Investigating display-related cognitive fatigue in oil and gas operations (DCF-VME)

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Oil and Gas Industry Situation

Vigilance Monitoring Settings

- Drilling/Production
- Midstream
- Refining/Chemical manufacturing

Characteristics

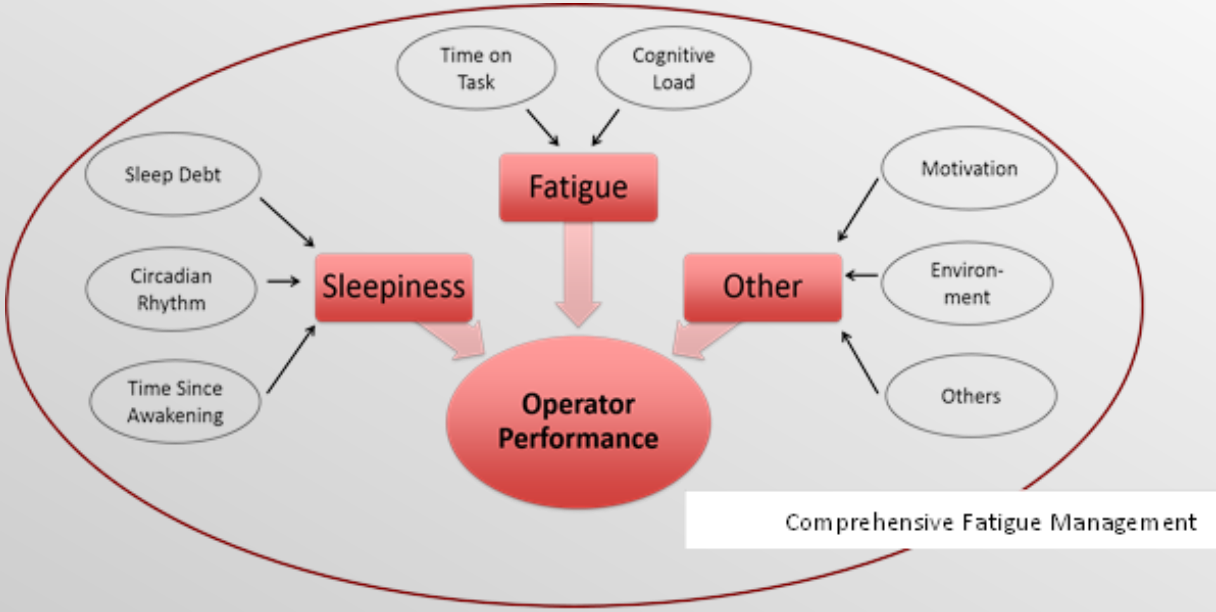
- 24/7 operations
- Complex/multiple displays
- P&ID interface
- Extended time on task
- High cognitive load
- Fatigue issues

Critical Gaps/Needs

- More comprehensive approach for managing fatigue
- Better understanding of cognitive and motivational performance factors
- Interface content and designs that support a sustained, high level of performance
- Improved fatigue assessment and mitigation approaches

Comprehensive Model of Operator Performance in Vigilance Monitoring Environments

- Sleepiness is distinct from cognitive fatigue
- Management of **sleepiness**, **cognitive fatigue**, and **motivation** are required to affect performance
- Task performance declines with longer time on task and high cognitive workload



Adapted from Balkin and Wesensten (2011).

Measuring Fatigue and its Impact on Performance

Subjective

- Self-reported fatigue assessment
- Interruption of tasks
- Retrospective reports

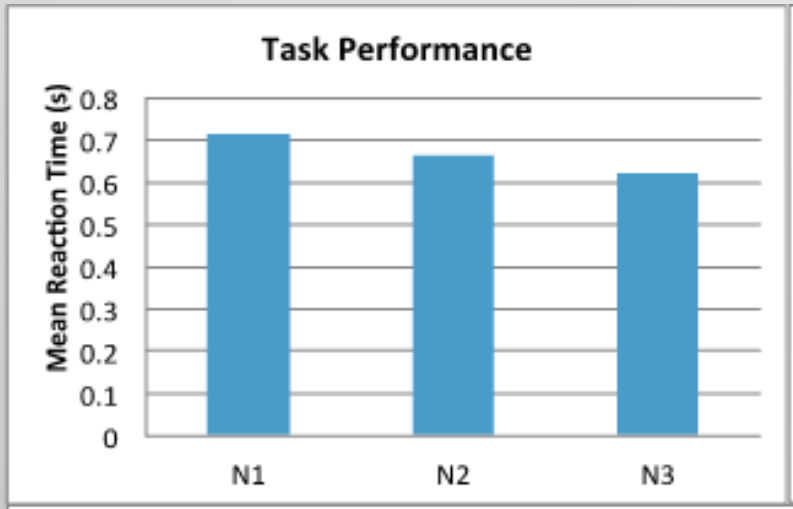
Neurophysiological

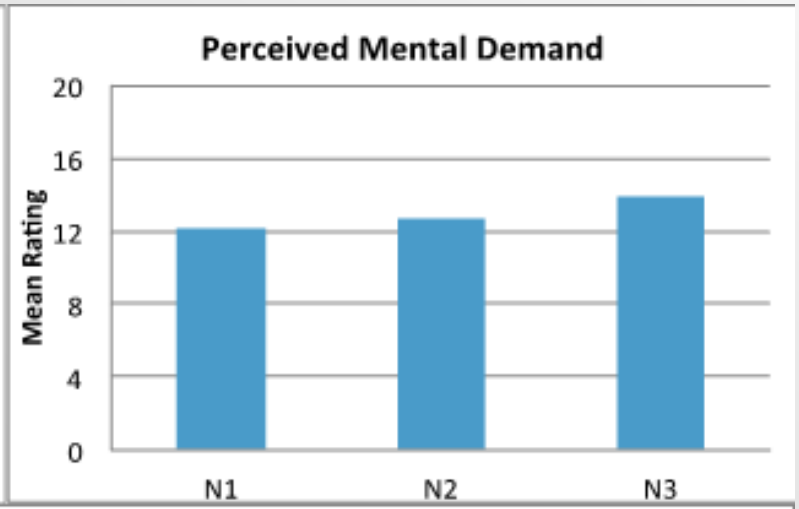
- Heart rate variability
- Functional brain activity
- Galvanic skin response

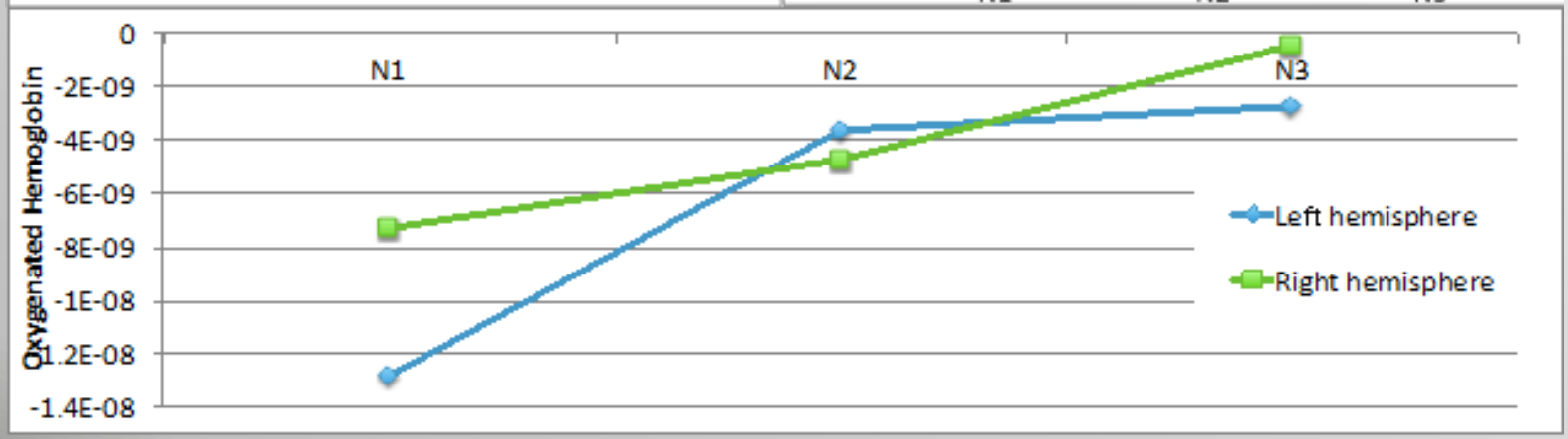
Performance

- Reaction times
- Accuracy, Precision

Relationship Between Mental Demand, Operator Performance, and Activation Across Three Stages of Task Time

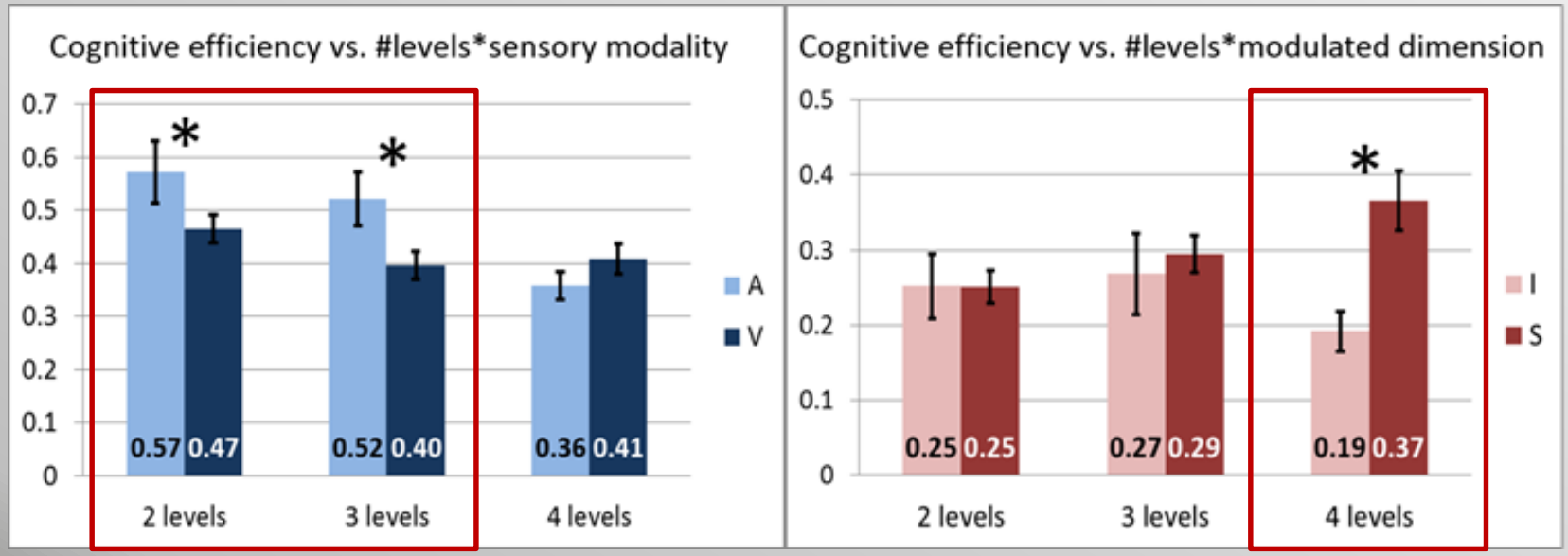






Display Influences on Cognitive Fatigue

- "Cognitive efficiency": information gained from a display per unit cognitive effort
- Affected by display (in addition to individual and contextual) characteristics
  - Engaged sensory modalities (vision, audition)
  - Information encoding methods (spatial vs symbolic encoding, intensity vs spectral qualities of display elements)



(Yang, Shukla, & Ferris, 2012)

Research Questions

1. How are operators in digital monitoring centers, control rooms affected by task-related *cognitive* fatigue?
2. Task factors?
3. Factors related to operator's knowledge structure?
4. Interface design elements associated with high cognitive fatigue?
5. Assessment methods?
6. Mitigation: task design, display design?

DCF-VME Study Approach

Phases

1. ***Systematic observation*** - identify the possible contributors to cognitive fatigue in typical oil, gas, or petrochemical monitoring environments
2. ***Simulation*** - conduct empirical studies to confirm the contributors to cognitive fatigue
3. ***Display Design*** - develop and test a new monitoring environment that may mitigate the elements of cognitive fatigue

Measures

- Cognitive assessments
- Performance measures
- Neurophysiological measures
- Subjective self-reports

Industry Benefits

- Better understanding of cognitive fatigue sources and performance effects
- Comprehensive fatigue risk management best practices
- Improved industry standards and guidelines
- Next generation display design approaches
- Optimized assessment, work scheduling, and task strategies
- Improved training procedures

Thank you for your time and attention

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