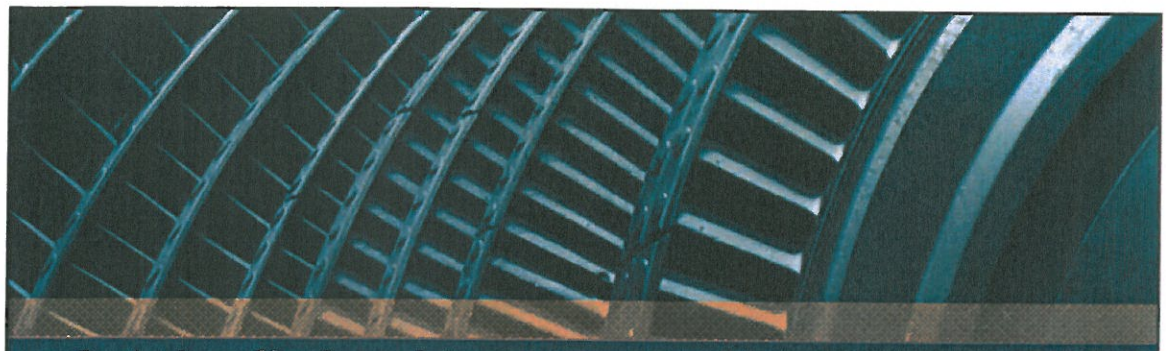


Designing effective training
Transfer of skills and refresher training

Dina Burkolter
This research was conducted at the Universities of St. Gallen (CH), Duisburg-Essen (DE) & Groningen (NL)

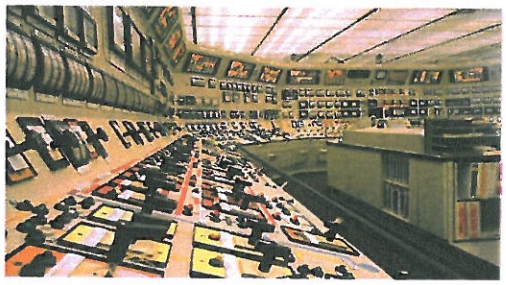
Lloyd's Register Consulting

Working together for a safer world

Challenge: Skill retention and transfer

How can effective training for complex, technical tasks be designed?
What kind of training can support transfer of acquired skills for longer durations?

- For complex and not regularly performed tasks
  (Ginzburg & Dar-El, 2000)
- Rare opportunities
- Automation: Risk of skill decay
- Skill decay of cognitive skills
  (Wickens, Hollands, Banbury, & Parasuraman, 2013)



Burkolter, Kluge & Frank, 2011; Kluge, Burkolter & Frank, 2012

Designing training for temporal and adaptive transfer

Transfer type	Description and Illustration	
Temporal transfer	Application of skills and knowledge after a period of non-use	
Adaptive transfer	Need to adapt acquired skills to novel situation	

Kluge & Burkolter, 2013; Kluge, Burkolter & Frank, 2012

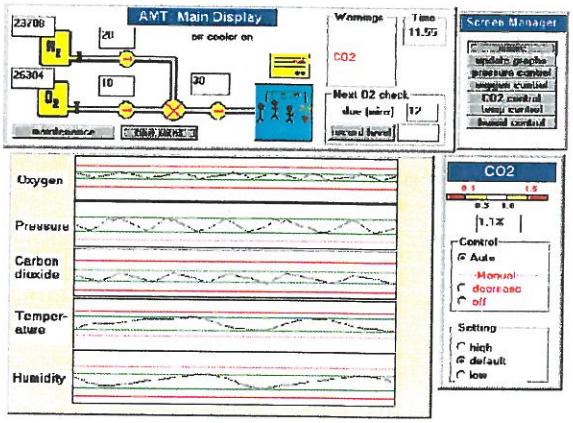
Comparison of training methods

	Emphasis Shift Training	Situation Awareness (SA) Training	Drill and practice
Rationale	Priority changes on subcomponents of a whole task	Randomized "freezing" of a task with SA questions & debriefing	Rehearsal, repetition and practice of a task
Empirical findings	Enhancing attention-management strategies, transfer to novel situations	Useful for individual SA and performance, but few empirical studies on effects of SA training	Useful for procedural tasks and longer retention intervals for familiar situations
Explanations for effectiveness	Reducing load allowing to invest more resources in learning other tasks	Improving competence to make decisions and project events in the future	Reducing load on working memory
Usefulness assumed for	System control performance Diagnostic performance of novel faults	System control performance Diagnostic performance of novel faults	Diagnostic performance of practiced faults

Burkolter, Kluge, Sauer, & Ritzmann (2010)

Simulated process control task

- Cabin air management system
- System control performance
- Diagnostic performance



CAMS: Sauer et al., 2000

Experimental design

Training
of 5 system faults

Testing sessions
with practiced and novel system faults

Drill and practice

Emphasis shift training (EST)

EST and Situation Awareness (EST/SA)

Test immediate → Test 2 weeks → Test 6 weeks

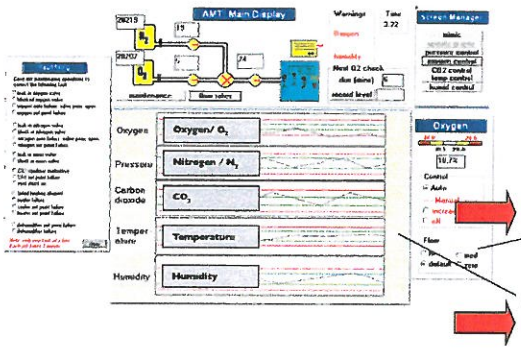
Burkolter, Kluge, Sauer, & Ritzmann (2010)

Training method

System fault 1: Leak in oxygen valve

➡ Training of system control

CAMS exercise: T3



Description of system fault

Oxygen leaks from the valve (which is located at the oxygen tank). This results in a reduced oxygen supply in the space craft.

Symptoms

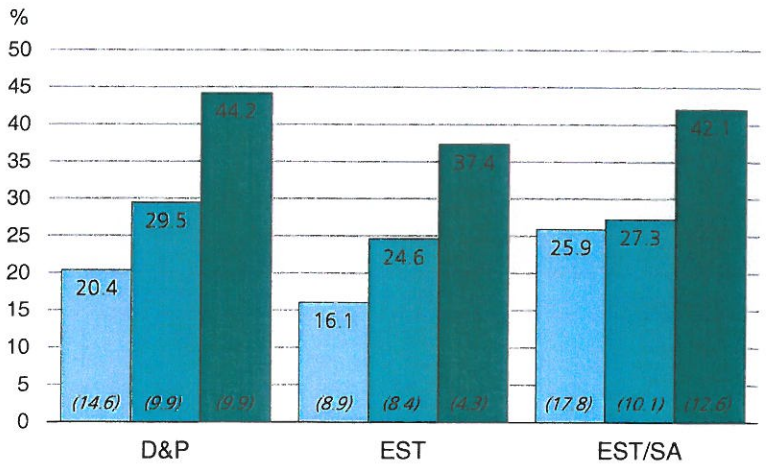
The oxygen graph shows a reduced amplitude and declines below norm range.
Oxygen flow rate does not correspond to the decline rates of the oxygen tank.

Intervention

1. **Increase oxygen in the automatic controllers of the oxygen settings from „default" to „high".**
2. With the system in stabilised crew parameters are in normal range (other countermeasures and conduct fault fixing).
3. **Monitor the parameters: Pay attention that that all parameters are in normal range.**
4. Set the flow settings on „default" after fault fixing.

Burkolter, Kluge, Sauer, & Ritzmann (2010)

Results: System control performance

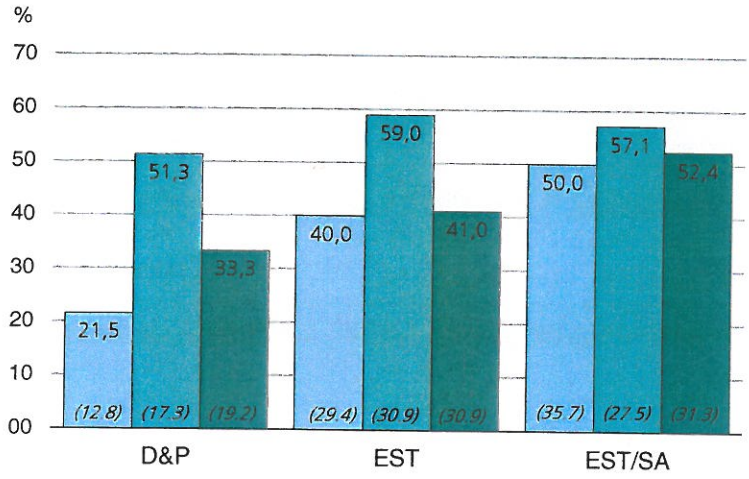


System control performance: Mean deviation from normal range in %, SD in brackets

- Test_immediate
- Test_2 weeks
- Test_6 weeks

Burkolter, Kluge, Sauer, & Ritzmann (2010)

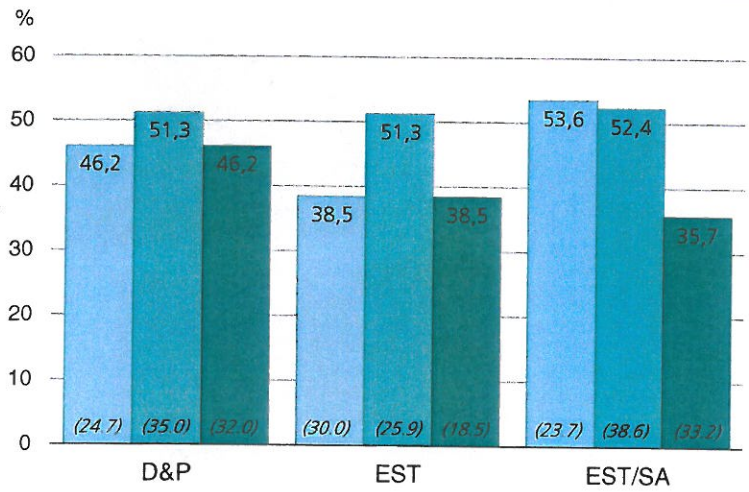
Results: Temporal transfer



Diagnostic accuracy (practiced faults): Mean incorrect fault diagnoses in %, SD in brackets

Burkolter, Kluge, Sauer, & Ritzmann (2010)

Results: Adaptive transfer



Diagnostic accuracy (novel faults): Mean incorrect fault diagnoses in %, SD in brackets

Burkolter, Kluge, Sauer, & Ritzmann (2010)

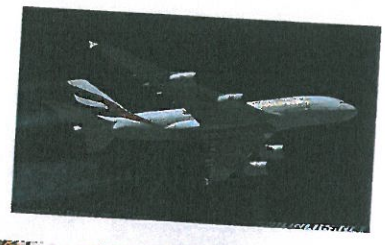
Summary of results

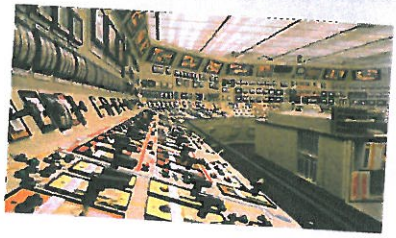
Training method	Temporal transfer	Adaptive transfer
Drill and practice	✓ Diagnosis	
EST/Situation awareness		✓ Diagnosis
Emphasis shift training (EST)	*Performance not as well as expected for system control*	

Burkolter, Kluge, Sauer, & Ritzmann (2010)

Refresher training

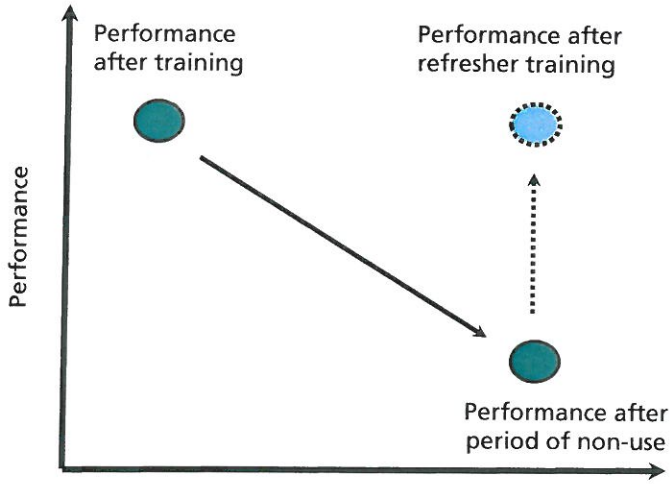
- **Prevalent/required in high-risk environments**
  (O'Connor et al., 2008)
- **However: Little research on design and methods**
  (Healy & Sinclair, 1996)





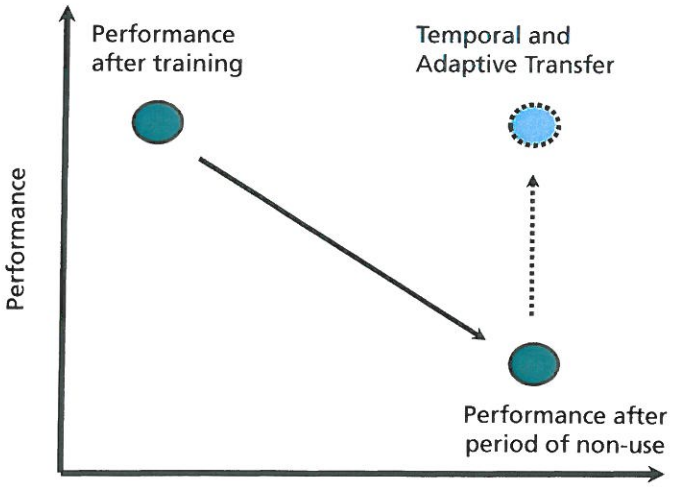
Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Refresher training



Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Refresher training: Hypotheses

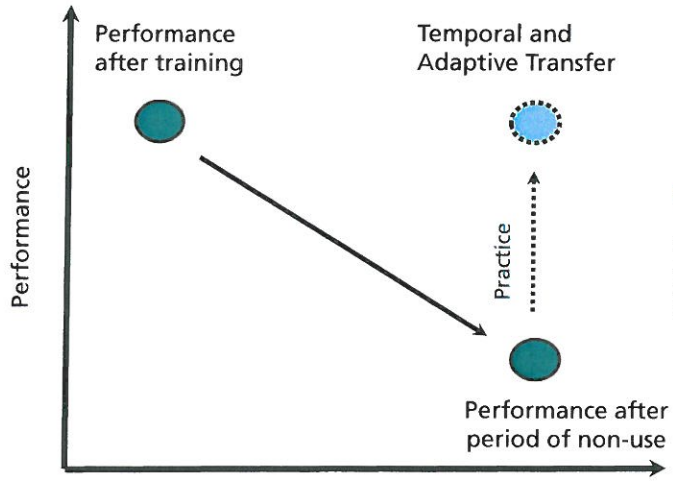


Hypothesis 1

(cf. Ginzburg & Dar-El, 2000)

Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Refresher training: Hypotheses

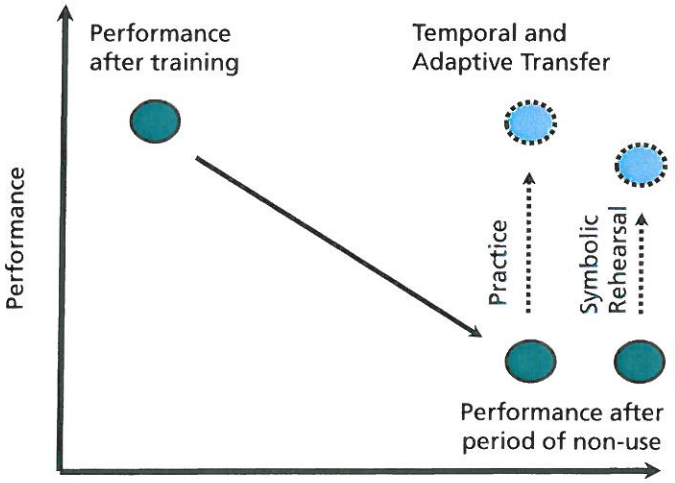


Hypothesis 2

Burkolter, Kluge, Sauer, & Ritzmann, 2010; Kluge, Sauer, Burkolter, & Ritzmann, 2010; Wickens & McCarley, 2008

Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Refresher training: Hypotheses

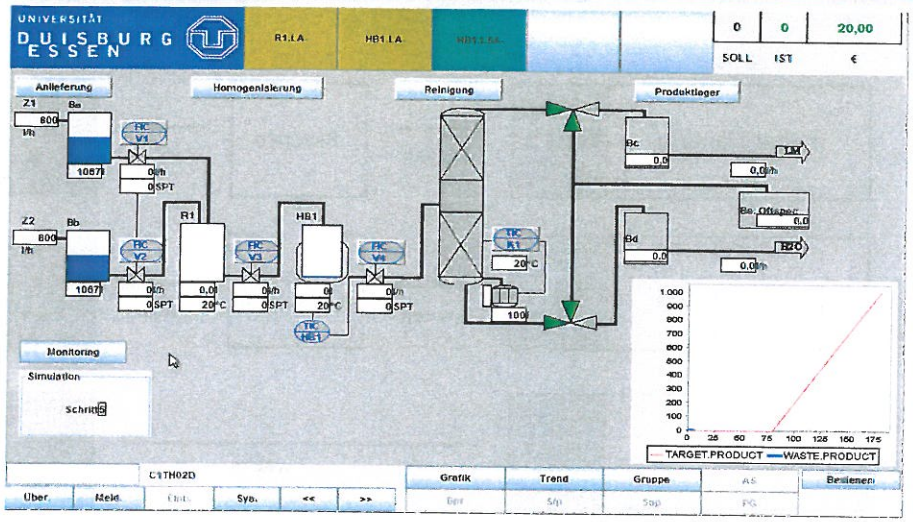


Hypothesis 2

Burkolter, Kluge, Sauer, & Ritzmann, 2010; Farr, 1987; Kluge, Sauer, Burkolter, & Ritzmann, 2010

Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

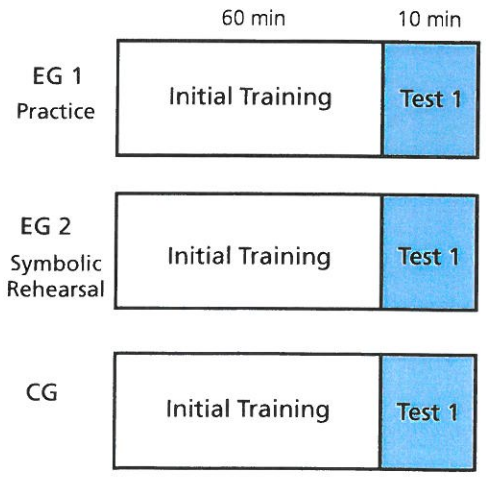
Waste Water Treatment Simulation (WaTr Sim)



©Lloyd's Register Consulting

Burkolter, Kluge, German, & Grauel (2009)

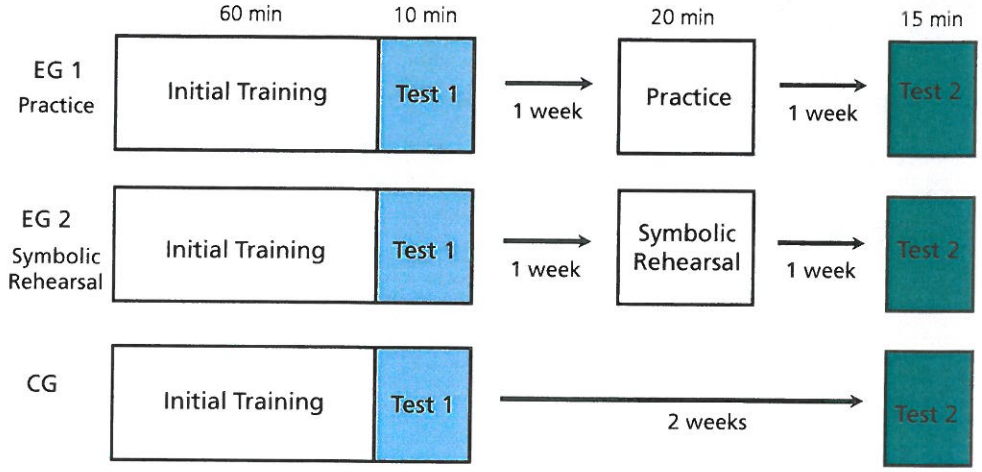
Experimental design



©Lloyd's Register Consulting

Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

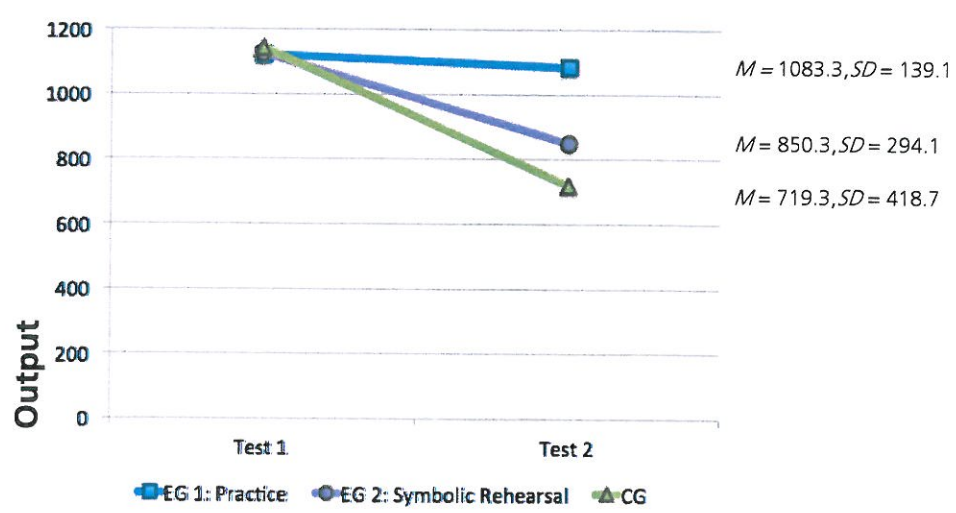
Experimental design



Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Results: Temporal transfer

Temporal transfer: Start-up procedure



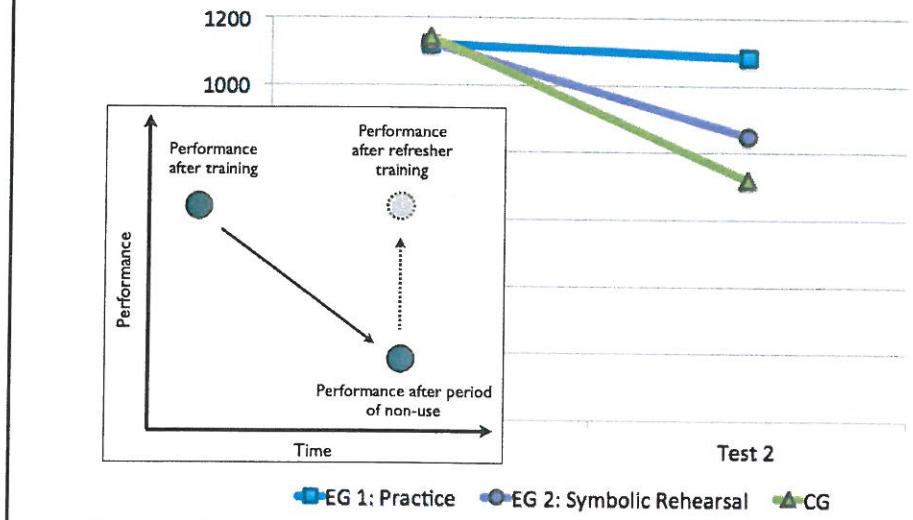
$M = 1083.3, SD = 139.1$

$M = 850.3, SD = 294.1$

$M = 719.3, SD = 418.7$

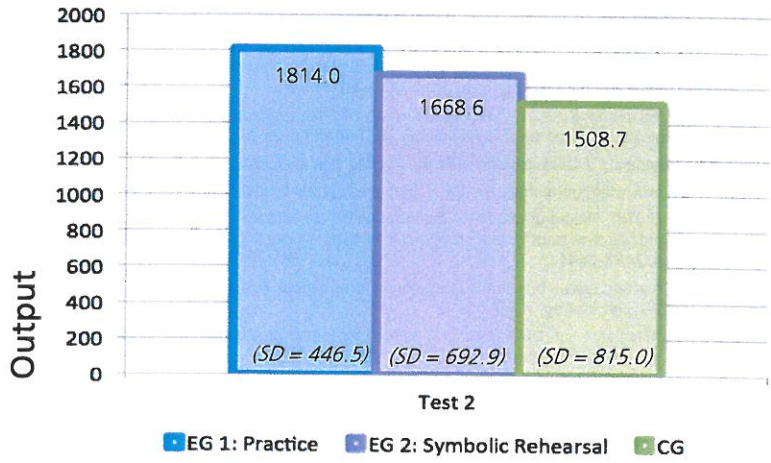
Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Results: Temporal transfer



Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Results: Adaptive transfer



Adaptive transfer: Non-routine situation

Burkolter & Kluge, 2011; Kluge, Burkolter & Frank, 2012

Summary and conclusion

- Refresher training effective and efficient for skill retention
- Refresher training: For temporal transfer not adaptive transfer
- Drill and practice for temporal transfer

Specific training methods for temporal transfer AND for adaptive transfer

Determine task characteristics and requirements thoroughly

Assess training outcomes in multi-faceted way

References

Burkolter, D., Kluge, A., German, S., & Grauel, B. (2009). Waste Water Treatment Simulation (WaTr Sim): Validation of a new process control simulation tool for experimental training research. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 53, pp. 1969–1973.

Burkolter, D. & Kluge, A. (2011). Refresher training for skill retention of complex tasks. Presentation given at the Human Factors and Ergonomics Society Europe Chapter Annual Meeting in Leeds, UK (Oct. 2011).

Burkolter, D., Kluge, A., Sauer, J., & Ritzmann, S. (2010). Comparative study of three training methods for enhancing process control performance: emphasis shift training, situation awareness training and drill and practice. *Computers in Human Behavior, 26*, 976–986.

Farr, M.J. (1987). *The long-term retention of knowledge and skills. A cognitive and instructional perspective*. New York: Springer.

Ginzburg, S. & Dar-El, E.M. (2000). Skill retention and relearning – a proposed cyclical model. *Journal of Workplace Learning, 12*, 327–332.

Kluge, A., Burkolter, D., & Frank, B. (2012). "Being prepared for the infrequent": A comparative study of two refresher training approaches and their effects on temporal and adaptive transfer in a process control task. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 56, pp. 2437–2441.

Kluge, A. & Burkolter, D. (2013). Enhancing research on training for cognitive readiness: Research issues and experimental designs. *Journal of Cognitive Engineering and Decision Making, 7*, 96–118.

Kluge. A., Sauer, J., Burkolter, D., & Ritzmann, S. (2010). Designing training for temporal and adaptive transfer: A comparative evaluation of three training methods for process control tasks. *Journal of Educational Computing Research, 43*, 327–353.

Sauer, J., Wastell, D., & Hockey, G. R. J. (2000). A conceptual framework for designing micro-worlds for complex work domains: A case study of the Cabin Air Management System. *Computers in Human Behavior, 16*, 45–58.

Wickens, C., Hollands, J.G., Banbury, S., & Parasuraman, R. (2013). *Engineering psychology and human performance*. Boston: Pearson.

Wickens, C.D. & McCarley, J.S. (2008). *Applied attention theory*. Boca Raton: CRC Press.

Thank you very much for your attention!

Dina Burkolter
Dr., Senior Human Factors Consultant
Malmö, Sweden
T +46 70 273 15 17 E dina.burkolter@lr.org

Lloyd's Register Consulting
www.lr.org/consulting

Lloyd's Register Consulting

Working together
for a safer world