


Bio- and other feedback in a virtual stress training to reduce errors and increase performance

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Presentation content

1. Project background

2. Literature background
   a) Model

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   a) Introduction
   b) Methods
   c) Results

4. Experiment; Feedback System


Project background

Project background

Brain & Cognition

Nationaal Initiatief Hersenen & Cognitie

Project background

Brain & Cognition

- Emergency workers experience high stress levels
- Crisis situations need to be steered with good decisions
- Penalty for errors is high
- Stress and pressure can influence decision making processes in a negative way.

Project background

Better decision under high pressure

- Main Objective:
  - Reducing negative effects of stress during high pressure and increasing quality of decisions.

- End goal:
  Creating interventions and technological tools


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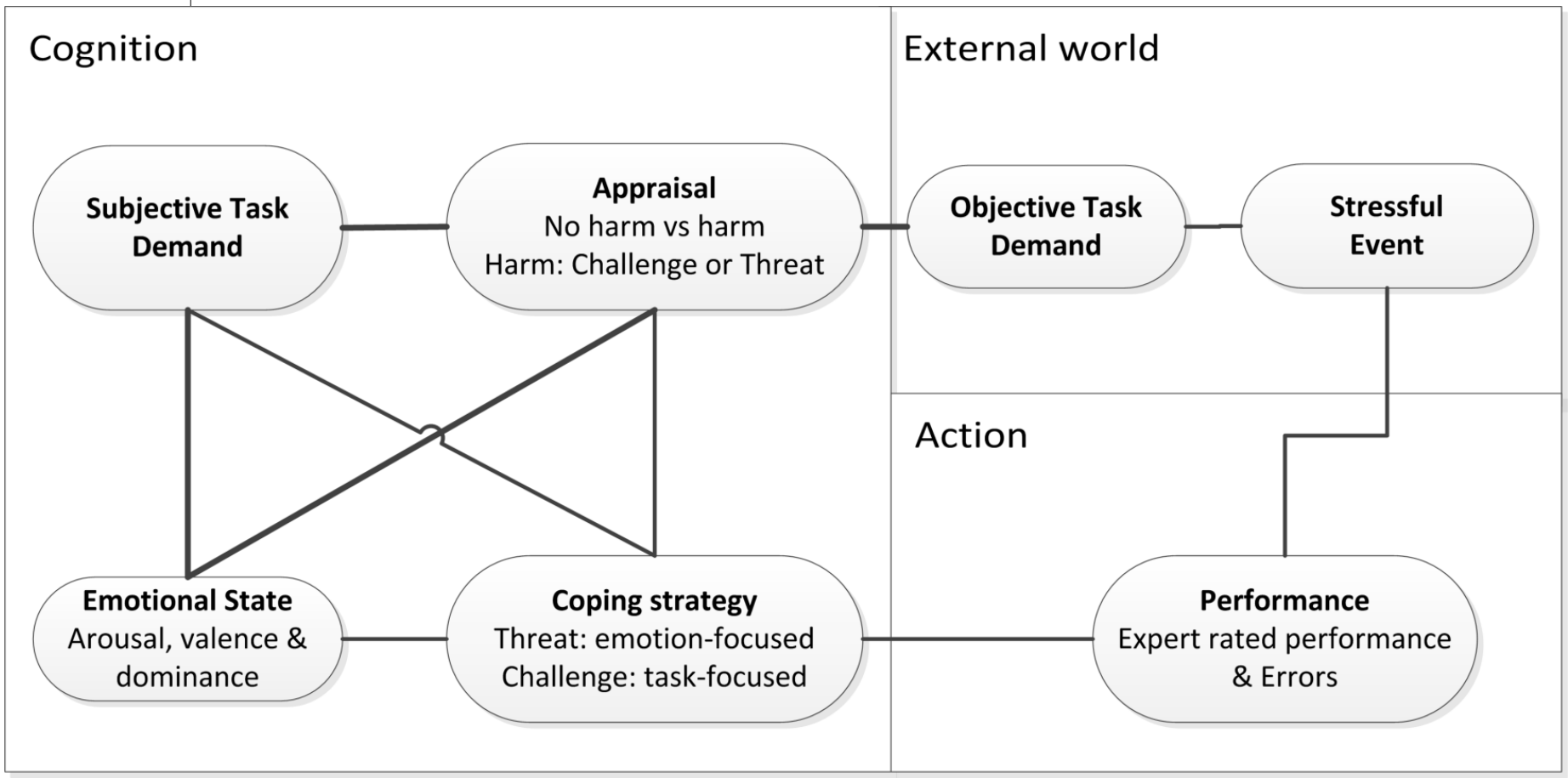
Literature Background


Literature background

- Stress studies: positive or negative effect
- Cognition reduced by acute stress
  - Cognition → Decision making

Literature background

Model




Literature background

Model

- Model needs validation
  - Are the variables related to each other in the way the model indicates?
- Prediction of performance?
  - Are the variables good predictors for performance?

Experiment; Navy


Experiment; Navy

Introduction

- Simulator study at the Navy (Royal Netherlands Naval College) in Den Helder
- Participants experienced a stressful scenario
- Realistic virtual environment
- Realistic events and decisions

Experiment; Navy

Scenario

- 2 Dutch naval ships

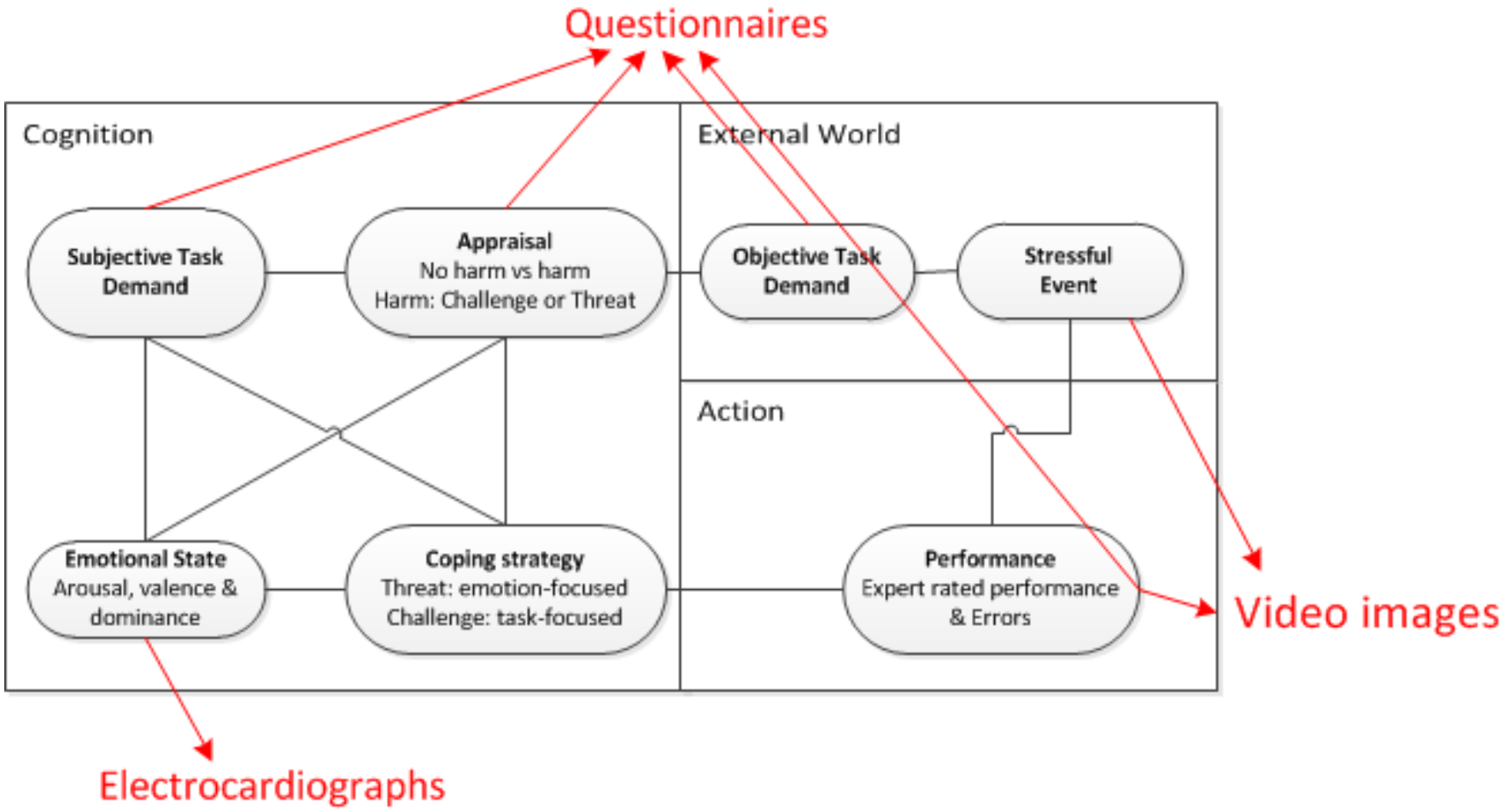

Experiment; Navy

Introduction / Methods

- Variables measured:
  - Task Demand → **Questionnaire**
  - Appraisal → **Questionnaire**
  - Emotional State/Arousal → **ECG measurement**
  - Performance → **Questionnaire**
  - Errors → **Video**

Experiment; Navy

Introduction / Methods




Experiment; Navy

Results

Experiment; Navy

Results

- Correlations:

	HR	HRV	Appraisal Threat	Appraisal Challenge	Objective Task Demand	Subjective Task Demand
HR	1.00					
HRV	**-0.99**	1.00				
Appraisal Threat	0.03	-0.03	1.00			
Appraisal Challenge	0.14	-0.13	**-0.23**	1.00		
Objective Task Demand	0.09	-0.08	**0.40**	**0.63**	1.00	
Subjective Task Demand	-0.01	0.02	**0.47**	**0.23**	**0.75**	1.00


Experiment; Navy

Results

- Predictive models:
- Performance = regression analysis
- Error = logistic regression

Experiment; Navy

Results

Performance predictors	*B*	Std error	*t*	Sig.
HR	0.00	0.01	-0.42	0.68
HRV	-0.73	0.83	-0.88	0.38
Appraisal Threat	0.12	0.03	4.52	**<0.01**
Appraisal Challenge	0.07	0.01	5.8	**<0.01**
Objective task demand	-0.06	0.01	-4.8	**<0.01**
Subjective task demand	0.01	0.01	0.79	0.43
Intercept	0.42	1.45	0.29	0.77

r = 0.79 between predicted and observed data

Experiment; Navy

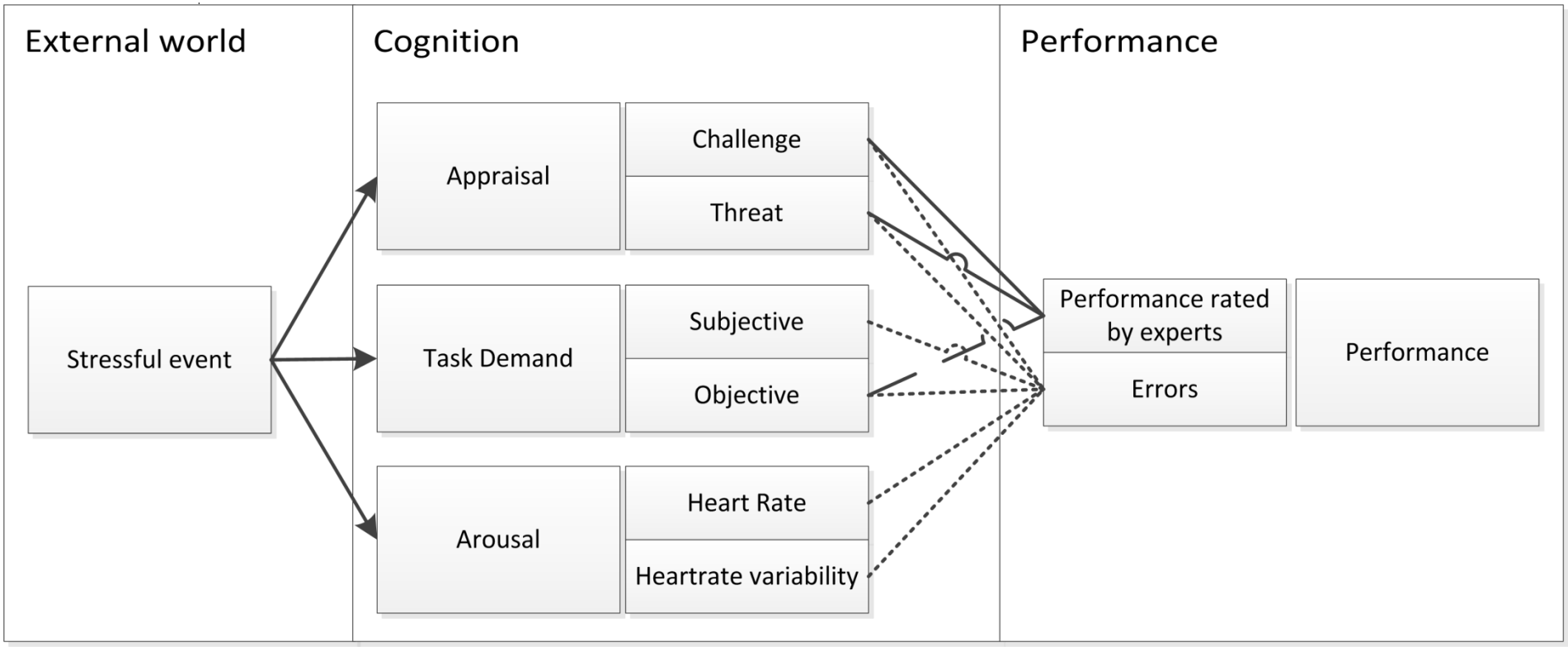
Results

Error predictors	*B*	*S.E.*	Wald	df	Sig.
HR	-0.04	0.02	5.32	1	0.02
HRV	-7.61	1.76	18.66	1	<.01
Appraisal Threat	-0.36	0.03	208.30	1	<.01
Appraisal Challenge	-0.14	0.01	139.39	1	<.01
Objective Task Demand	-0.07	0.01	36.99	1	<.01
Subjective Task Demand	0.03	0.01	13.81	1	<.01

66.4% correct predictions. Cox & Snell's $R^2 = 0.17$

Experiment; Navy

Results

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Experiment Feedback System


Experiment; Feedback System

- Now we have:
  - A better understanding of the influences of stress on cognition and the decision making process and outcomes.
  - Real-time predictions

- This will be used as an extra feedback option:

  Biofeedback

  &

  Real-time predictions


Experiment; Feedback System

- Trainee component
  - Heart rate (biofeedback)
  - Performance predictions
  - Error predictions
- Trainer component
  - What task is being performed?


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Experiment; Feedback System

Output: Predictions

Expected performance

Chances on errors

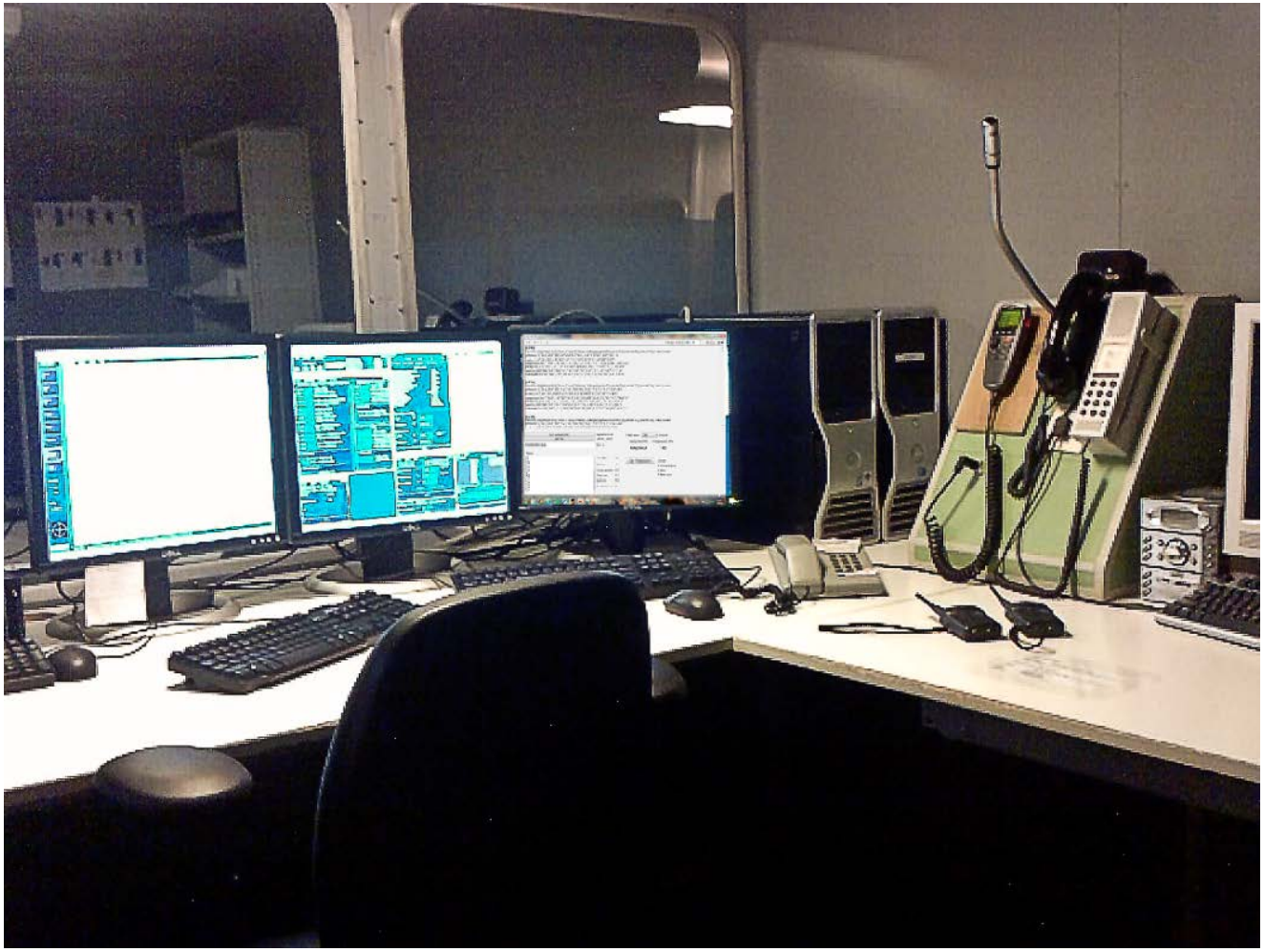
Input: Event

Appraisal + Task Demand: already in model

ECG: measured real-time

Experiment; Feedback System

Experiment; Feedback System

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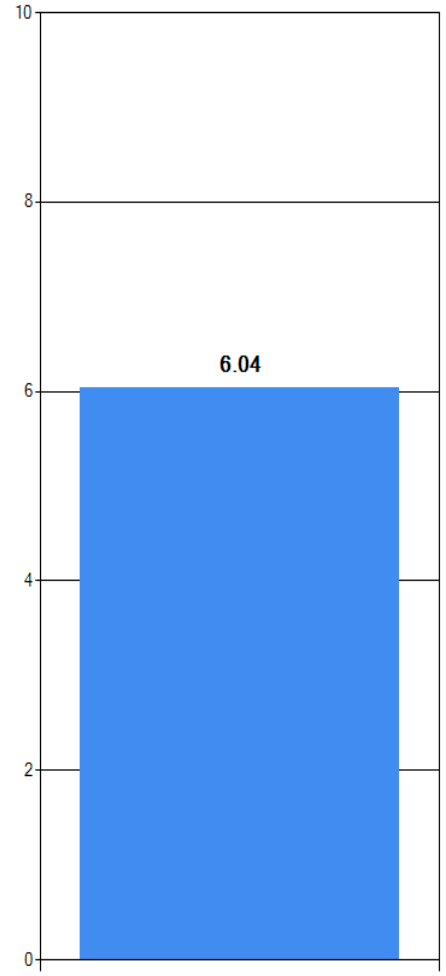
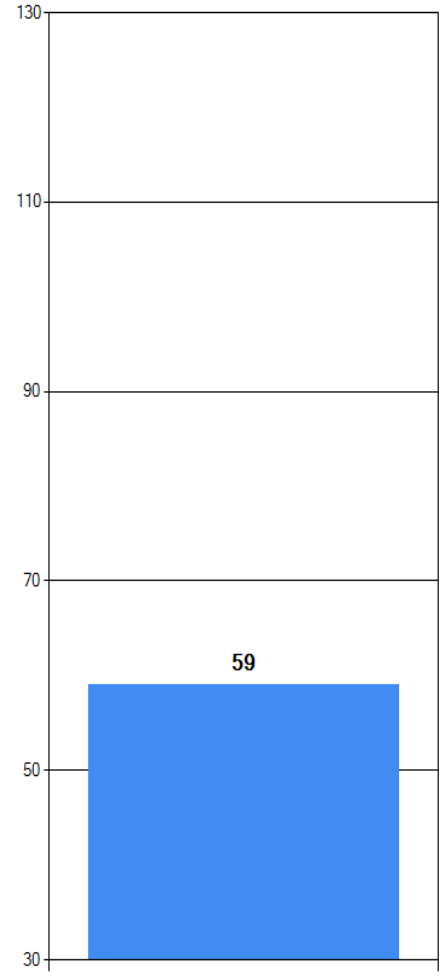
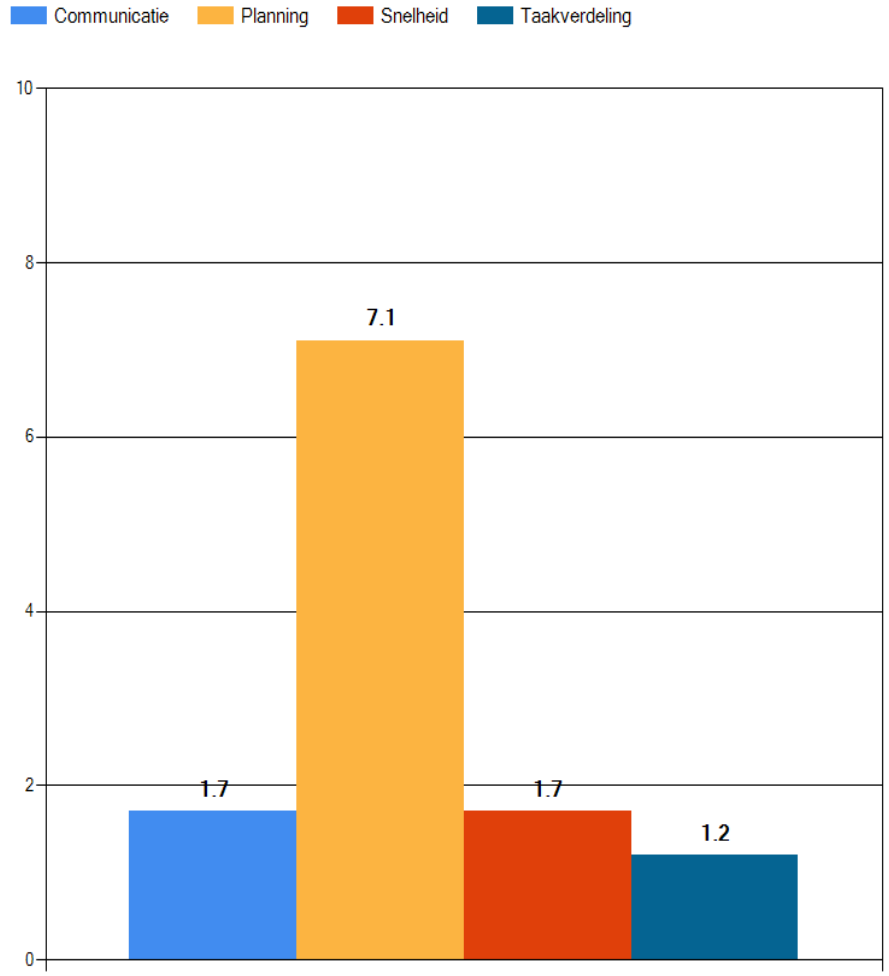
Cognitief Feedbacksysteem - Professionalscherm





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Cognitief Feedbacksysteem - Trainerscherm

Bestand Sessie Log Help

Calculatie interval (seconden) 10

Sessietijd 00:00:00

```
[0:00:00]
Loaded task file: D:\iriscohen\My Documents\zz_PhD\Release v1.0.2.0\Tasks_navy_easy.txt
task: name = 1. schaduwen van target schip {(Threat = 1)(Challenge = 2.94)(objectiveTD = 5.67)(subjectiveTD = 2.37)}
task: name = 2. start van de training {(Threat = 1)(Challenge = 2.39)(objectiveTD = 4.5)(subjectiveTD = 3)}
task: name = 3. reageren op ontdekking {(Threat = 1.75)(Challenge = 2.55)(objectiveTD = 6)(subjectiveTD = 5)}
task: name = 4. andere scheepvaart ontwijken {(Threat = 1.5)(Challenge = 3)(objectiveTD = 4)(subjectiveTD = 3.32)}
task: name = 5. boarding voorbereiden {(Threat = 2.8)(Challenge = 2)(objectiveTD = 6.667)(subjectiveTD = 5.68)}
task: name = 6. taakverdeling teams {(Threat = 1.6)(Challenge = 2.3)(objectiveTD = 7.67)(subjectiveTD = 4.68)}
task: name = 7. positioneren van de schepen {(Threat = 1.57)(Challenge = 3.36)(objectiveTD = 6.33)(subjectiveTD = 5)}
task: name = 8. boarding uitvoeren {(Threat = 1.75)(Challenge = 2.75)(objectiveTD = 6.5)(subjectiveTD = 4.89)}
task: name = 9. hailing van schip {(Threat = 0)(Challenge = 2.17)(objectiveTD = 6)(subjectiveTD = 2.42)}
task: name = 10. positioneren van target schip {(Threat = 1)(Challenge = 2.22)(objectiveTD = 5.67)(subjectiveTD = 2)}
task: name = 11. crew aansturen {(Threat = 1.67)(Challenge = 2.64)(objectiveTD = 4.67)(subjectiveTD = 4.05)}
task: name = 12. onderlinge communicatie {(Threat = 2.33)(Challenge = 2.85)(objectiveTD = 5.33)(subjectiveTD = 5.68)}
task: name = 13. reageren op mayday {(Threat = 2.44)(Challenge = 2.4)(objectiveTD = 5.33)(subjectiveTD = 5.95)}
task: name = 14. search & rescue uitvoeren {(Threat = 1.83)(Challenge = 2.33)(objectiveTD = 7)(subjectiveTD = 5.63)}
task: name = 15. overdracht target schip aan kustwacht {(Threat = 0)(Challenge = 1.83)(objectiveTD = 6)(subjectiveTD = 0.74)}
task: name = 16. lancering helicopter {(Threat = 3)(Challenge = 2.8)(objectiveTD = 4.67)(subjectiveTD = 3.26)}
task: name = 17. tegen de stroom opvaren {(Threat = 1.5)(Challenge = 3)(objectiveTD = 5)(subjectiveTD = 2.37)}
task: name = 18. navigeren tussen zandbanken {(Threat = 2)(Challenge = 2.63)(objectiveTD = 5)(subjectiveTD = 3.32)}
task: name = 19. zoeken naar man-over-board {(Threat = 2)(Challenge = 2.75)(objectiveTD = 6.67)(subjectiveTD = 0.84)}
task: name = 20. medic/arts inzetten {(Threat = 2.33)(Challenge = 2)(objectiveTD = 7)(subjectiveTD = 1)}
```

Open regressiemodellen.. Regressionsnavy.txt

Open taken.. Tasksnavy_easy.txt

Individual variance value value = 0

Hartslag sensor COM3 Verbonden!

Hartslagsnelheid (HR) Hartslagvariabiliteit (HRV)

65 slagen/minuut **0.907 s**

Takenlijst

- [ ] 1. schaduwen van target schip
- [ ] 2. start van de training
- [ ] 3. reageren op ontdekking
- [ ] 4. andere scheepvaart ontwijken
- [ ] 5. boarding voorbereiden
- [ ] 6. taakverdeling teams
- [ ] 7. positioneren van de schepen
- [ ] 8. boarding uitvoeren
- [ ] 9. hailing van schip
- [ ] 10. positioneren van target schip
- [ ] 11. crew aansturen
- [ ] 12. onderlinge communicatie
- [ ] 13. reageren op mayday
- [ ] 14. search & rescue uitvoeren
- [ ] 15. overdracht target schip aan kustwacht

Performance -

Total error -

Communication error -

Planning error -

Speed error -

Task allocation error -

Open Professionalscherm

Zichtbaar:

- [x] Prestatie voorspelling
- [x] Hartslag
- [x] Kans op fouten


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task: name = 17. tegen de stroom opvaren {(Threat = 0)(Challenge = 3)(objectiveTD = 3.33)(subjectiveTD = 2.5)}
task: name = 18. navigeren tussen zandbanken {(Threat = 3)(Challenge = 3.25)(objectiveTD = 3)(subjectiveTD = 4)}

Open regressiemodellen..
Regressionsnavy.txt

Open taken..
Taskexperienced.txt

Individual variance value
value = 0

Hartslag sensor
COM-poorten..
Niet verbonden

Hartslagsnelheid (HR)
geen

Hartslagvariabiliteit (HRV)
geen

Takenlijst

- 1. schaduwen van schip
- 2. start van training
- 3. reageren op ontdekking
- 4. andere scheepvaart ontwijken
- 5. boarding voorbereiden
- 6. taakverdeling teams
- 7. positioneren van de schepen
- 8. boarding uitvoeren
- 9. hailing van schip
- 10. positioneren van target schip
- 11. crew aansturen
- 12. onderlinge communicatie
- 13. reageren op mayday
- 14. search & rescue uitvoeren
- 15. overdracht target schip aan kustwacht

Performance -
Total error -
Communication error -
Planning error -
Speed error -
Task allocation error -

Open Professionalscherm

Zichtbaar:
- [x] Prestatie voorspelling
- [x] Hartslag
- [x] Kans op fouten


Experiment; Feedback System

Still needs to be tested:

Effect of system on performance + errors

- Between subjects:
  - Full Feedback screen vs. No Feedback screen
- Usability
  - Instructions
  - Easy to use
  - Easy to understand


Bio- and other feedback in a virtual stress training

More information:

http://ii.tudelft.nl/fast_decisions