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Formal methods of Countering Deception and Misperception in Intelligence Analysis

by

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Deception vs. Misperception?

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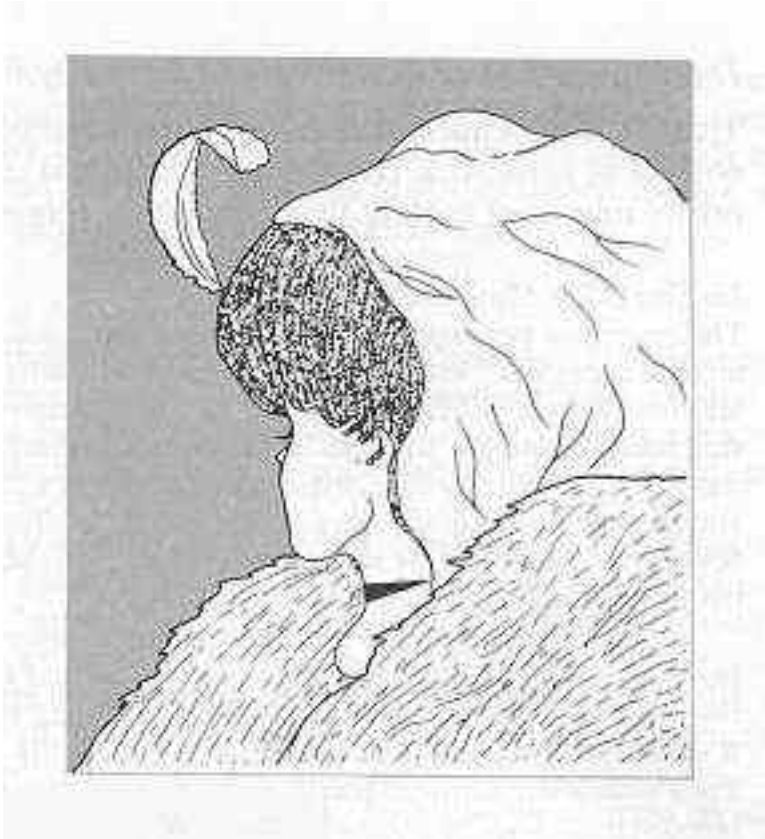
Misperception

- A false perception whereby the perceiver erroneously believes some aspect of the world to be in some state

Deception

- A type of misperception characterised by the intentional act of causing misperception in another



Why does Deception work?

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Fact

- Every human being has the same ‘hard-wired’ perceptual and cognitive biases, and limitations on working memory.
- Our expectations and experiences have a lasting and direct effect on our future judgements.

Therefore

- We fail to correctly reason about alternatives that do not align with our expectations;
- We assign and judge evidence according to our expectations and our experiences.

Assimilation Bias

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At what point did you perceive a change from a man's face change into a woman's body?

Look at the man's face ...

Once formed, mental models are resistant to change

Some sources of misperception

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- Inadequate hypotheses formation
  - ‘Failure of imagination’
- Cognitive biases and limitations
  - Availability, Anchoring, Confirmation biases
- Unreliable sources of information
  - Untested and misjudged, or deceptive sources
- Exclusion of ‘weak’ indicators from analysis
  - Complexity of analysis vs. Limitations of working memory
- Over/under-confidence in time-sensitive information
  - If ‘X’ was at ‘P’ at time t_0, what is the likelihood at time t_1?

Formal methods can help with these

Detecting deception and misperception

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- Consider deception as explicit hypothesis during analysis
  - Relies on analyst to consider deception
  - Can be cumbersome since a large number of possible hypotheses can be generated
  - Does not protect against general misperception
- Generate indicators of misperception/deception as standard part of analysis
  - Does not rely on analyst explicitly modelling possibility of deception
  - Explicit deception hypotheses can still be considered
  - Helps to protect against general misperception

Support for indicators within ACH-SL

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Diagnosticity

How well an item of evidence is capable of distinguishing between hypotheses.

Sensitivity

The relative influence of a single item of evidence on the results for a hypothesis. It provides an indication of the degree to which the value of the result could change if the item of evidence were to alter in value.

Support

The degree to which the value of an item of evidence supports or opposes the overall result for a hypothesis.

Concordance

The agreement for a hypothesis result with all the result values of the items of evidence.

Consistency

How consistently the result values of each item of evidence support the hypothesis result.

Example uses

Low consistency of a result *and* low concordance for one or two items of evidence (coupled with high certainty of a result) could indicate:

- Possible attempted deception, or misperception due to unreliable sources.
- Examination of sensitivity -- particularly of evidence with low concordance -- may reveal sources of questionable reliability.

Low consistency of more than one result could indicate the hypotheses have poor explanatory value due to:

- Inadequate hypotheses formation; or,
- Significantly flawed or weak analytical model of relationship between evidence and hypotheses.

Value of weak diagnostic evidence

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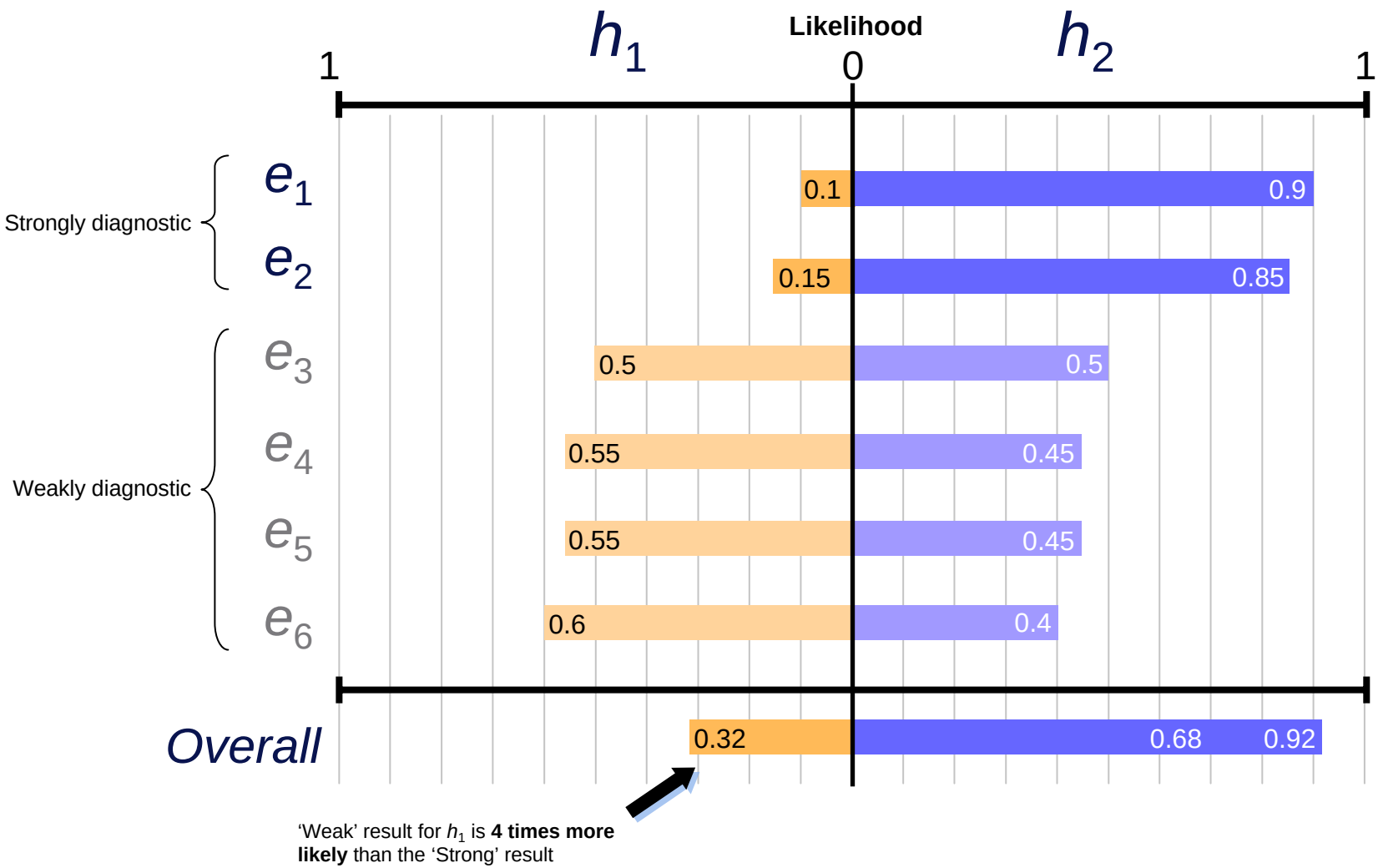

'Weak' result for h_1 is **4 times more likely** than the 'Strong' result

Support and Consistency

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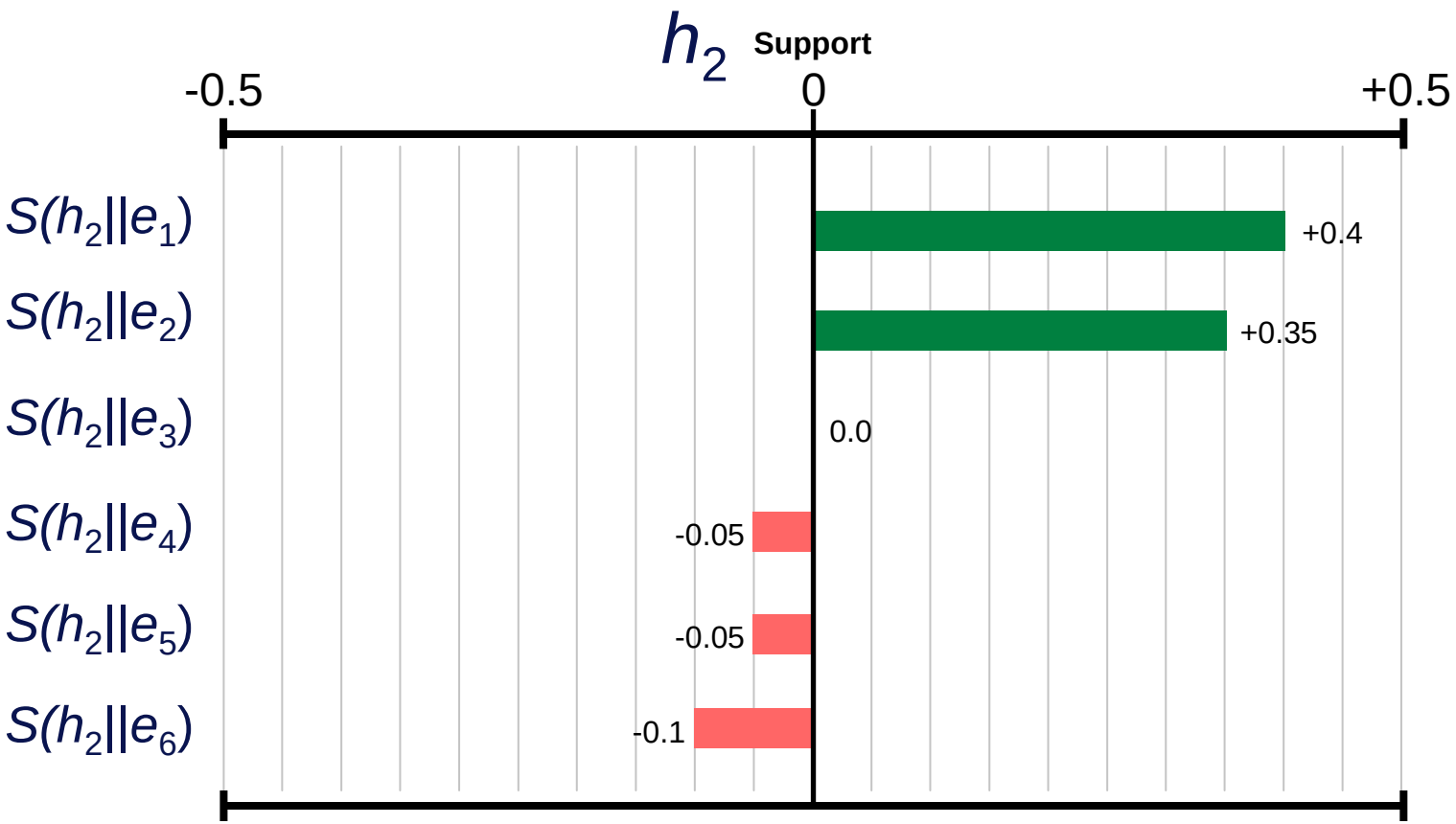

Consistency of result for h_2 = 0.785

Mitigating deception and misperception

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- Assign correct reliability to sources
  - Reliability varies across sources, changes over time, and varies with type of information provided.
- Original Source vs Intermediate Source
  - E.g. Witness to a robbery is an ‘original source’, the newspaper quoting her account of the robbery is an ‘intermediate’ source.
- Use multiple sources for each item of evidence

Effects of source reliability

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Single path to source

QuickTime™ and a
BMP decompressor
are needed to see this picture.

Information that is passed along a source chain may have been altered by the intermediate sources. If these sources are not reliable, then the certainty (or confidence) in the veracity of the information decreases.

Multiple paths to source

QuickTime™ and a
BMP decompressor
are needed to see this picture.

If the same information that is received from two (or more) independent intermediate sources, then the certainty in the veracity of the information is greater than for a single intermediate source.

Differing reliability and credibility

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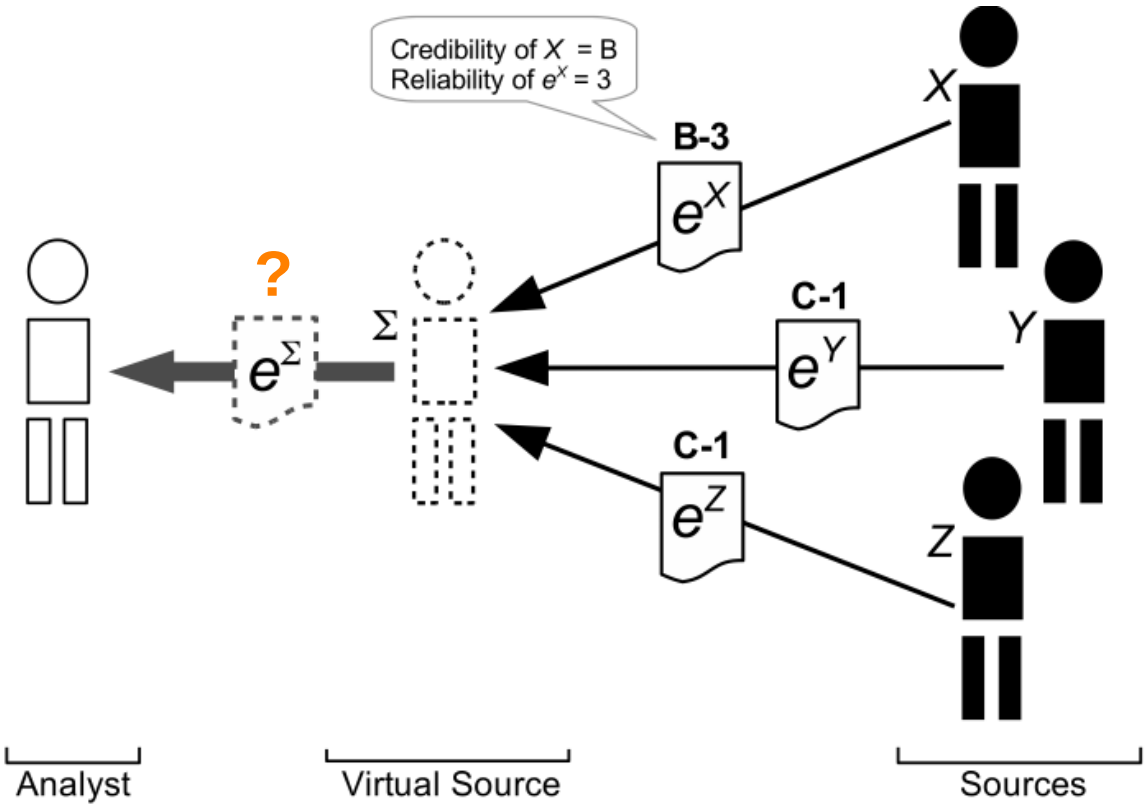
Example Admiralty Scale

Reliability	
A	Almost always reliable
B	Usually reliable
C	Fairly reliable
D	Fairly unreliable
E	Unreliable

Credibility	
1	Almost certainly true
2	Likely
3	Chances about even
4	Unlikely
5	Almost certainly false



Each source's reliability varies -- and so does the strength of the information that they provide. Some information may be presented as little more than rumor or gossip -- others may be presented as information gleaned from conversations with knowledgeable people -- others still may be in the possession of highly credible documents that answer the question definitively. So, how do we resolve it?

Decay of time-sensitive information

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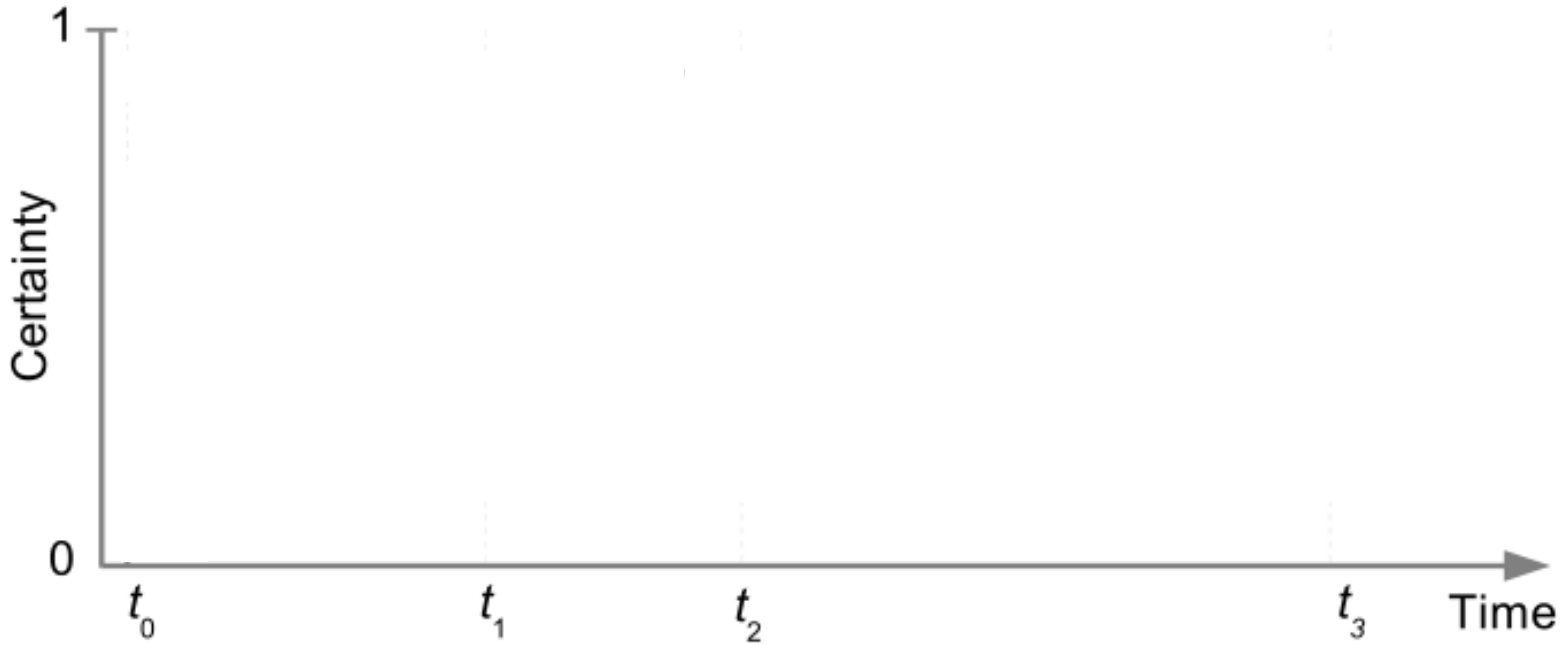

If we observe that “John is at home” at 9:00am, we will in general be less certain that this is still true at 12:00pm, and far less certain at 3:00pm. If we periodically observe John’s location over the course of the day, then the belief that “John is at home” will vary over the entire course of the day.

The effect of belief decay can have a large effect on the results of analysis, as the certainty and likelihood of evidence (and therefore hypotheses) change as a result.

Summary

- Misperception and deception can be mitigated through:
  - Formal analytical methods, such as ACH-SL
  - Using metrics which are indicative of misperception and deception
  - Accurately modelling source reliability and information credibility
  - Effects of information decay for time-sensitive information
- Too complex to undertake manually
  - Technology support is needed
  - Embedded in prototype DSTO system S*h*EBA for estimative intelligence analysis
- Further research needed
  - Development of misperception indicators into a higher-level theory of counter-deception
  - Comprehensive empirical evaluation