CoRa
Conflict
Resolution
Assistant

CORA
COnflict Resolution Assistant

Human Factors Lab experiments

NEXTOR-FAA Conference

June 3, 2003

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Aims of the CORA HF Experiments

Evaluate different 'design philosophies' for CORA:

- User-driven   (psychological – comparison)
- Automatic   (technological – left-over)
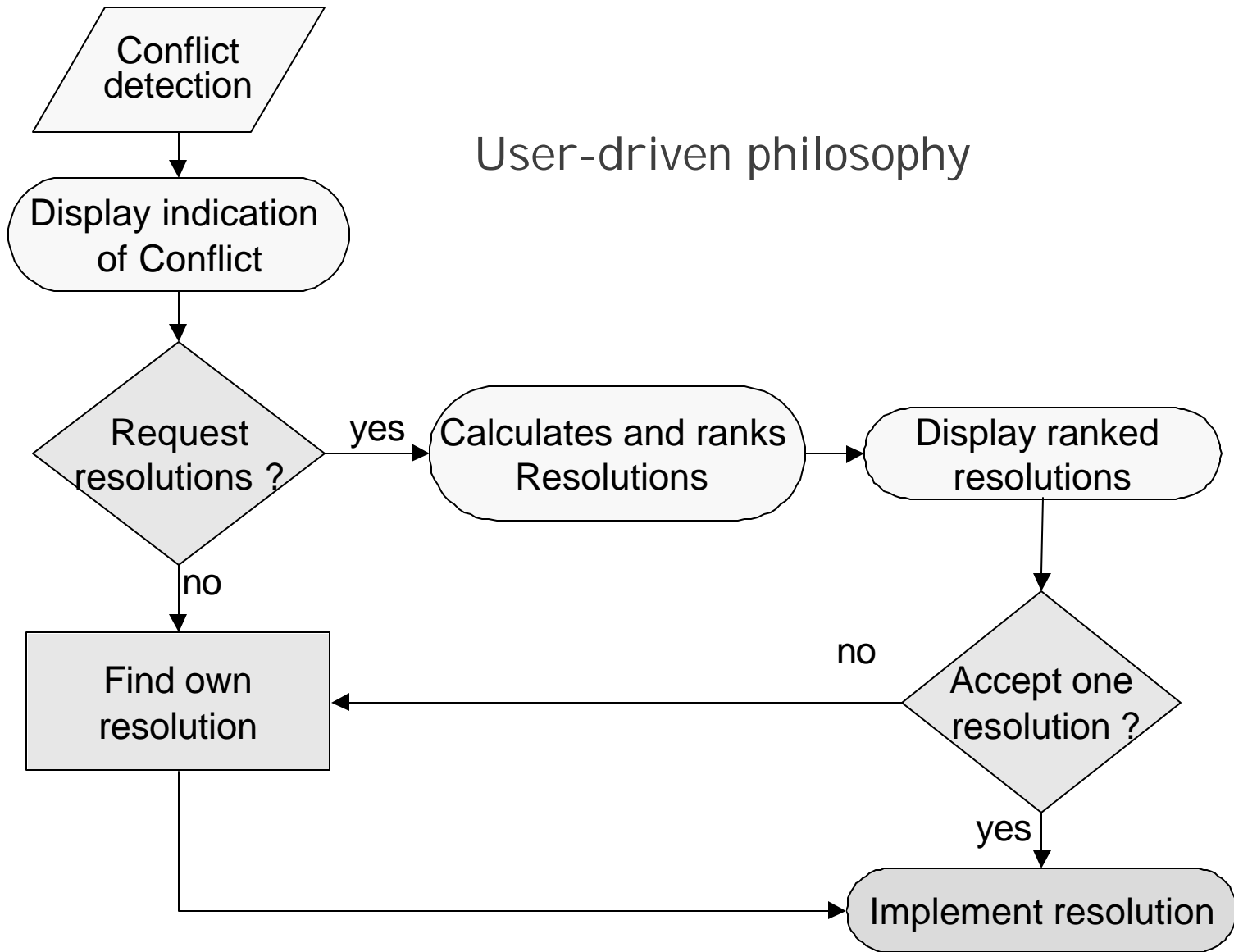- Collaborative   (cybernetic – complementary)

Evaluate different conflict detection (resolution) timelines:

- 5 minutes prior to conflict
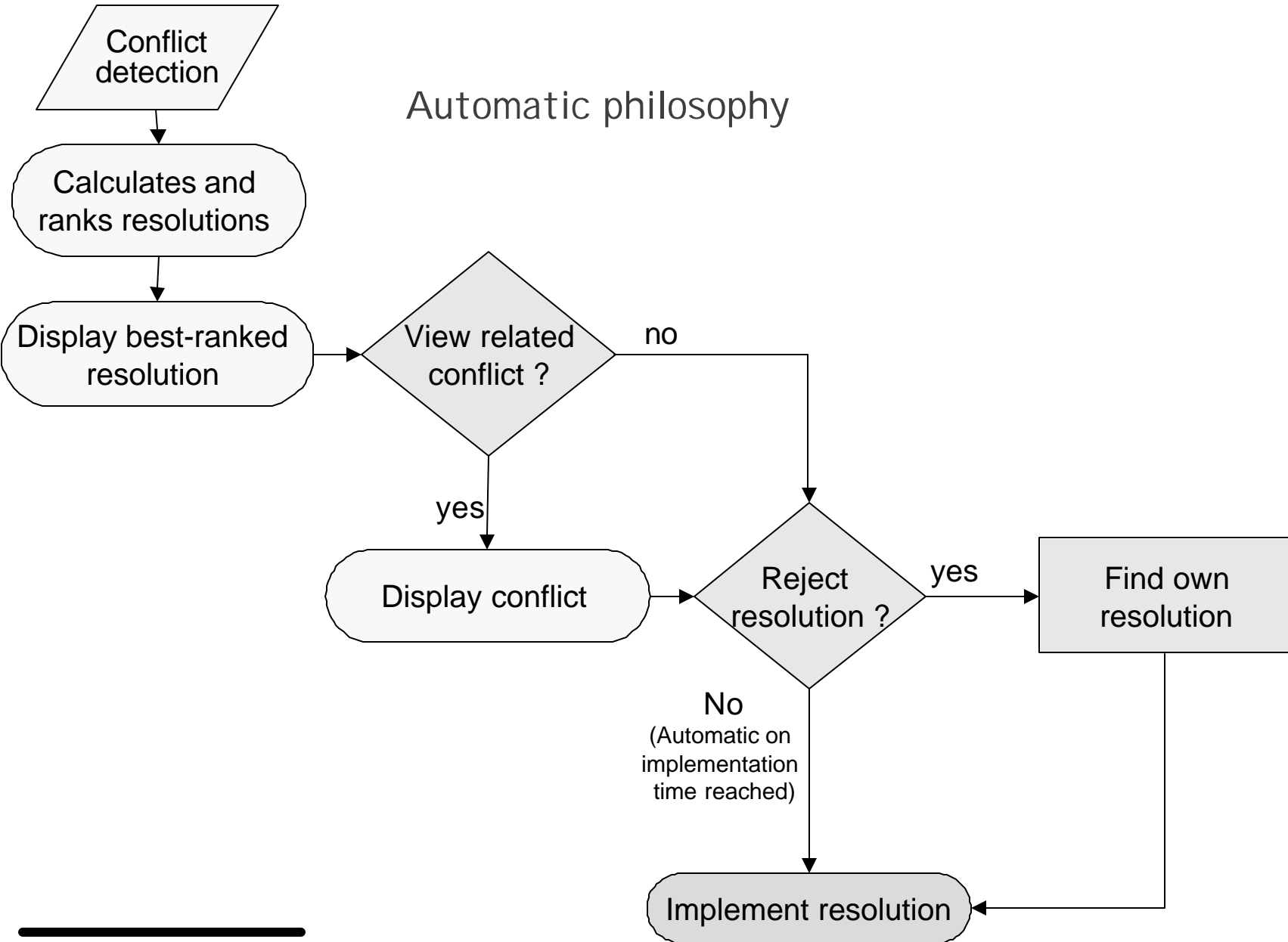- 10 minutes prior to conflict
- 15 minutes prior to conflict
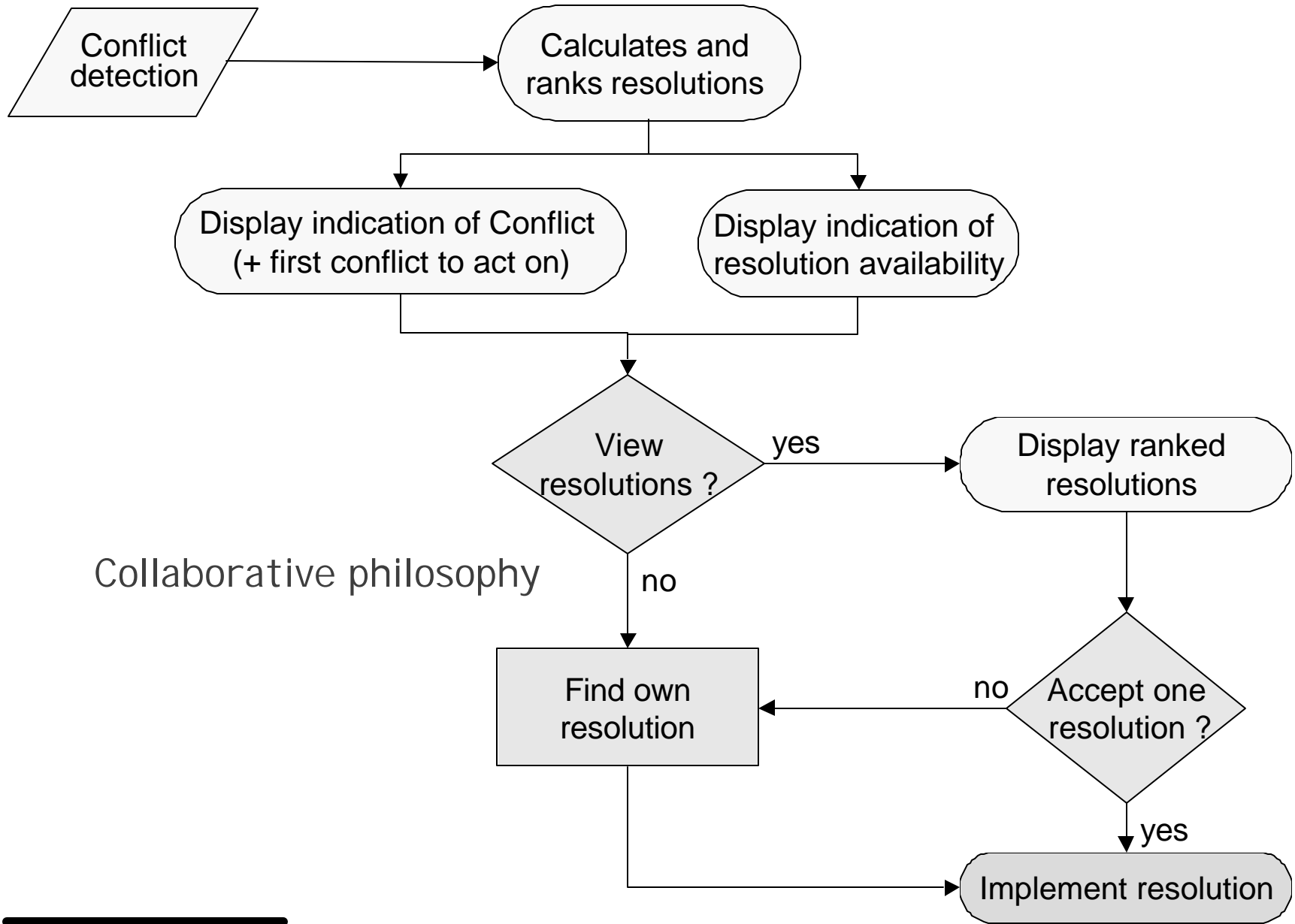
Determine whether resolutions should be presented in a:

- Fixed order (by type)
- Ranked order (by quality-index)

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User-driven philosophy

Conflict detection

↓

Display indication of Conflict

↓

Request resolutions ? — yes → Calculates and ranks Resolutions → Display ranked resolutions

| no   ↓

Find own resolution ← no — Accept one resolution ?

| | yes

↓   ↓

Implement resolution

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Automatic philosophy

Conflict detection

Calculates and ranks resolutions

Display best-ranked resolution

View related conflict ?

no

yes

Display conflict

Reject resolution ?

yes

Find own resolution

No
(Automatic on implementation time reached)

Implement resolution

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Conflict detection → Calculates and ranks resolutions

Display indication of Conflict (+ first conflict to act on)

Display indication of resolution availability

View resolutions ? — yes → Display ranked resolutions

no

Collaborative philosophy

Find own resolution

Accept one resolution ? — no → Find own resolution

yes → Implement resolution

EATMP ASA Programme

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Summary of the philosophies

CORA system	CORA philosophies		
	User-driven	**Automatic**	**Collaborative**
Calculation	On request	Automatic	Automatic
Resolution display	On request	Automatic	**Automatic** (indication of availability) + **On Request** (resolutions)
Number of resolutions	Several (5 best-ranked by type)	One (overall best-ranked resolution)	Several (5 best-ranked by type)
Conflict Indication	Automatic	No	Automatic + Indication of the first conflict to act on
Conflict data	On request	On request	On request

User-driven HMI

Automatic HMI

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Collaborative HMI

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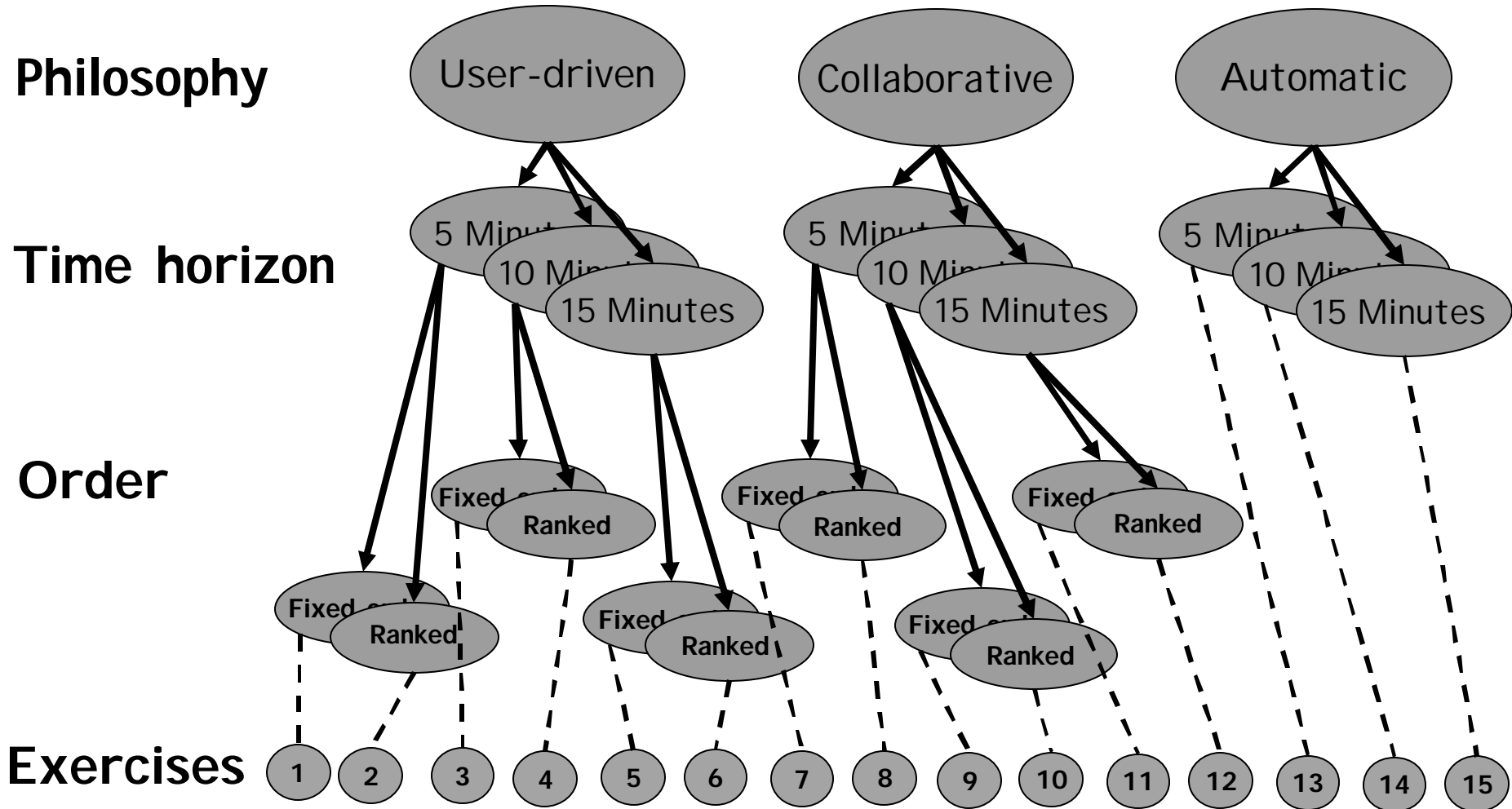
Schedule

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25 to 29 November 2002

10 Controllers (6 active), male, mean age 42.2, mean experience 18.7 yrs.

2 Austria, 1 Finland, 3 Great Britain, 1 Germany, 1 Hungary, 1 Italy,

1 Maastricht (Experience: All ACC and one Departure/Approach)

08.30 – 09.30	Welcome and Overview
	Presentation of the simulation environment
	and the goals of the experiments
	Training
09.30 – 10.15	Runs**
10.15 – 10.30	Coffee Break
10.30 – 12:00	Runs
12.00 – 13.00	Lunch
13.00 – 14.30	Runs
14.30 – 14.45	Coffee Break
14.45 – 15.30	Runs
15.30 – 16.30	Questionnaire + Debriefing
16.30	Departure

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Two Factorial Designs

Philosophy

User-driven | Collaborative | Automatic

Time horizon

5 Minutes | 10 Minutes | 15 Minutes

Order

Fixed | Ranked

Exercises

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Evaluation

Questionnaires

- **Post-exercise questionnaire** (21 questions)
  - Human-Automation Co-operation (Halden Co-operation scale)
  - Mental workload (NASA TXL revised)
  - Situation Awareness (SAHSA_Q revised)

- **End-of day questionnaire**
  - Design philosophy
  - Resolution timeline
  - Sorting
  - General questions

Debriefing:

- **End-of-day debriefing**
  - Based on observations and open questions
  - After the end-of-day questionnaire

Experimental Design

- Route Structure:
  - based on sectors from Reims FIR, France and Maastricht UAC.

- Traffic:
  - based on 2 x 2.5 hour periods from 10 July 1998 (baseline).
  - Air traffic scenarios prearranged (Controllers unable to interact).
  - Each scenario presented one conflict.

- Factorial Designs (two partly overlapping):
  - 3 x 2 x 2 (time/design/sorting) within subject.
  - 3 x 3 (time/design) within subject.

- Incomplete counterbalancing:
  - Randomised - Controllers tested simultaneously experienced different scenarios and treatment levels.

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Experimental Design

- Power analysis:
  - probability that the experimental design could produce statistically significant results (ok for large and typical effects).

- Dependent variables:
  - checked to ensure no extreme violations about the assumptions about normal distribution and measurement level occurred.

- Questionnaires:
  - Reliability and validity of subjective rating scales evaluated:
    - inter-item reliability testing (Cronbach's Alpha) (All)
    - factor analysis (SA)

- Hypotheses:
  - Non-directional
  - P-value approach for significance.

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Timeline
Human–Automation Co-operation

Main effect of Treatment A (Timeline)
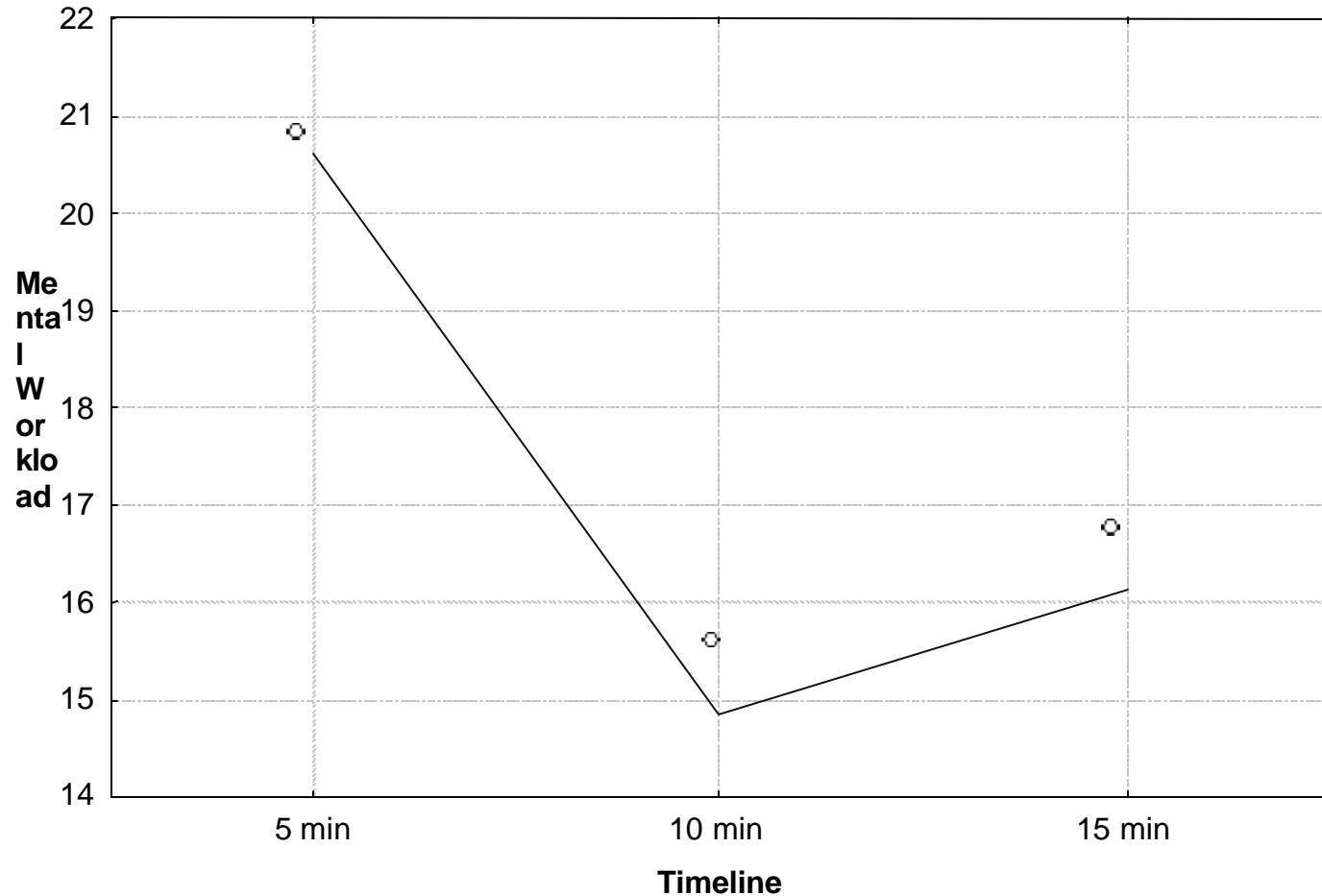$F(2, 18)=8{,}2445$, $p={,}00287$
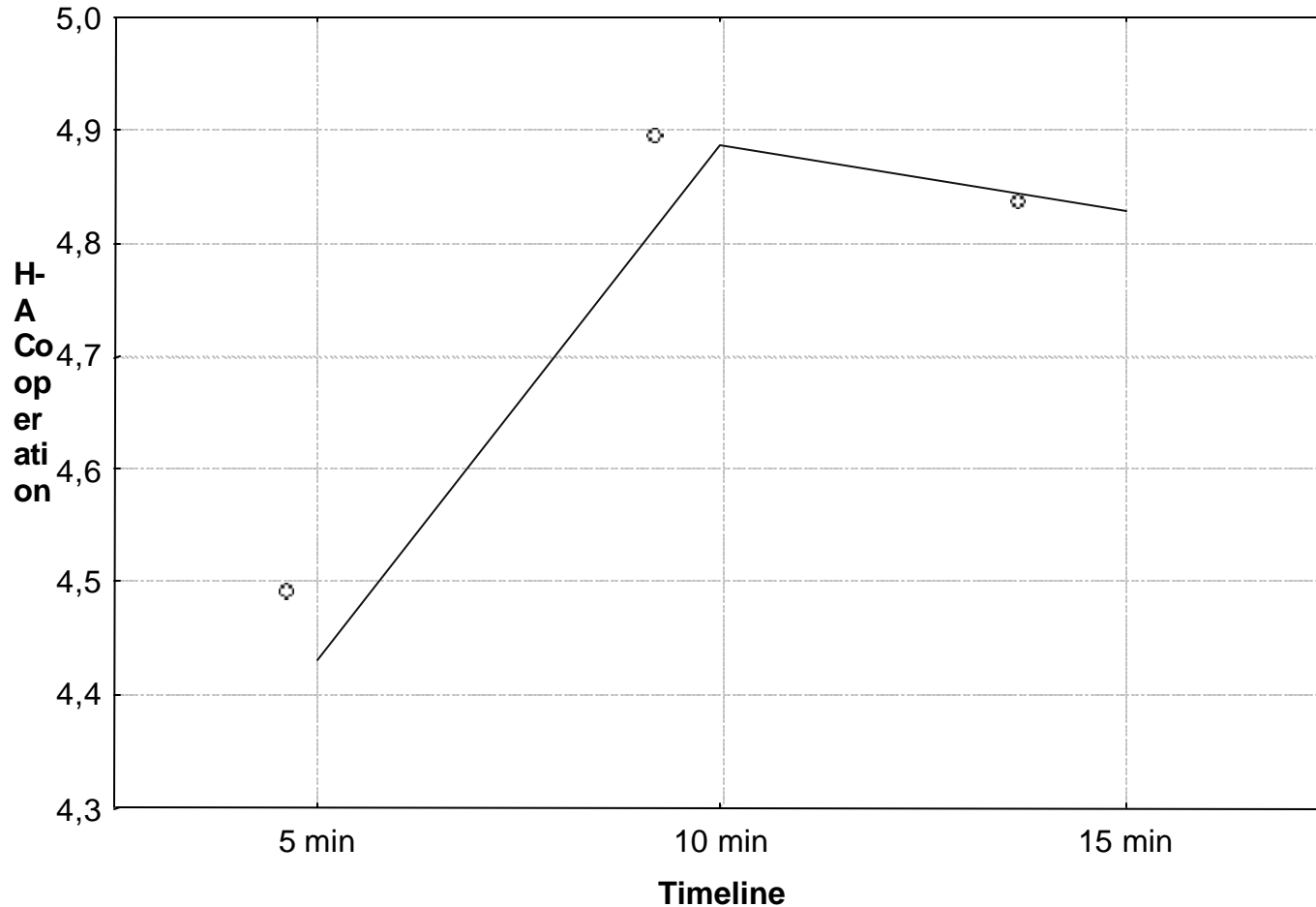
Timeline
Mental Workload

Main effect of Treatment A (Timeline)
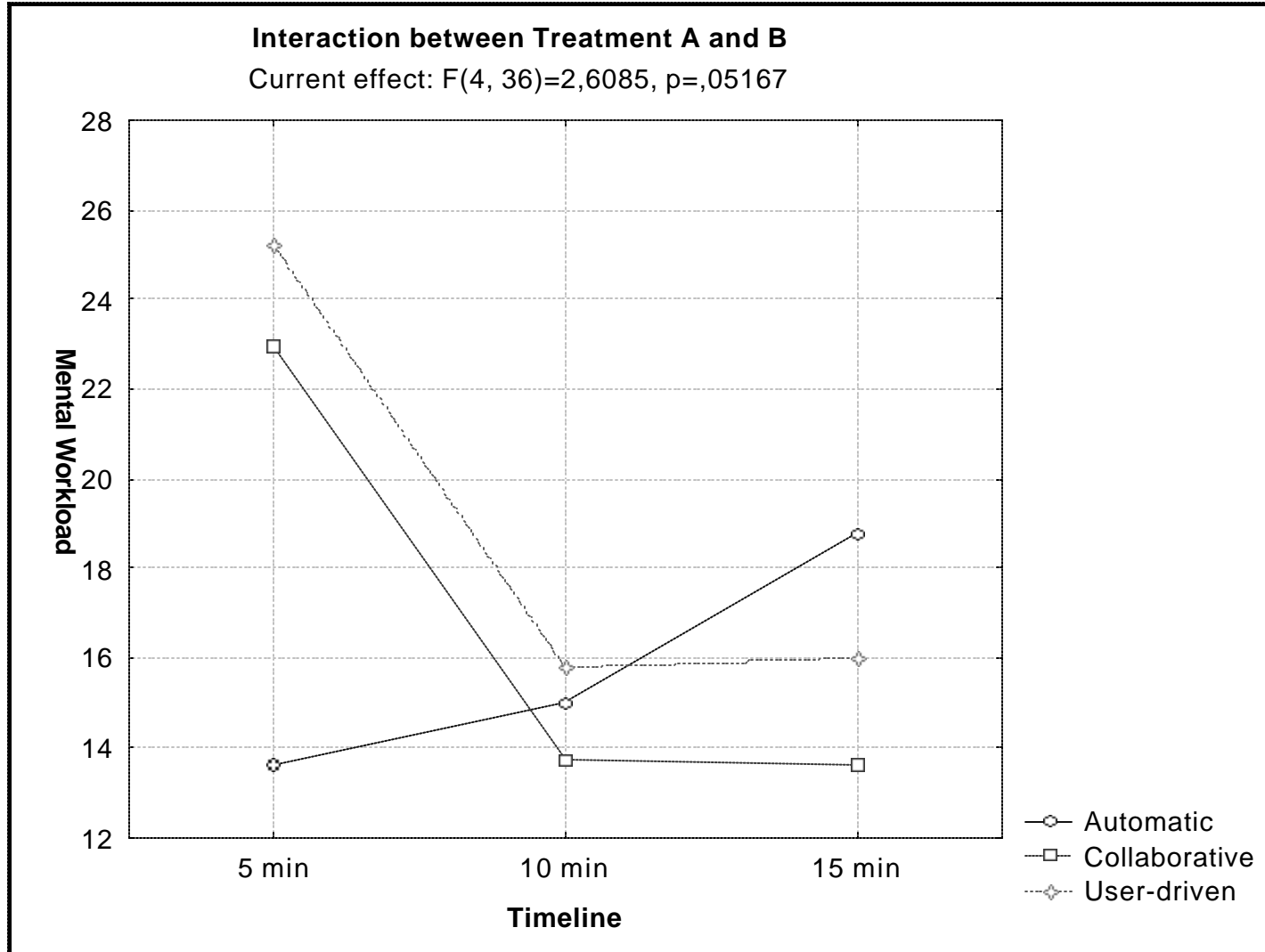
F(2, 18)=2,9411, p=,07848

Design Philosophy

No statistical evidence to suggest that the different design philosophies did not have an equal effect on Human-Automation Co-operation
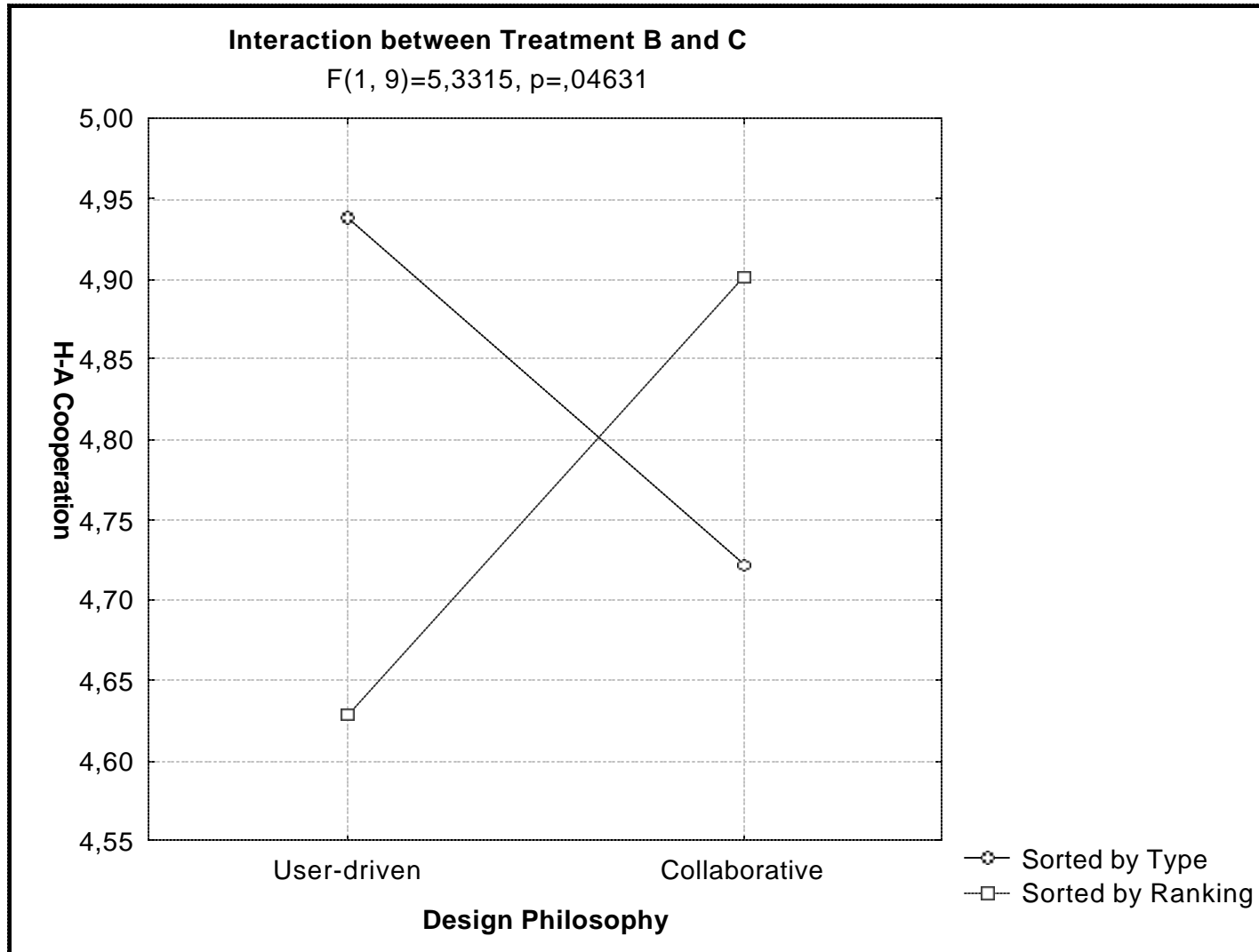
–   Observational nature of the task

–   Controllers not able to tell the difference

–   Controllers' preferences politically motivated

–   Experimenter bias

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Timeline & Design Philosophy Mental Workload
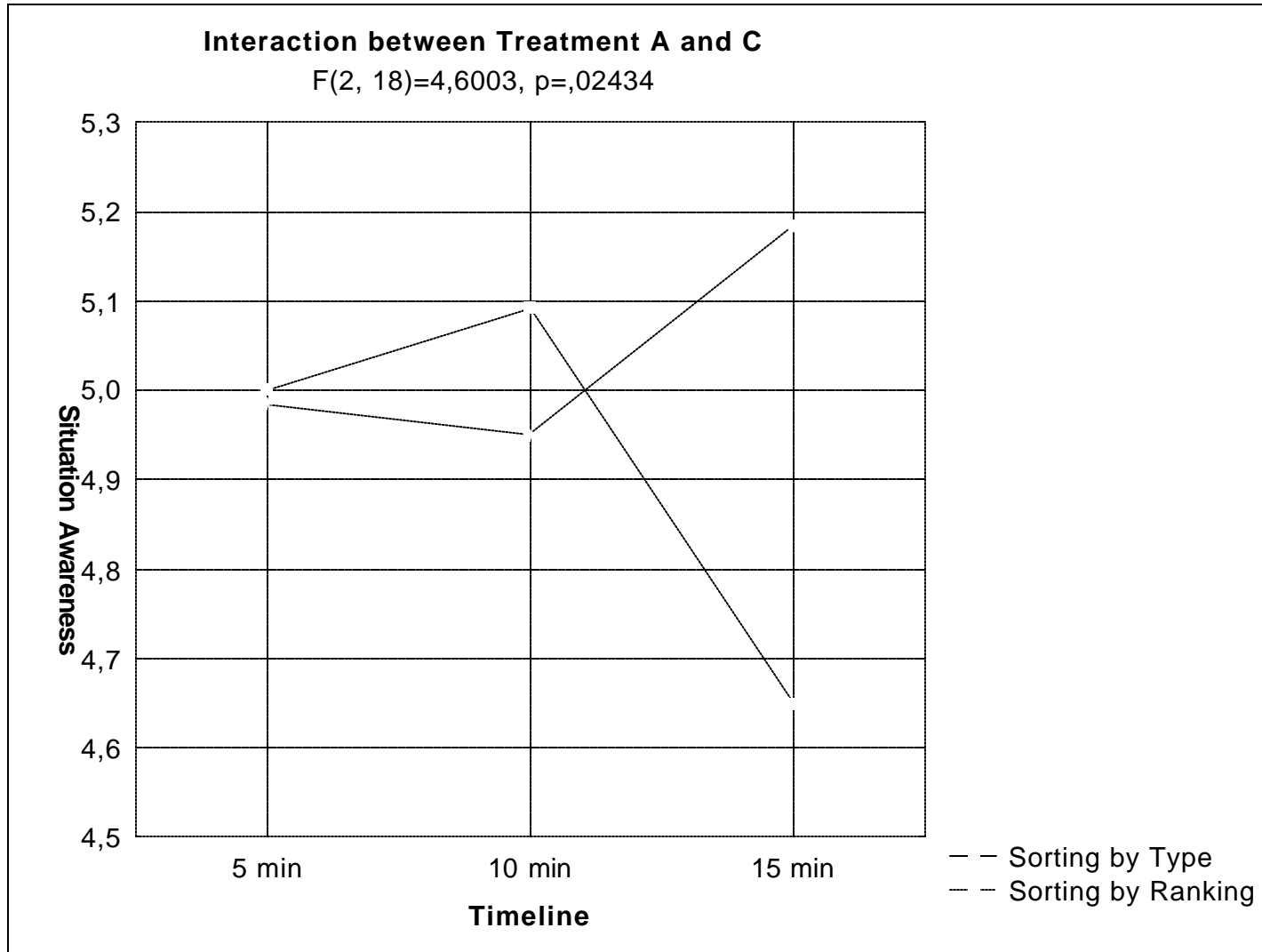

Interaction between Treatment A and B

Current effect: $F_{(4, 36)}=2{,}6085$, $p=,05167$

Chart axes: Mental Workload (12–28) vs. Timeline (5 min, 10 min, 15 min)

Legend:
- Automatic
- Collaborative
- User-driven

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Design Philosophy & Sorting Human-Automation Co-operation

Interaction between Treatment B and C

F(1, 9)=5,3315, p=,04631

Y-axis (H-A Cooperation): 4,55 to 5,00
X-axis (Design Philosophy): User-driven, Collaborative

Legend:
- Sorted by Type
- Sorted by Ranking

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Timeline & Sorting Principle Situation Awareness

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Interaction between Treatment A and C
F(2, 18)=4,6003, p=,02434

- – – Sorting by Type
- – – Sorting by Ranking

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Timeline preference
– forced & free choice –

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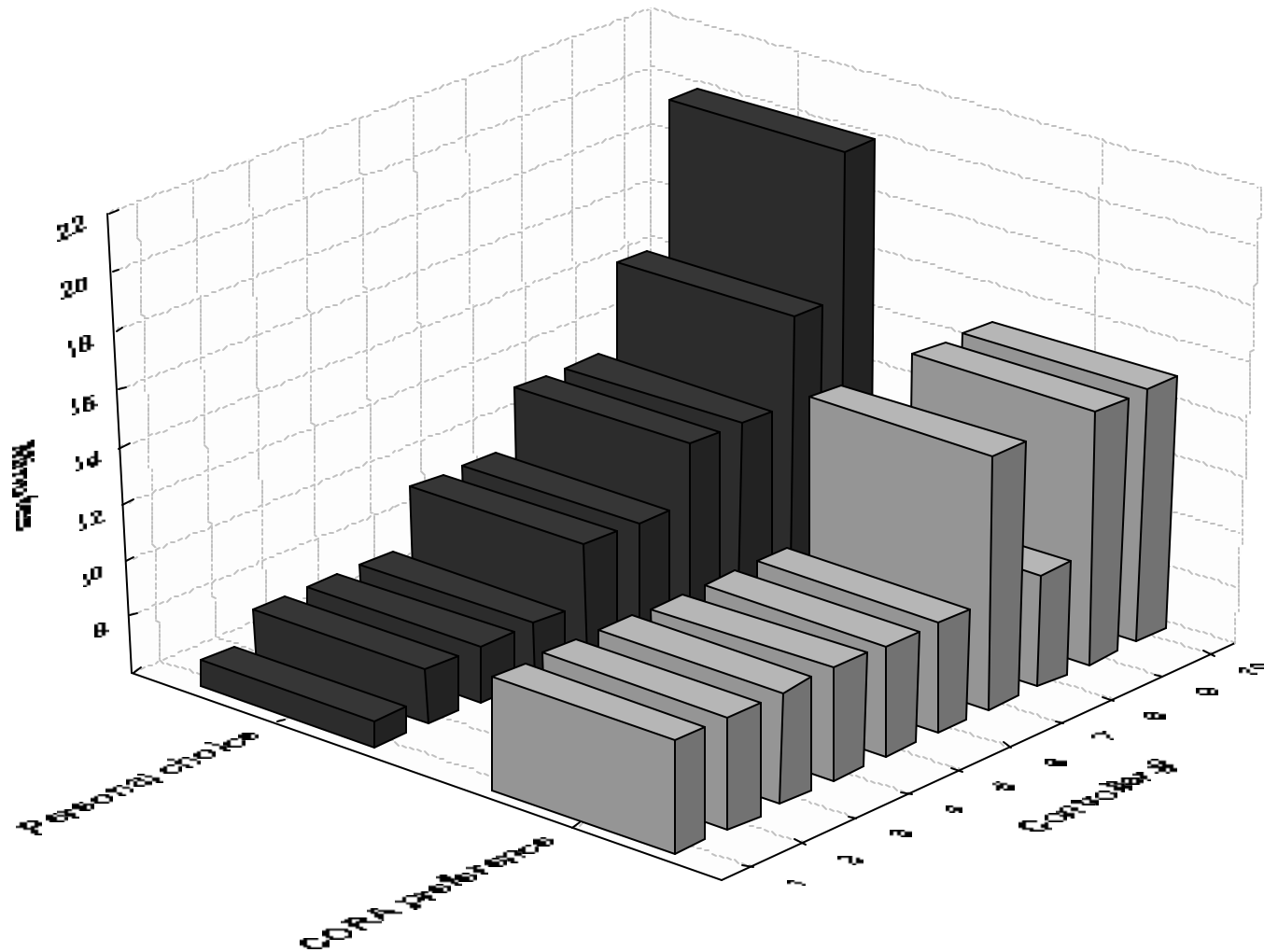
Timeline preference
– by Design Philosophy –

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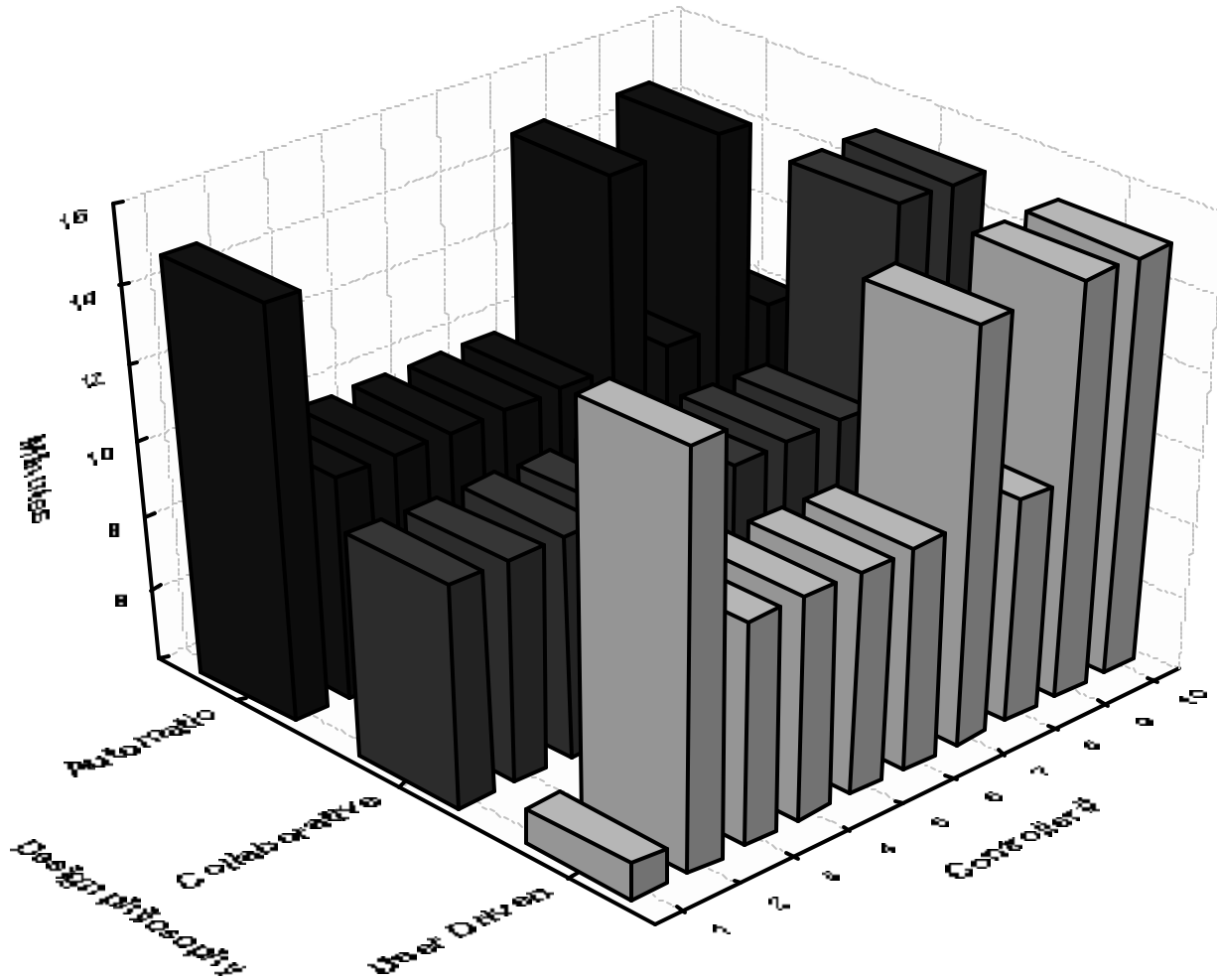
Results – End of Day Questionnaire / Debriefing

'Design Philosophies' for CORA:

- 📄 **User-driven**   3/10
- 📄 **Collaborative**   7/10
- 📄 **Automatic**   0

   (LOA/HMI – Controller bias – Researcher bias – Design)

Situation Awareness – very difficult to measure

Timeline:

- 📄 **10 & 15 minutes – more support at Planning stage**

   (7 – 20 minutes free choice)

Sorting:

- 📄 **By type for User-driven**
- 📄 **By quality-index for Collaborative**

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