A nighttime photograph of an airport. In the center, a tall, cylindrical control tower is illuminated from within, with a glowing ring of lights at the top. To the right, a smaller, more complex control tower is also lit up. In the foreground, a twin-engine aircraft is parked on the tarmac, surrounded by several orange traffic cones. The scene is lit with a mix of warm yellow lights from the ground and the towers, and cooler blue and green lights from the aircraft and surrounding area. The sky is dark blue.

Ecological Approach to Train Air Traffic Control Novices in Conflict Detection and Resolution

Roeland Visser, **Clark Borst**, René van Paassen, Max Mulder

Are ecological interfaces useful in supporting ATC training?

Future ATC: more automation support

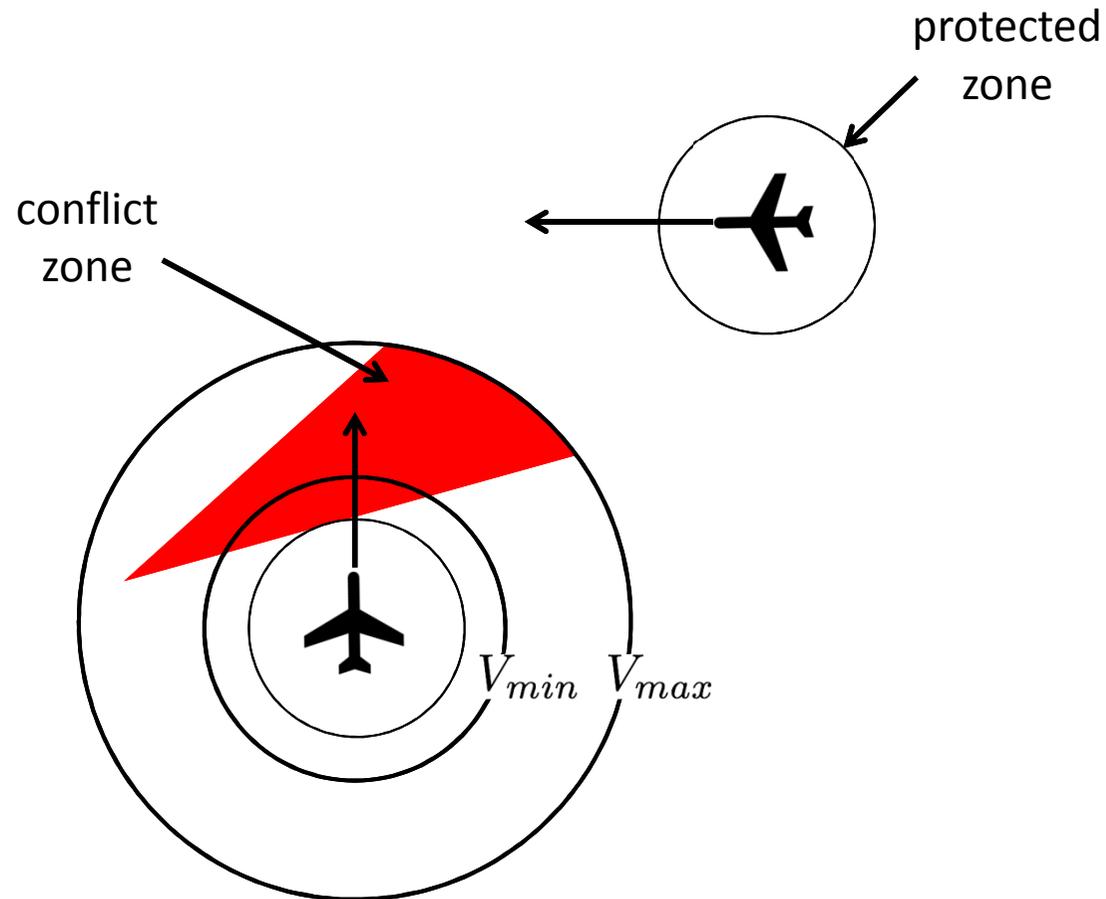
Problem: erosion of skills and expertise

This presentation: training of expertise
through 'transparent' decision-support tools

An empirical study in conflict detection & resolution



Ecological decision-support tool: Solution Space Diagram (SSD)

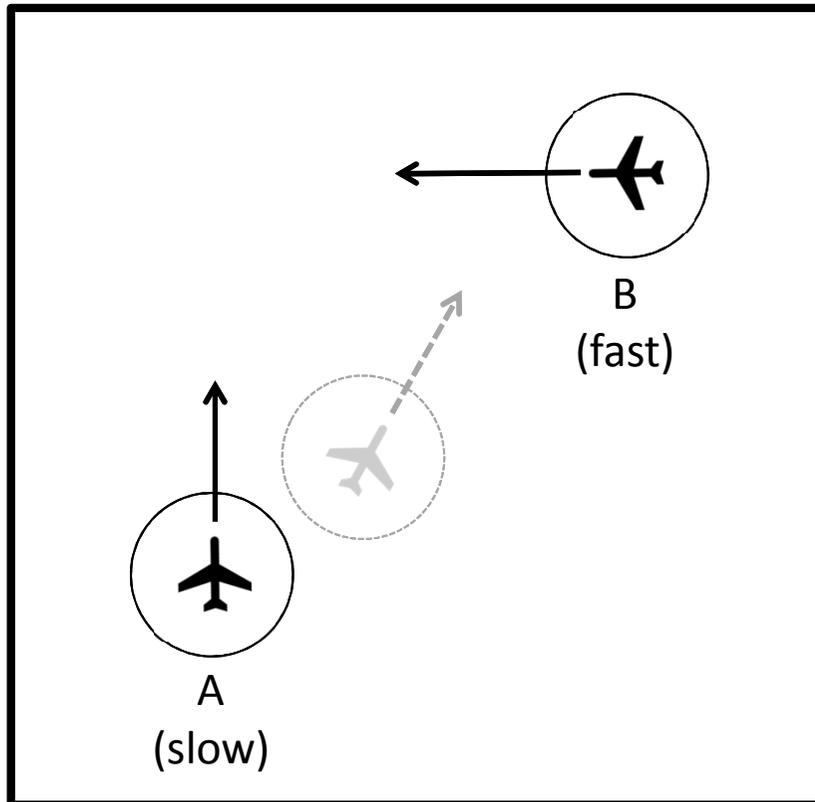


Solution Space Diagram (SSD)

ATC best practice: workload mitigating strategies

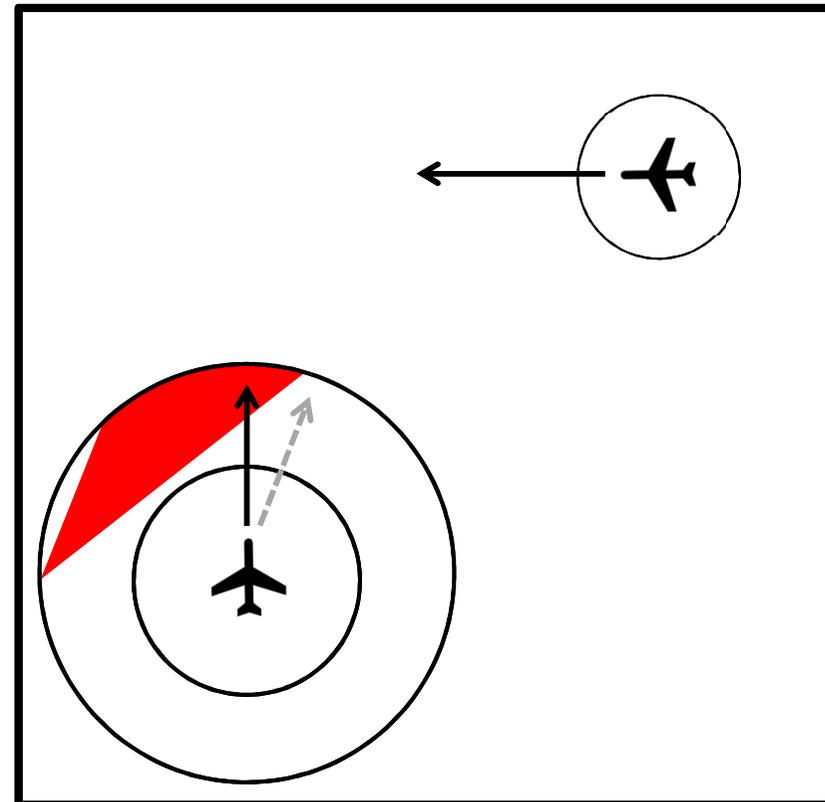
'best practice':

put slower aircraft A behind faster aircraft B

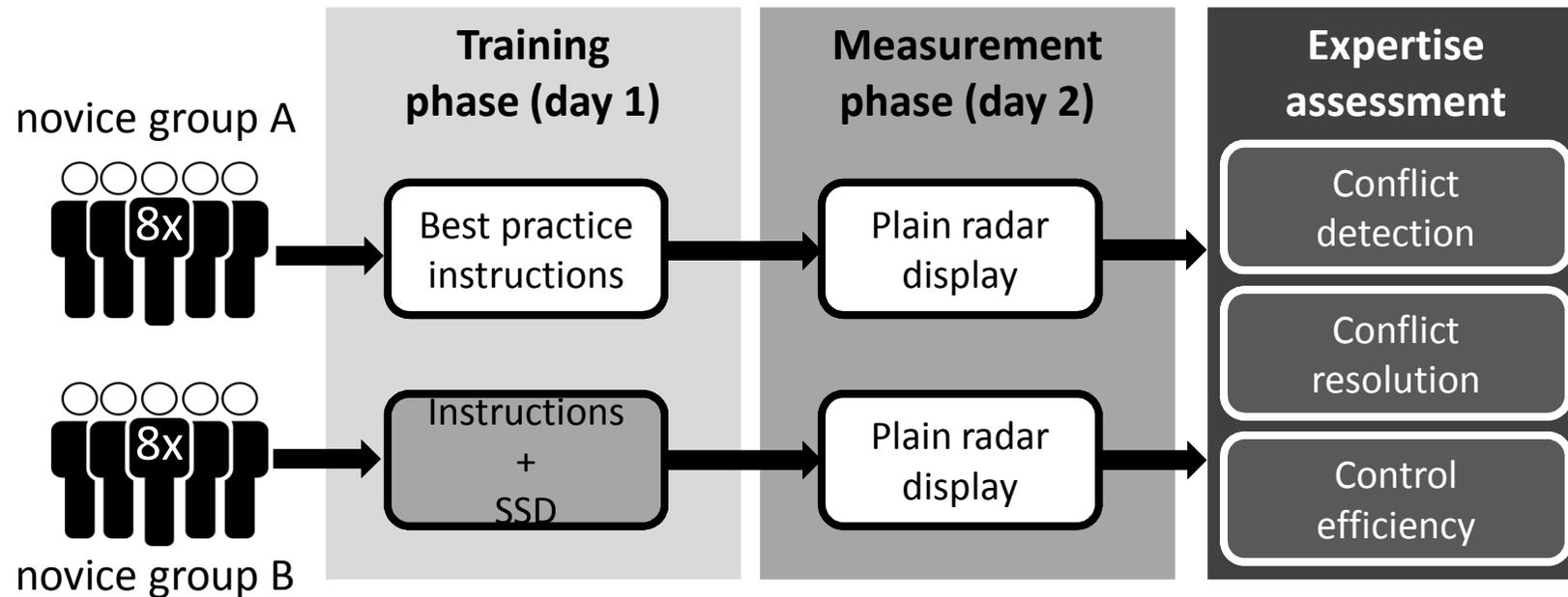


Solution Space Diagram:

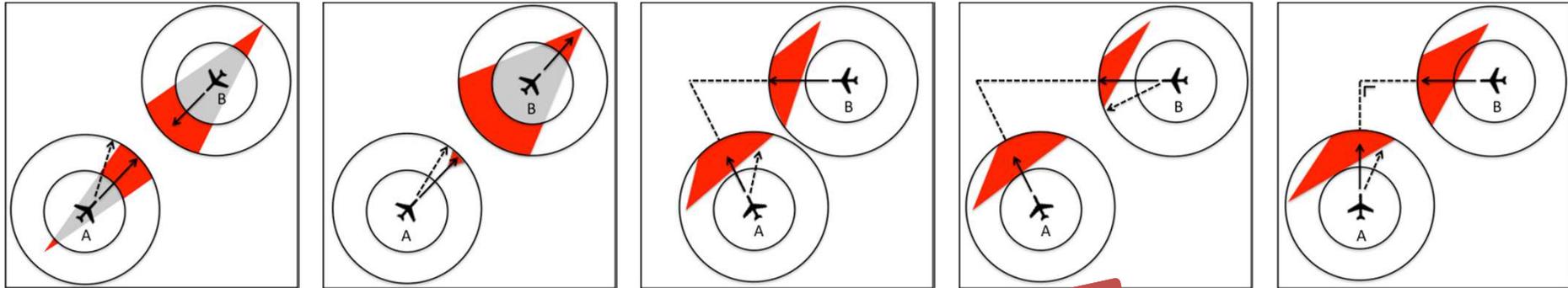
put slower aircraft A behind faster aircraft B



Two-day experiment



Conflict scenarios and solutions to be learned during training (day 1)



Head On
(HON)

Overtaking
(OVR)

Crossing

+ bias

Perpendicular
(PER)

Only valid for aircraft pairs!

Type

Solution (speed difference)

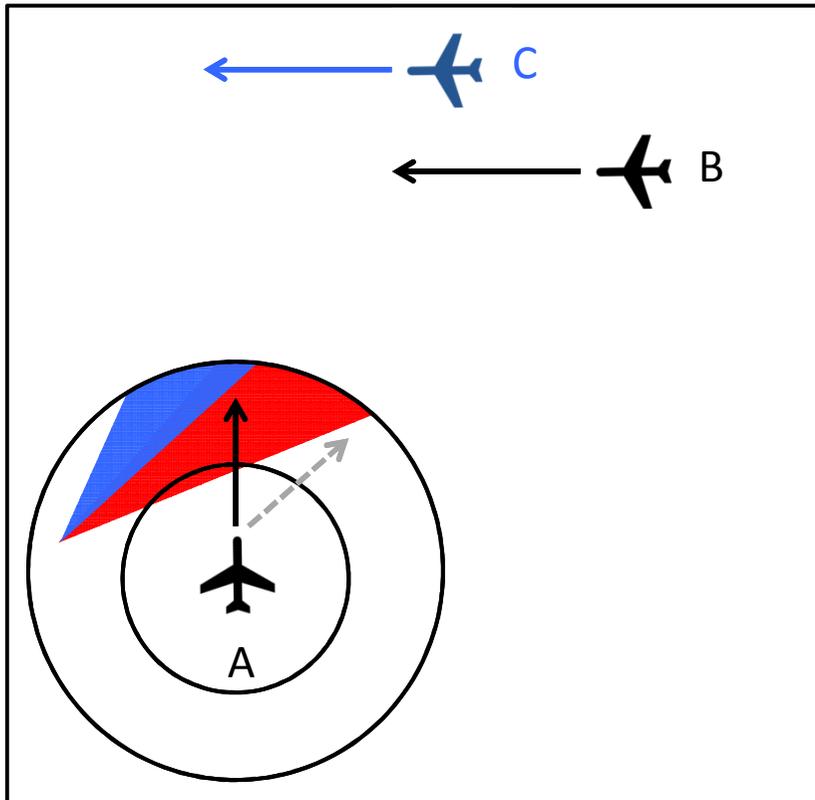
Solution (equal speeds)

HON
OVR
CRO
CRB
PER

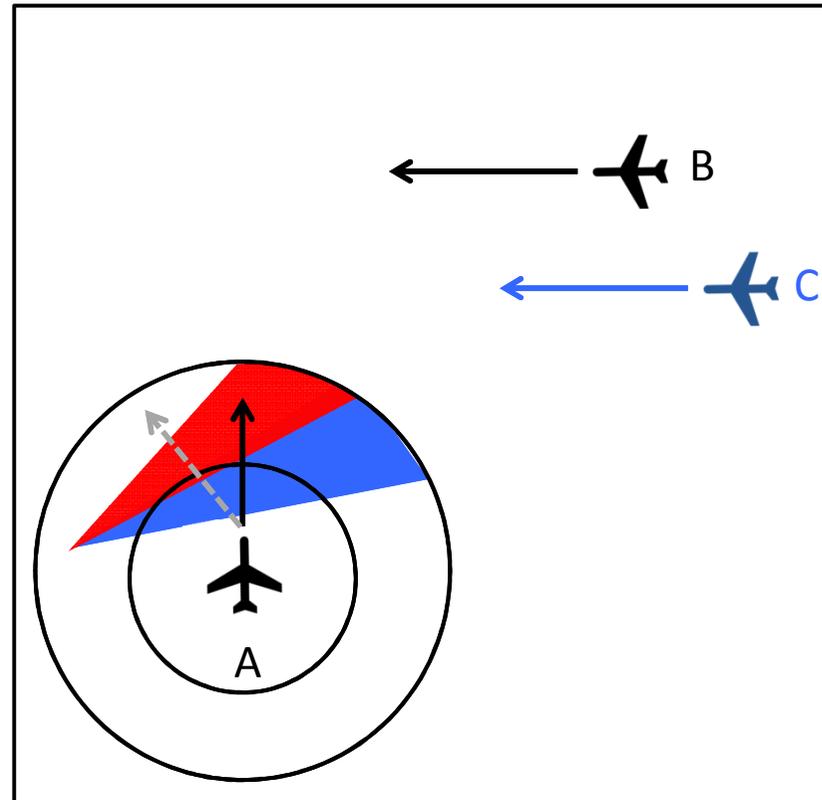
faster aircraft evades conflict
overtaking aircraft evades conflict
slower aircraft evades conflict
aircraft arriving later evades conflict
slower aircraft evades conflict

either aircraft, depending on surrounding traffic
n/a
either aircraft, depending on surrounding traffic
aircraft arriving later evades conflict
either aircraft, depending on surrounding traffic

Conflict scenarios during final measurement trials (day 2)

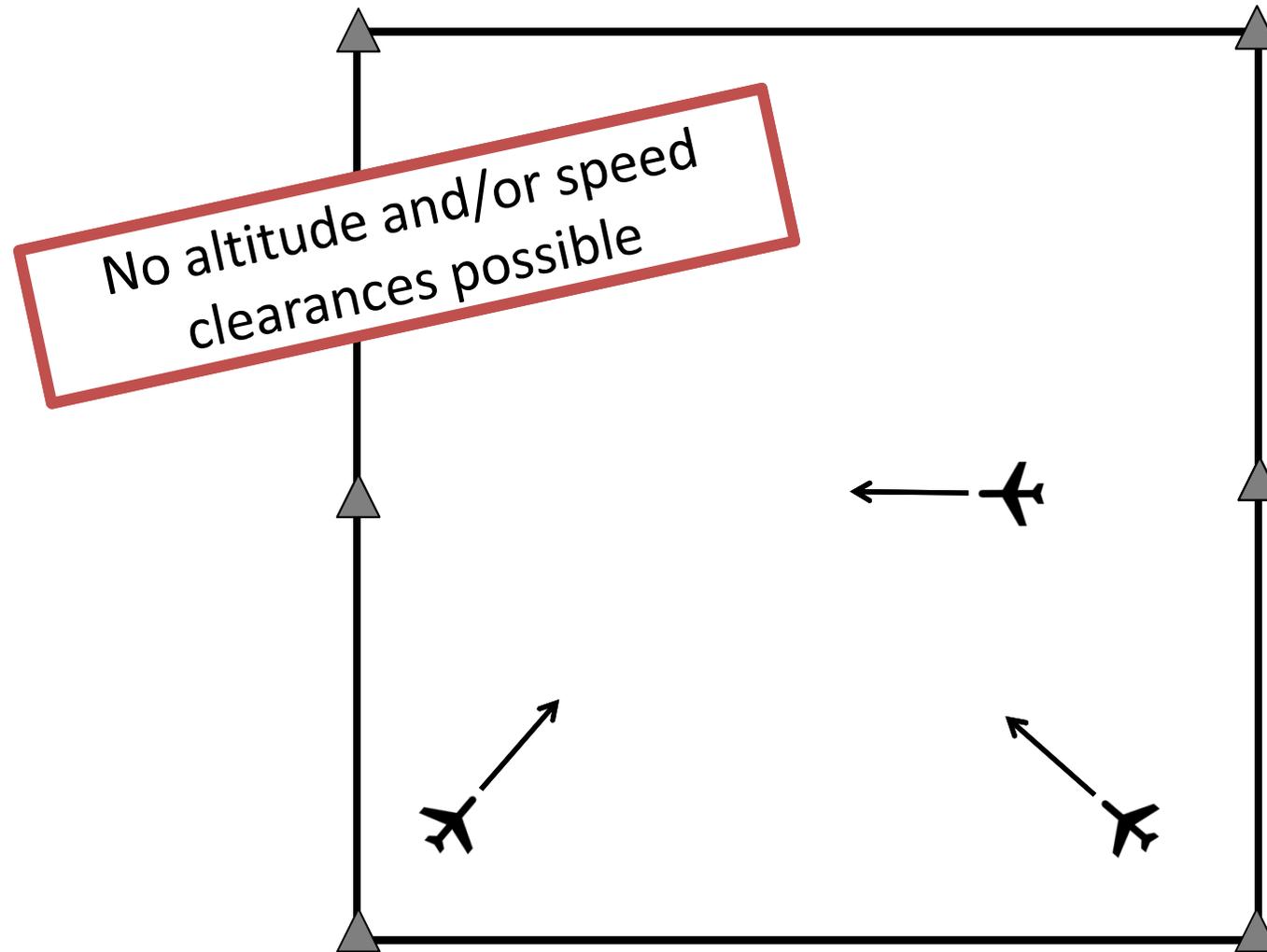


Third aircraft C strengthening the best practice.

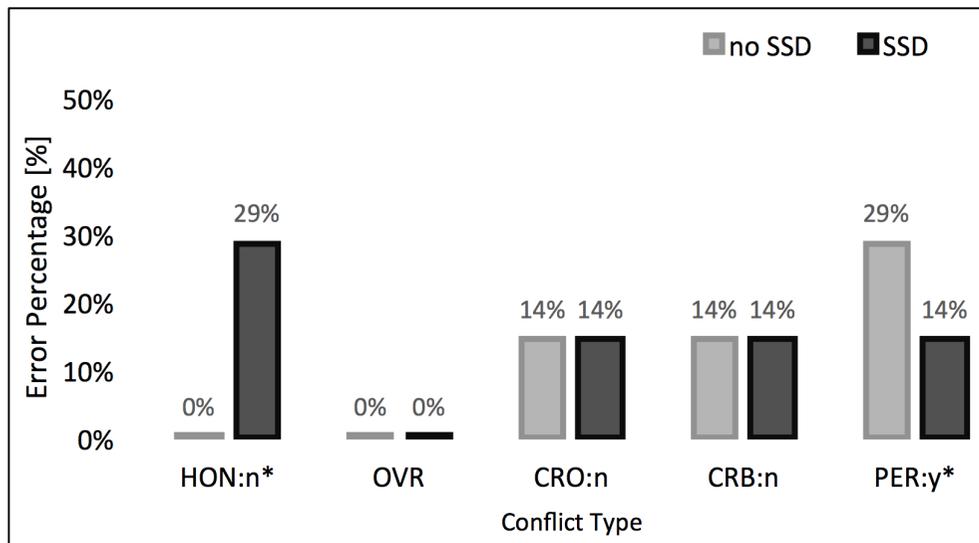


Third aircraft C enforcing departure from best practice.

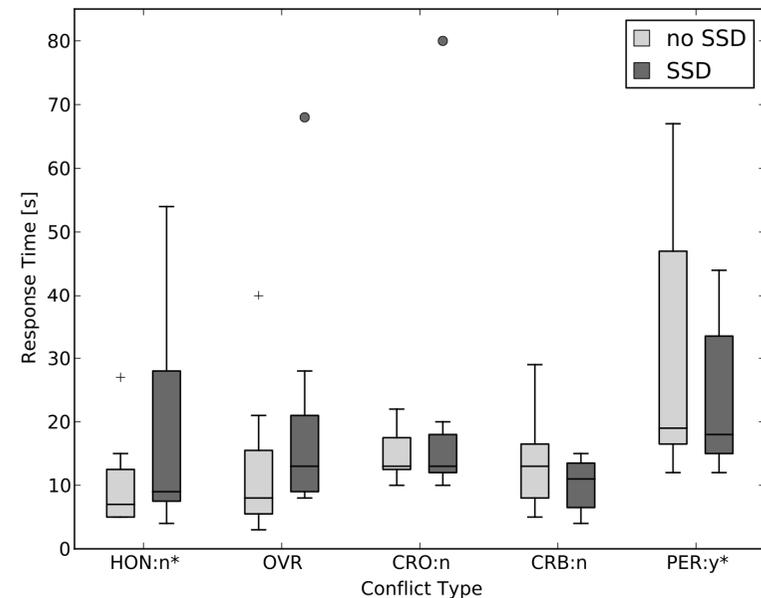
Participant task: resolve conflict and clear to exit waypoint



Results: conflict detection



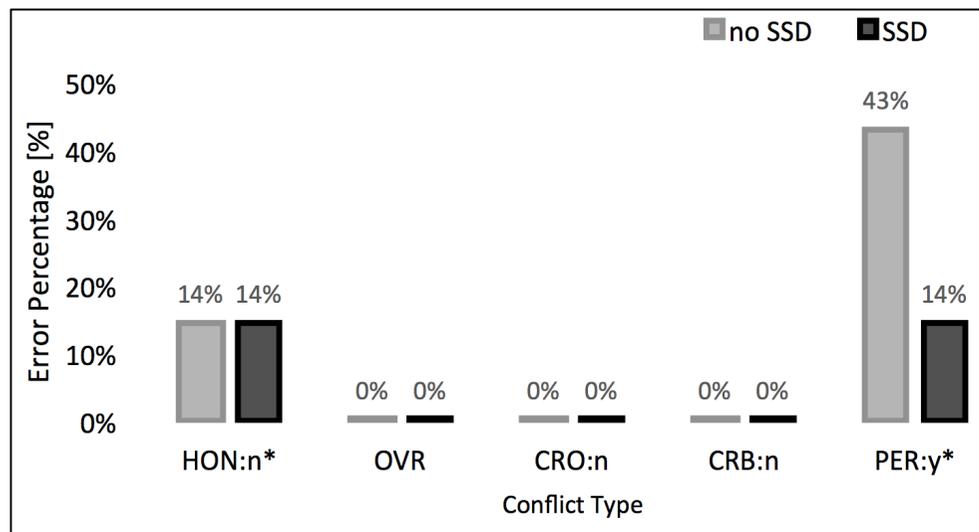
Percentage incorrect conflict recognition



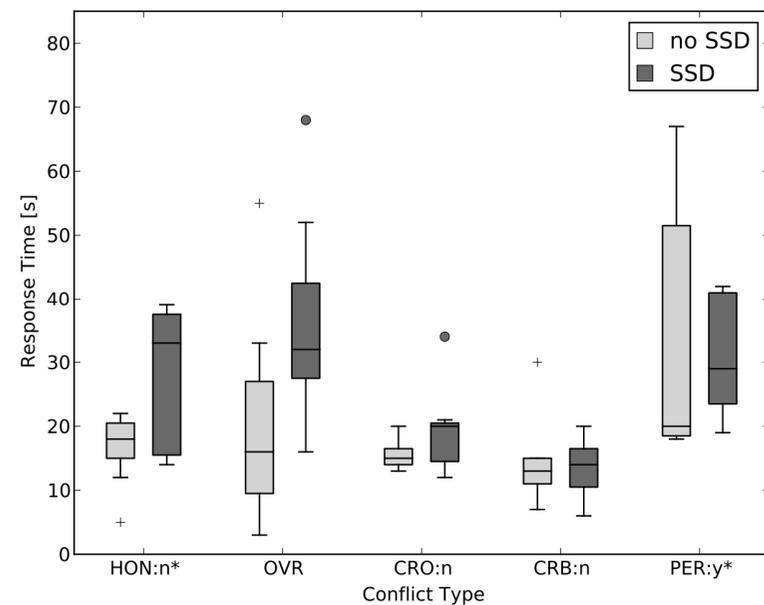
Cumulative correct conflict recognition response time [s]

* : departure from best practice
y/n : speed or no speed difference

Results: conflict resolution: aircraft choice



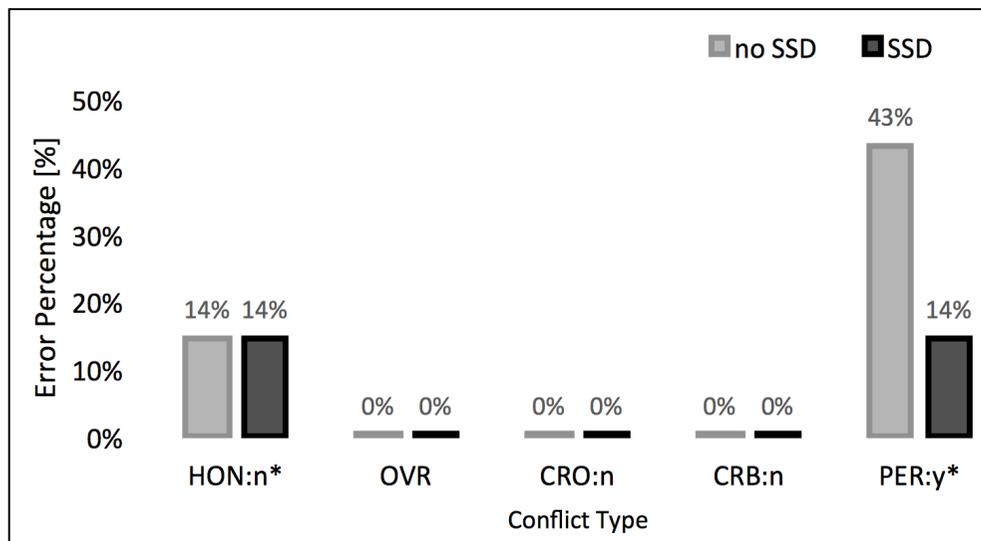
Percentage incorrect aircraft choice



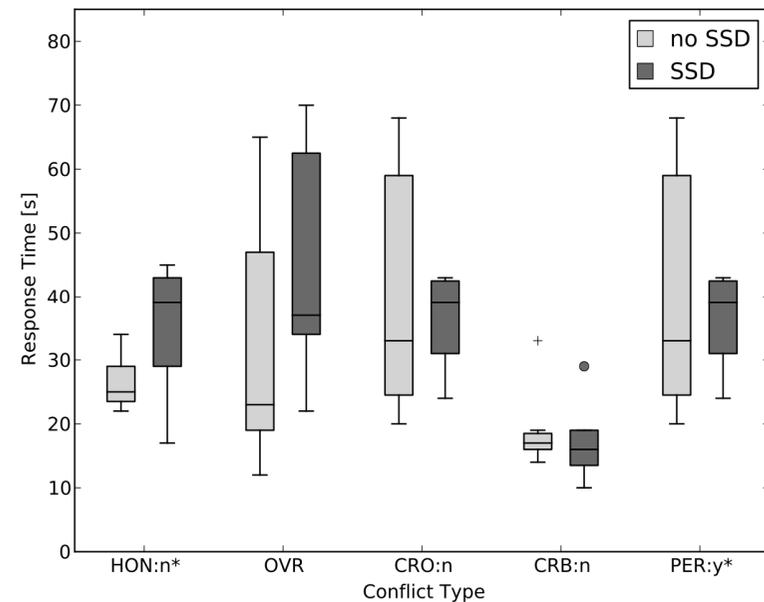
Cumulative correct aircraft choice response time [s]

* : departure from best practice
y/n : speed or no speed difference

Results: conflict resolution: solution choice



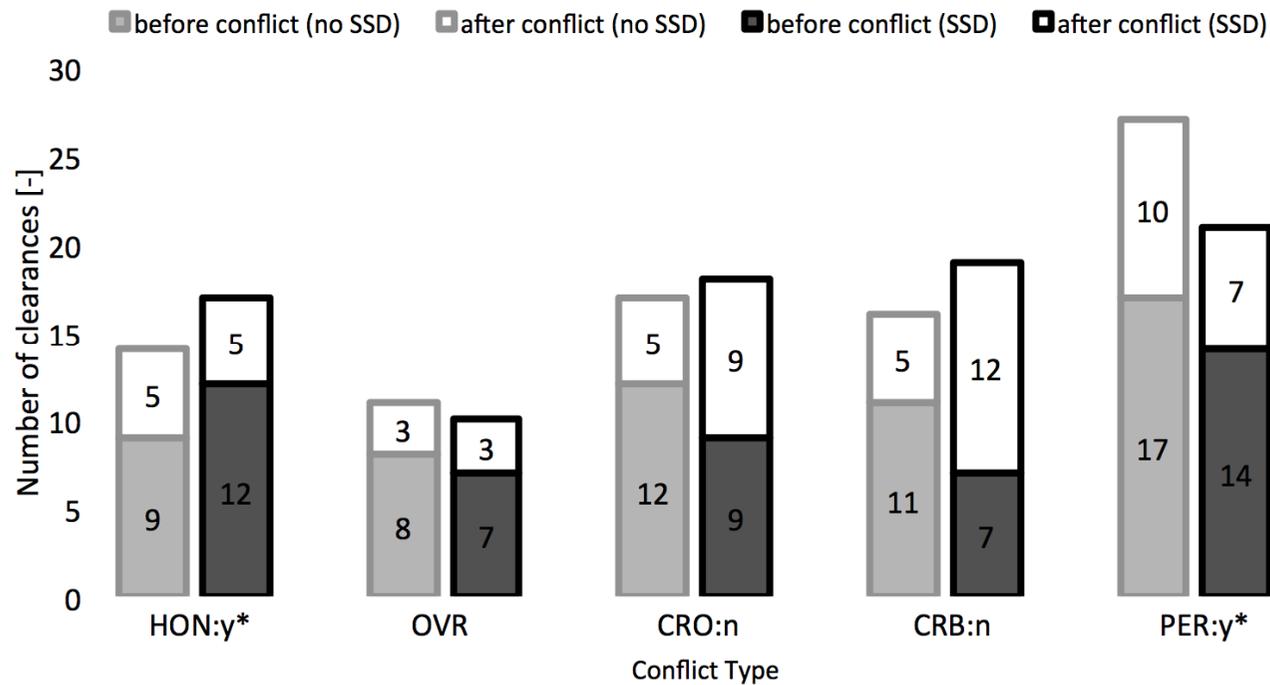
Percentage incorrect solution choice



Cumulative correct solution choice response time [s]

* : departure from best practice
y/n : speed or no speed difference

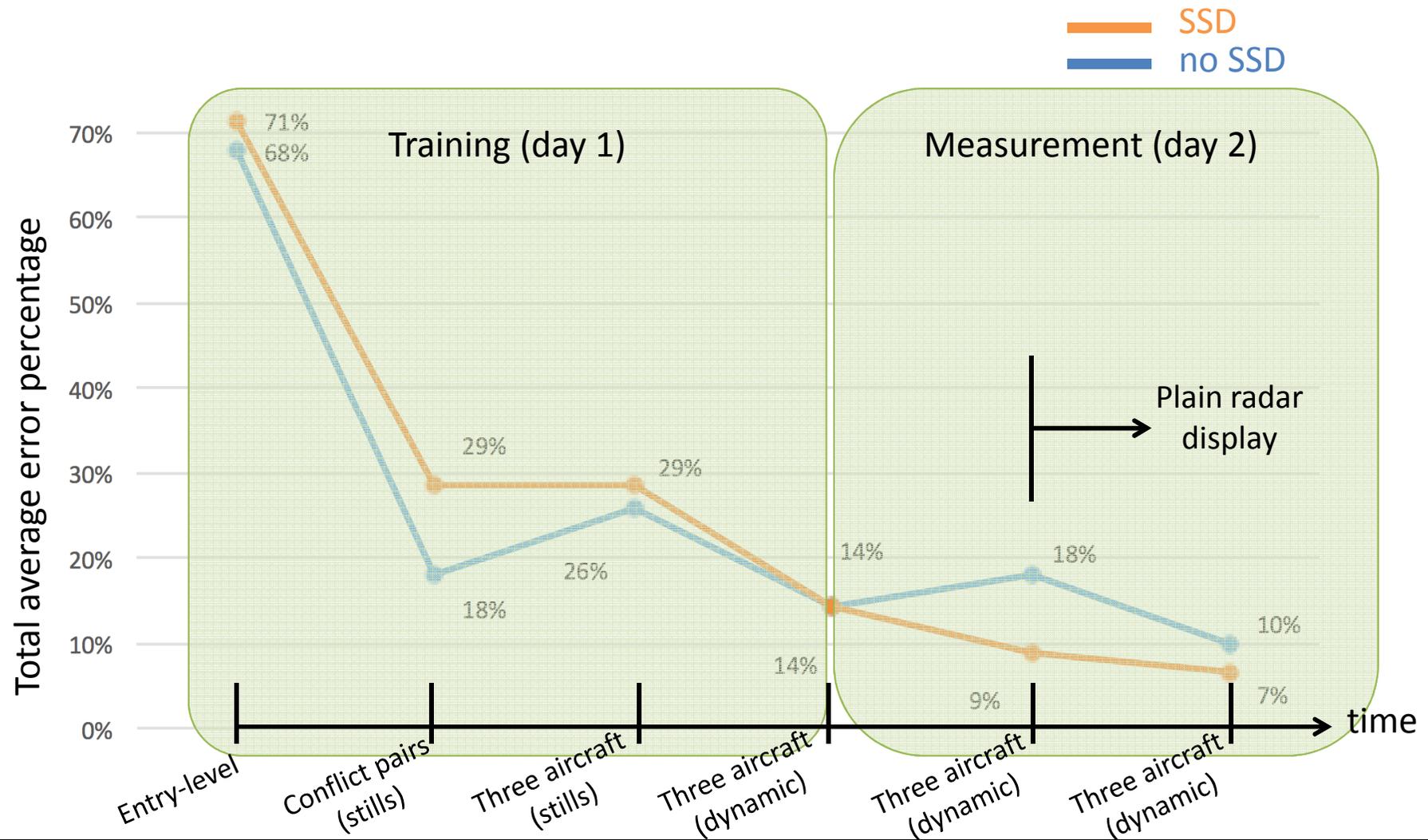
Results: control efficiency: number of clearances



* : departure from best practice
 y/n : speed or no speed difference

SSD group : 85 clearances
 Non-SSD group : 55 clearances

Observed 'learning' curve



Conclusion

Did training with the ecological interface lead to better and more desirable ATC behavior?

The SSD helped most in solving particular and 'novel' traffic situations (i.e., PER conflict requiring deviation from the learned best practice.)

The SSD also led to more delayed responses and reduced decisiveness (due to critical reflections and over-analyzing the traffic scenarios).

BUT: this study was focused on *training* and *learning*, in which critical reflection is crucial in bridging the gap between abstract theory and practice.

Further steps

- Map decision-making strategies
- Longer training time (weeks/months)
- Larger sample size