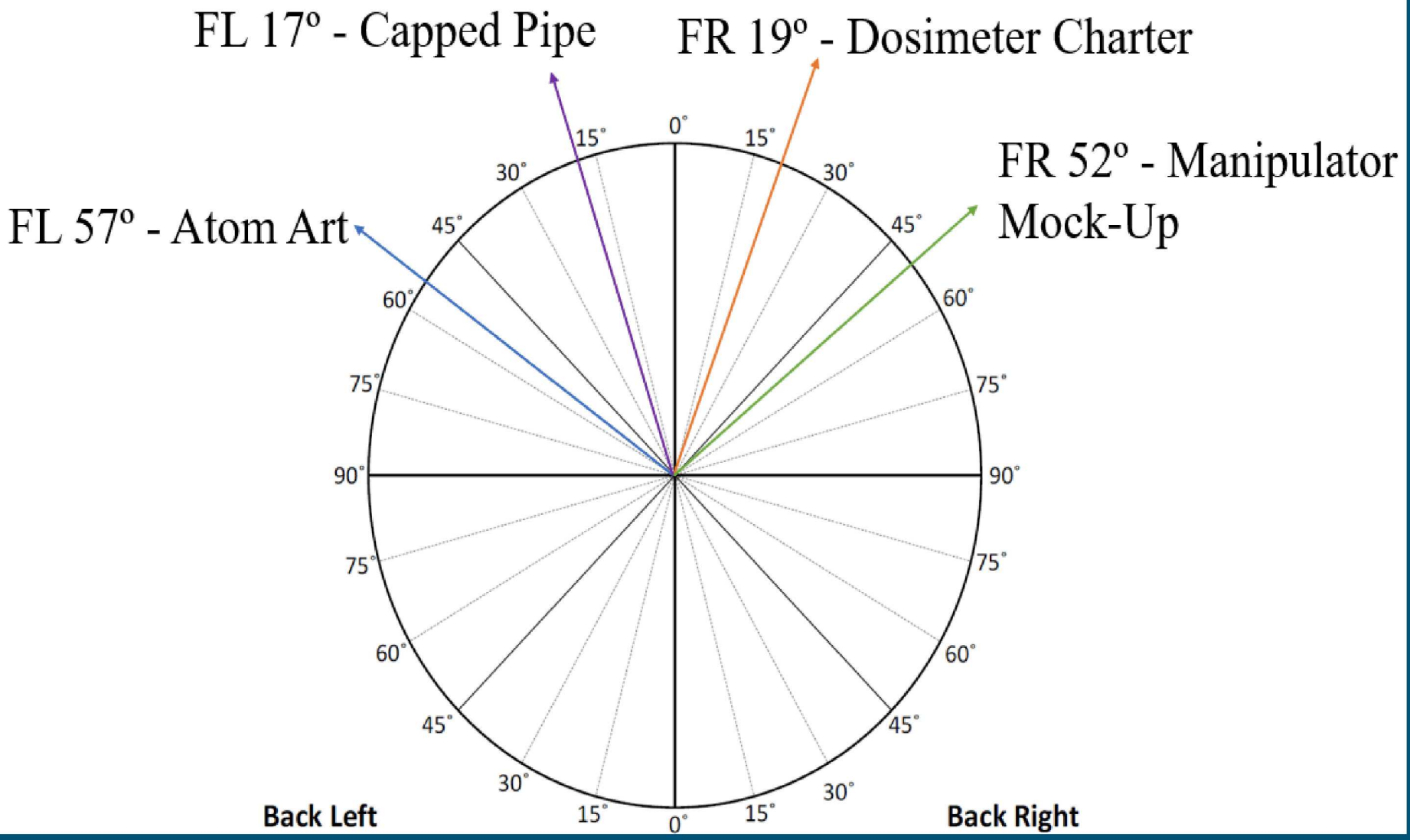
The International Atomic Energy Agency (IAEA), which operates under the auspices of the United Nations, is the agency tasked with verifying safeguards for those countries that have signed safeguards agreements. A State declares nuclear materials and facilities, and the IAEA periodically verifies the declaration. Verification of international safeguards is based on technical measures. The basic verification method used by the IAEA is nuclear material accountancy (NMA), achieved through nuclear materials measurements and examination of records and reports. The IAEA also inspects nuclear facilities to determine operational status, design, and production capacity. Containment and surveillance technologies (such as seals and cameras) are applied to maintain continuity of knowledge of nuclear materials, measurement equipment, and IAEA information systems between inspection intervals.

Specific inspection tasks may include:

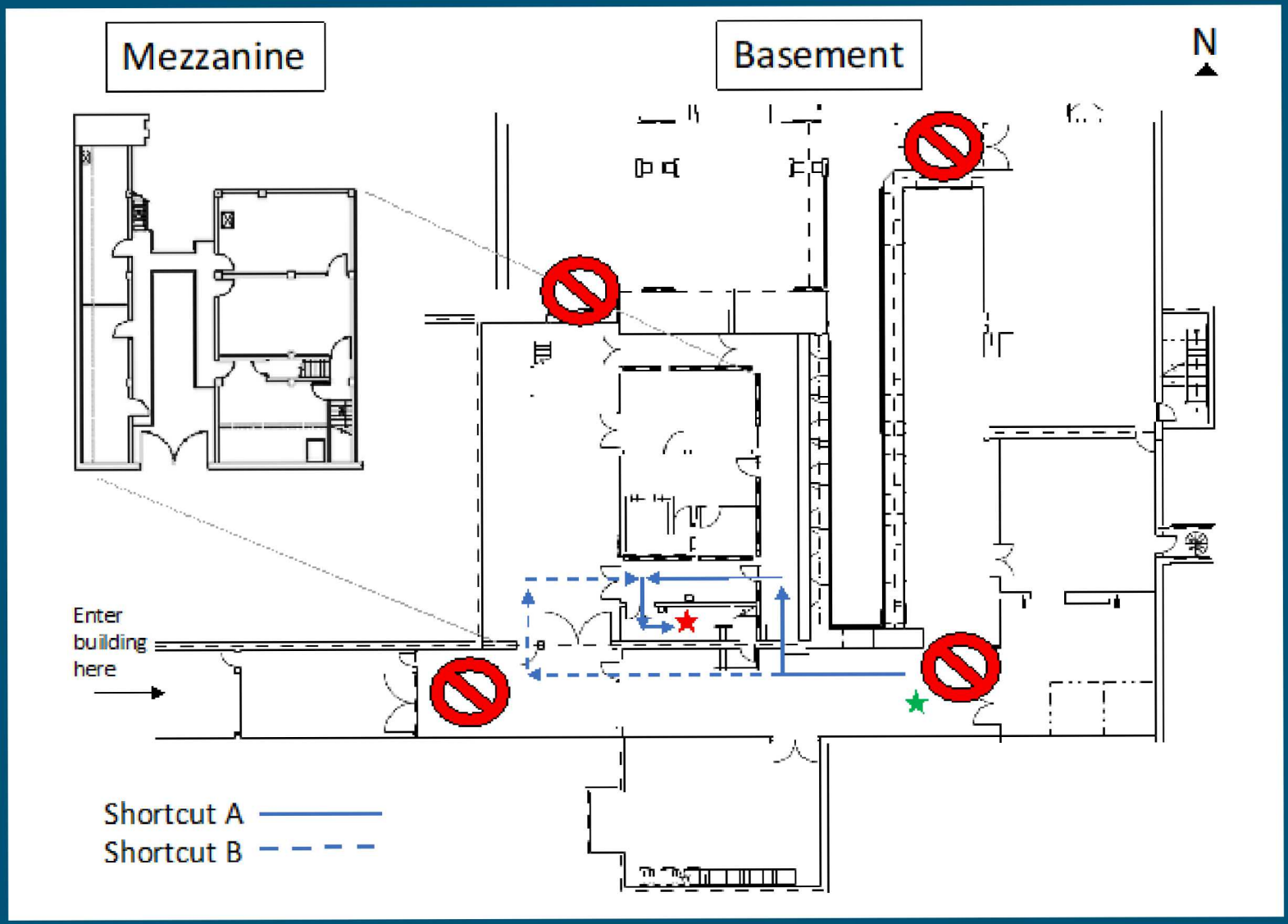
- verifying seals have not been tampered with and checking seal numbers on monitored items to inventory lists
- comparing State records with their declarations to the IAEA (i.e. book audit)
- taking material measurements using non-destructive and destructive assay
- looking for anomalies in a facility that may be indications of misuse

Upon culmination of a safeguards inspection, IAEA inspectors collect data, samples, and observations and work with a multi-disciplinary team at IAEA headquarters to determine if the nuclear material in a country is satisfactorily accounted for and if there is any indication of undeclared nuclear activities.

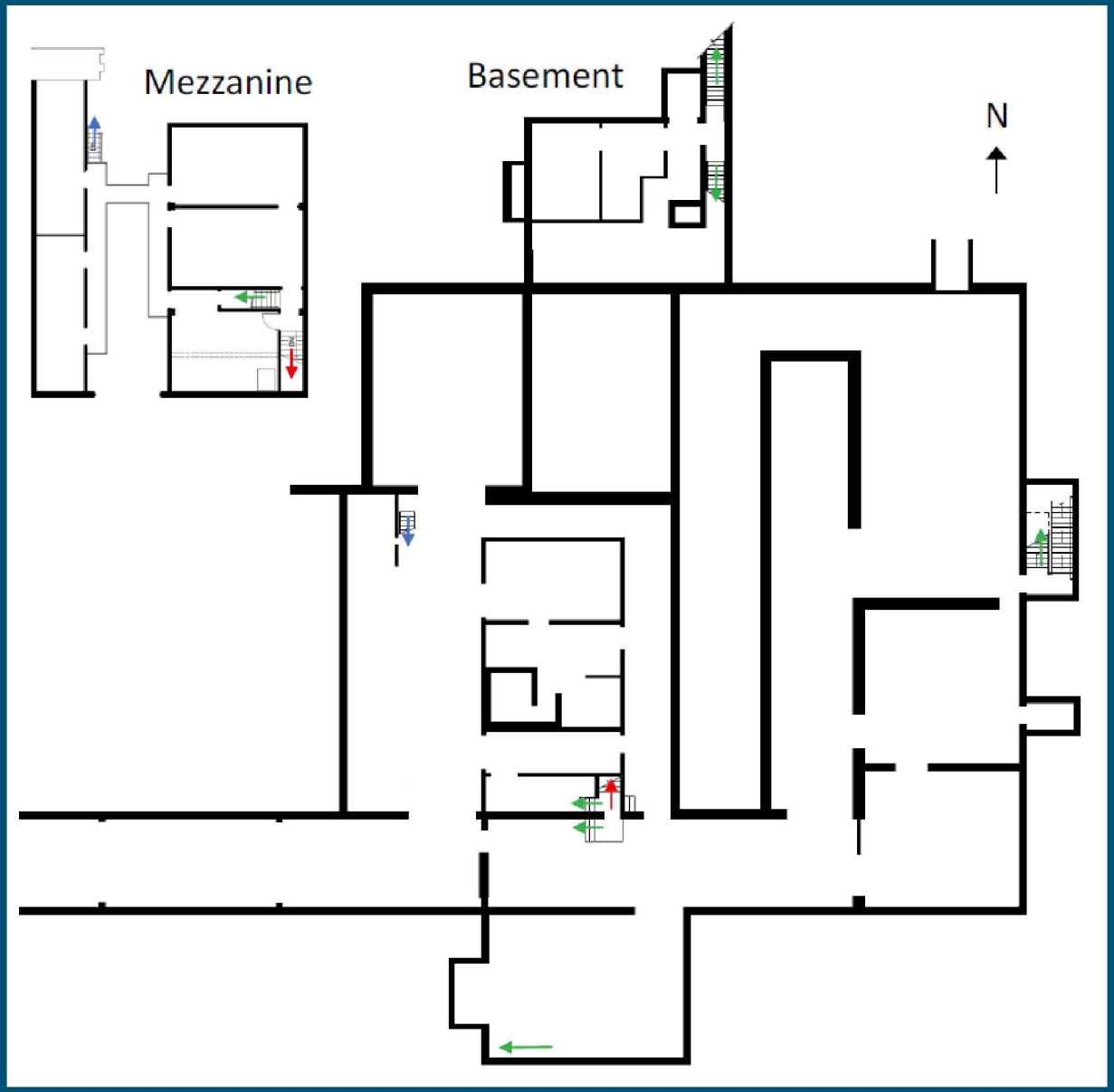
Task: Directional Pointing



Task: Shortcut



Task: Map Completion with Landmarks



Task: Landmark Recognition

Task: Santa Barbara Sense of Direction Scale

1. I am very good at giving directions.

strongly agree 1 2 3 4 5 6 7 strongly disagree

2. I have a poor memory for where I left things.

strongly agree 1 2 3 4 5 6 7 strongly disagree

3. I am very good at judging distances.

strongly agree 1 2 3 4 5 6 7 strongly disagree

4. My "sense of direction" is very good.

strongly agree 1 2 3 4 5 6 7 strongly disagree

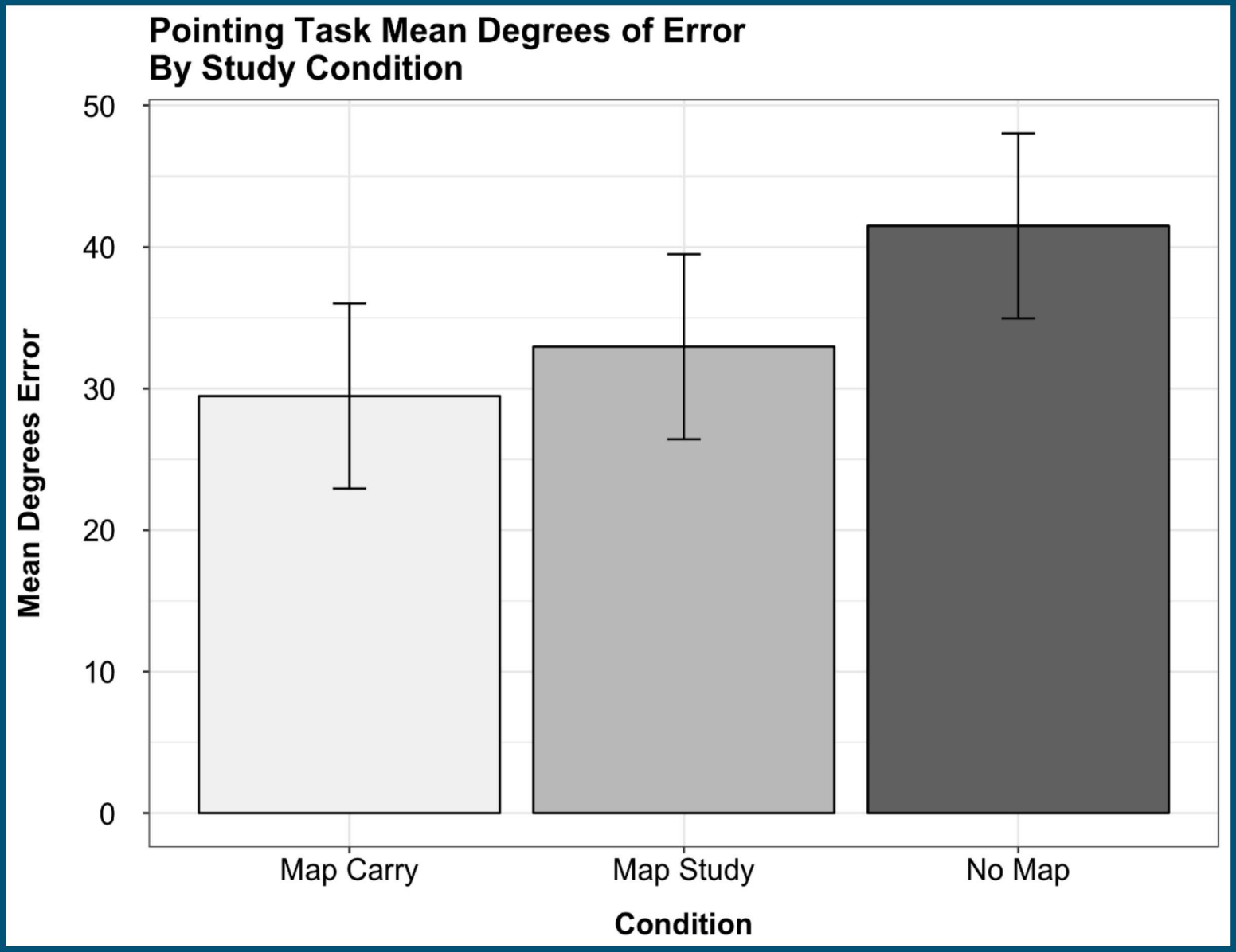
5. I tend to think of my environment in terms of cardinal directions (N, S, E, W).

strongly agree 1 2 3 4 5 6 7 strongly disagree

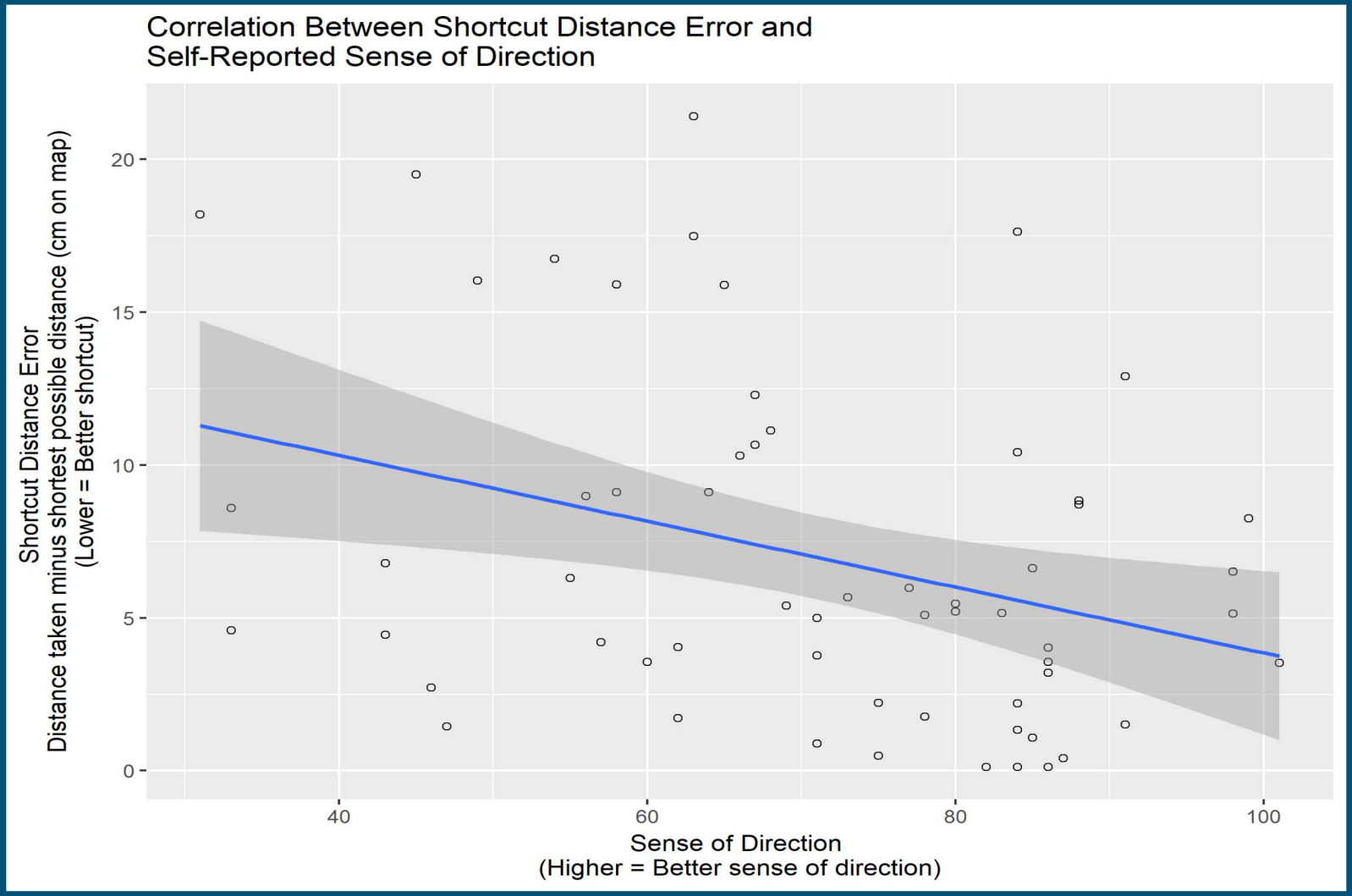
6. I very easily get lost in a new city.

strongly agree 1 2 3 4 5 6 7 strongly disagree

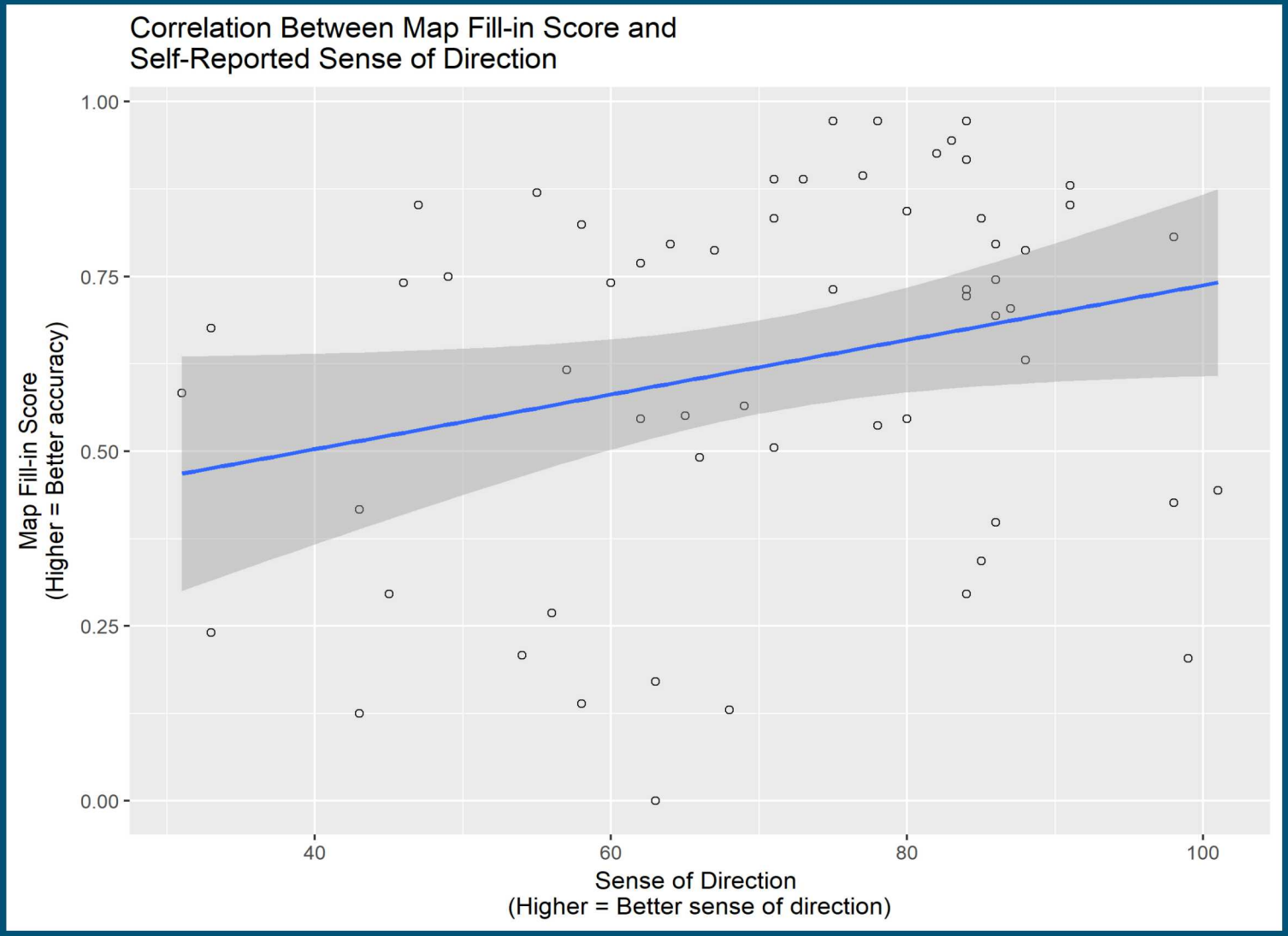
Results: Directional Pointing



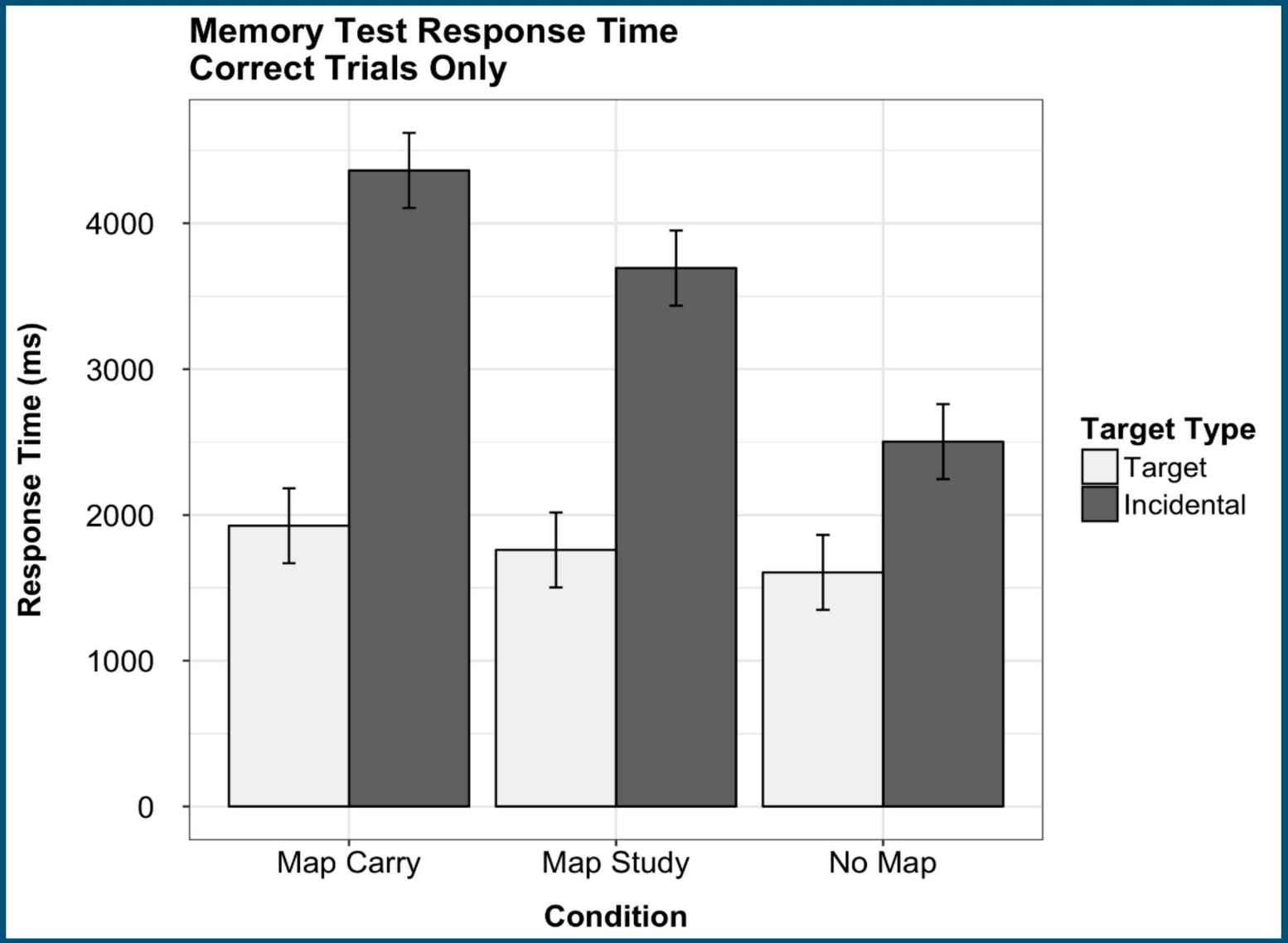
Results: Shortcuts



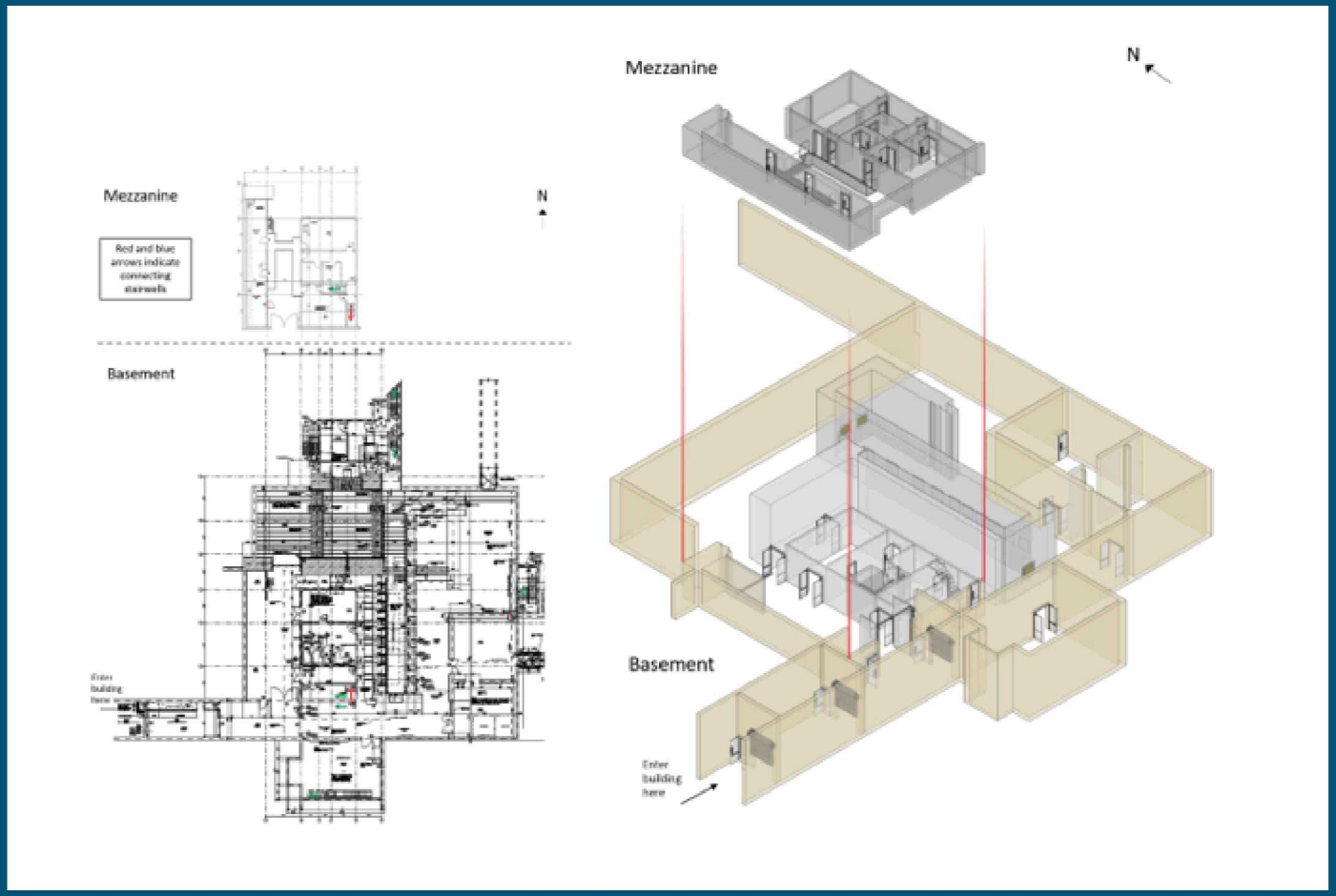
Results: Map Completion



Results: Landmark Recognition



Additional Experiments



Discussion

Many tasks were correlated with individual's sense of direction

In general, participants were able to accurately self-assess, especially for pointing task and map completion

Access to maps supported directional pointing

Map study and carry may have reduced situational awareness for landmark recognition

Want to Know More?

Approach/Overview:

- Testing Human Performance in Simulated In-Field Safeguards Information Environments. Gastelum, Matzen, Smartt, Horak, Solodov, Moyer, St. Pierre. Proceedings of the INMM Annual Meeting, July 2017.
- Brain Science and International Nuclear Safeguards: Implications from Cognitive Science and Human Factors Research on the Provision and Use of Safeguards-Relevant Information in the Field. Gastelum, Matzen, Smartt, Horak, Moyer, St. Pierre. ESARDA Bulletin, No. 54, June 2017.
- Human Performance Testing for Cognitive Science-Informed Information Provision for International Nuclear Safeguards Inspectors. Gastelum, Matzen, Smartt, Stites. IAEA Safeguards Symposium, November 2018.

Visual Inspection:

- Cognitive Science Evaluation of Safeguards Inspector List Comparison Activities Using Human Performance Testing. Gastelum, Matzen, Stites, Smartt. Proceedings of the INMM Annual Meeting, July 2018.
- The Impact of Information Presentation on Visual inspection Performance in the International Nuclear Safeguards Domain. Matzen, Stites, Smartt, Gastelum. (forthcoming) Proceedings of HCI International, July 2019

Wayfinding:

- The Role of Maps in Site Knowledge and Wayfinding: A Human Performance Evaluation for International Nuclear Safeguards Inspections. Gastelum, Stites, Matzen, Smartt. (forthcoming) Proceedings of the ESARDA Symposium, May 2019.

Knowledge Transfer:

- Human Performance Testing on Observation Capture Methods for International Nuclear Safeguards Inspections: Transferring Knowledge from the Field to Headquarters and Back. Gastelum, Matzen, Stites, Smartt. (forthcoming) Proceedings of the INMM Annual Meeting, July 2019.
- Effects of Note-Taking Method on Knowledge Transfer in Inspection Tasks. Stites, Matzen, Smartt, Gastelum.(forthcoming) Proceedings of HCI International, July 2019