

Limitations on the Use of Eye-Tracking Data to Understand Operator Awareness

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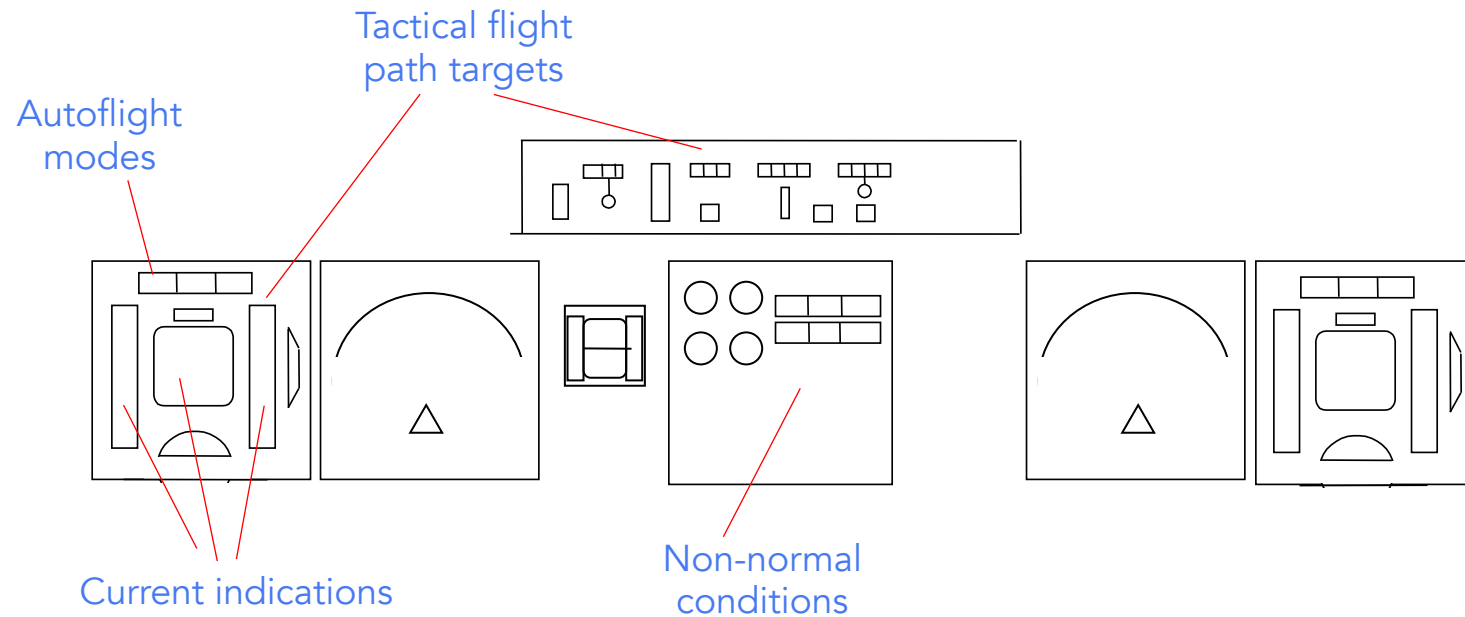
RESEARCH FOUNDATION

Airplane State Awareness

Mechanisms for awareness

Airplane State Awareness can include:

- Current indications: airspeed, altitude, pitch, bank, vert speed
- Current flight path targets
- Current and "next" autoflight states
- Airplane system faults, limitations
- Proximity to terrain, obstacles, weather



Airplane State Awareness

Accidents implicate “failures” in awareness

- ✈ Decreasing airspeed / increasing pitch on approach
 - Turkish Airways 1951
 - Asiana 214
- ✈ Excessive pitch down attitude
 - Atlas Air 3591
 - Armavia 967
- ✈ Large bank angle changes
 - Flash Airlines 604
 - Kenya Airways 507
- ✈ Autoflight state
 - Bhoja Air 213
 - Thomsonfly 3894

A Well-Documented Issue

A sample of studies and reports

- ✈ CAST (Commercial Aviation Safety Team) Airplane State Awareness work
- ✈ NASA's Post-CAST research activities (to develop flight deck aids)
- ✈ BEA ASAGA study (go-around maneuver)

And, by the way . . .

Issues other than AWARENESS were present in these accidents/incidents:

- Mode confusion / poor feedback
- Spatial disorientation
- Distractions
- Inappropriate control actions / intentional violations
- CRM

A Need to Assess Awareness

Technology to the rescue



Eye Fixation Measures in the Literature

✈ Eye Fixation

- Presence
 - Fixation dwell time
 - Percent dwell time
 - Event-triggered fixation
- Absence
 - Aol Neglect latency

✈ Area of Interest (Aol) Relevance

✈ Fixation Sequences / Scan Pattern

- Consistent pattern
- Explore / Exploit ratio

What are the Determinants of Awareness?

Psychologically . . .

Task and Attention Management

Mental State

Visual Attention

Auditory Attention

Expectations

Situation Model

Context

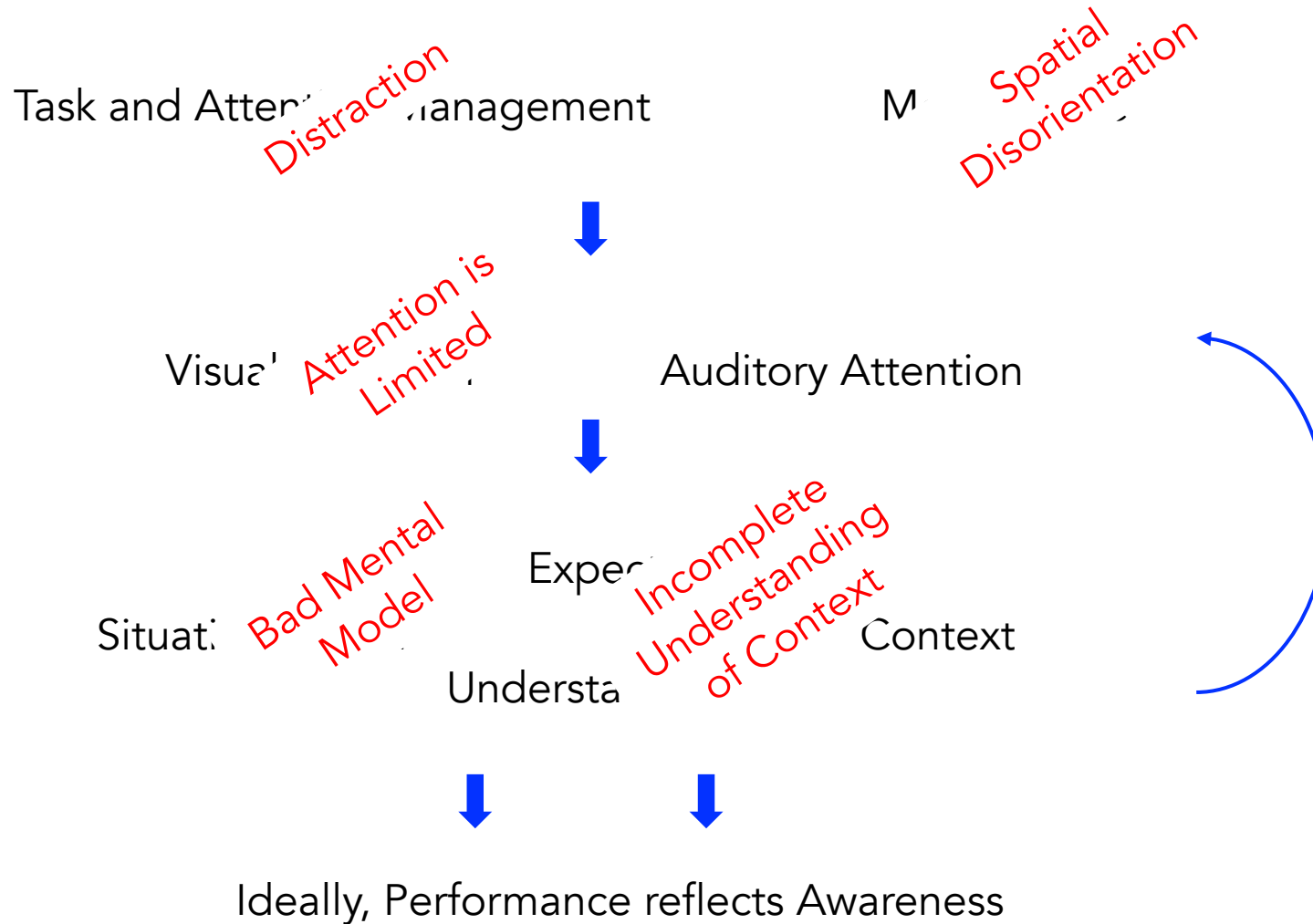
Understanding

Ideally, Performance reflects Awareness



What are the Determinants of Awareness?

Reasons for failure



Are Eye Fixations an Indicator of Visual Attention?

Concerns that the eyes do not reflect the mind's attention

- ✈ Mind wandering
 - Reading a boring document
- ✈ Auditory attention supersedes visual attention
 - Complex clearance from the radio
- ✈ Information in the visual periphery
 - Other pilot is looking through the FCOM
- ✈ Inattention blindness / selectivity
 - Gorillas and basketballs
- ✈ Channelized attention
 - Severe form of attention narrowing (mental state)

Confirmatory Measures for Awareness

Eye fixation and . . .

- ✈ Subsequent Fixation
 - Unexpected heading → What is my lateral mode?
- ✈ Control actions
 - Change the state; Manage flight path
- ✈ Airplane or Airplane System outcomes
 - Comply with clearance; Appropriate system configuration
- ✈ Verbal reports
 - "We're going to be high at that waypoint"
 - "You're too fast"
- ✈ Prompted verbal report
 - Obscure the interface and check awareness
 - Check awareness after an event (retrospective)
- ✈ Knowledge checks of understanding
 - Underlying mental model / system knowledge

Summary and Conclusions

- ✈ There are a range of eye-tracking / eye-fixation measures.
Eye-tracking technology is more available / accessible.
But before you start using these measures to assess pilot awareness . . .
- ✈ Understand the various limitations on eye fixation measures.
- ✈ Develop methods to supplement eye fixations with confirmatory measures of awareness

Thanks for your time!