

Some Ideas for Future Directions in Annoyance Research

Patricia Davies

Director, Ray W. Herrick Laboratories,
Professor, Mechanical Engineering, Purdue University,
&
FAA/NASA/Transport Canada PARTNER
Center of Excellence Researcher



Acknowledgement

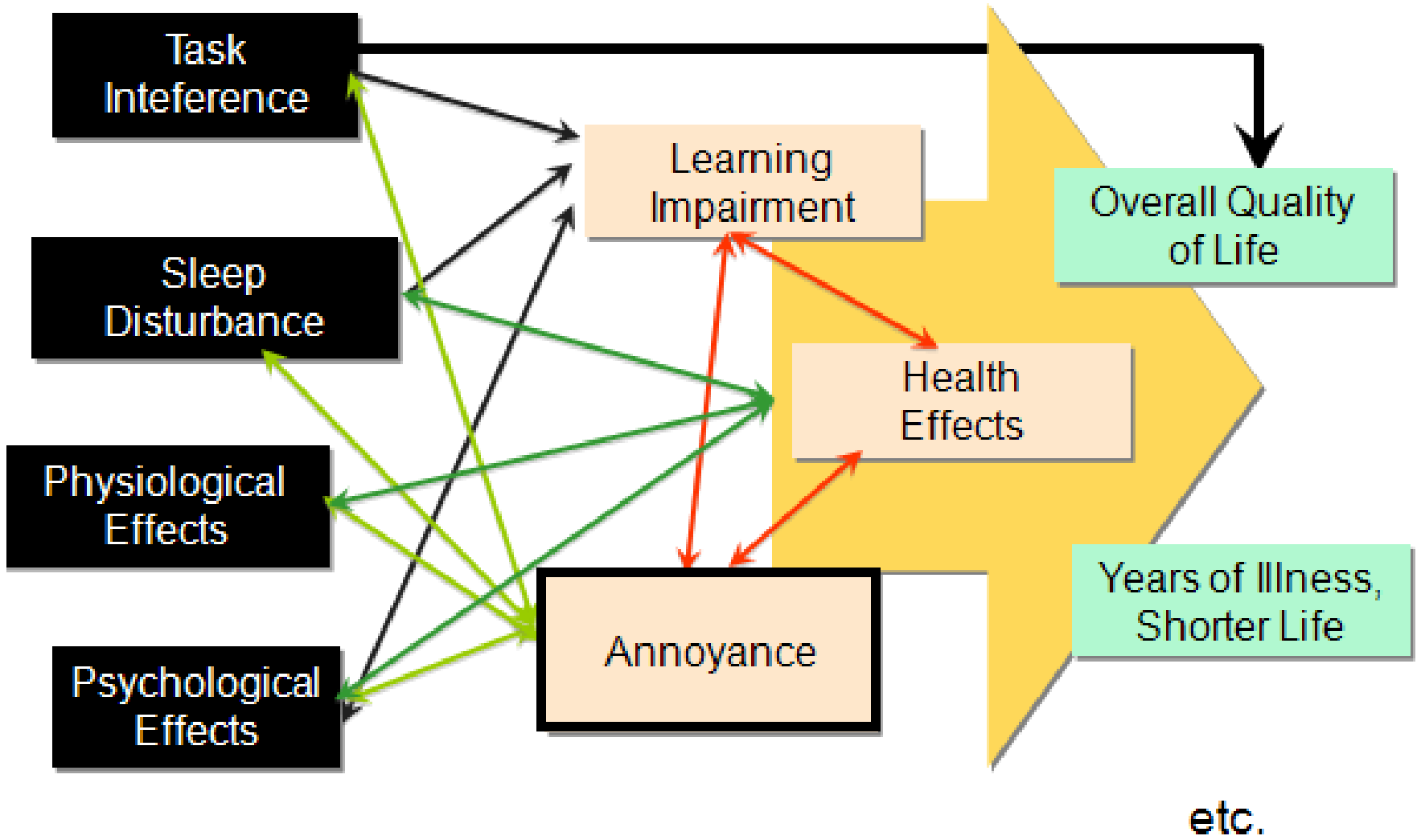


I wish to thank the FAA/NASA/TC PARTNER Center of Excellence for their financial support for some of the annoyance research that I have done:
Projects 2, 24, 25, 19 and 8

Any opinions, findings, and conclusions or recommendations expressed in this material are mine (P.Davies) and do not necessarily reflect the views of the FAA, NASA or Transport Canada.

Immediate Effects

Longer Term Effects



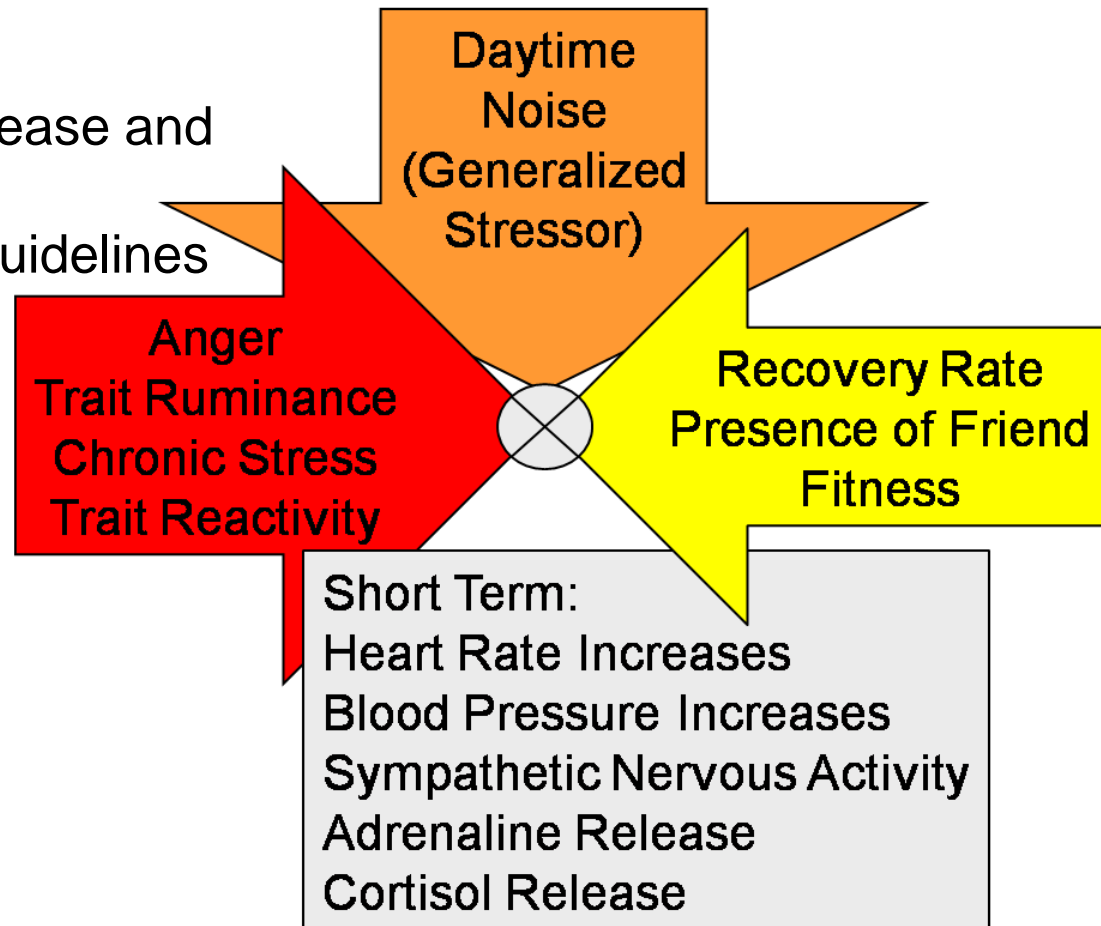
Annoyance & Cardiovascular Health: Plausible Pathways

Sound

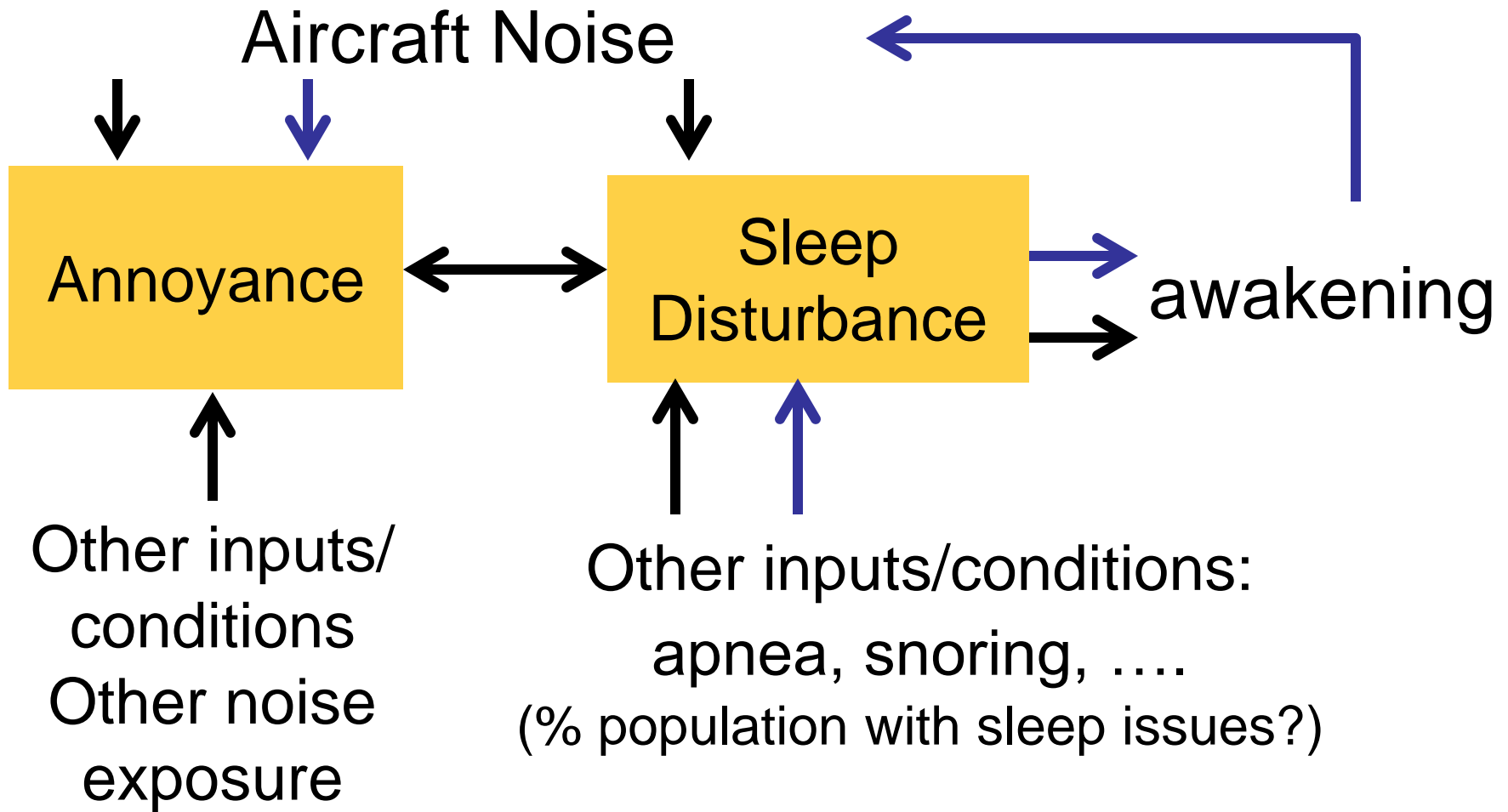
- annoyance (noise)
 - physiological arousal (stress indicators)
 - (biological) risk factors
 - disease (cardiovascular disease and hypertension) & mortality
- (Babisch, WHO Night Noise Guidelines for Europe, 2009)

Modifiers of Annoyance Reaction

Vulnerable groups:
noise sensitive, older people, people with anxiety,



Annoyance & Sleep Disturbance



Noise & Annoyance

- Loudness (statistics)
- Rate of Change of Loudness
- Impulsiveness
- Spectral Balance
- Fluctuation (amplitude & frequency modulations you can follow, max. at 4 times per second)
- Tonality
- Roughness/Harshness

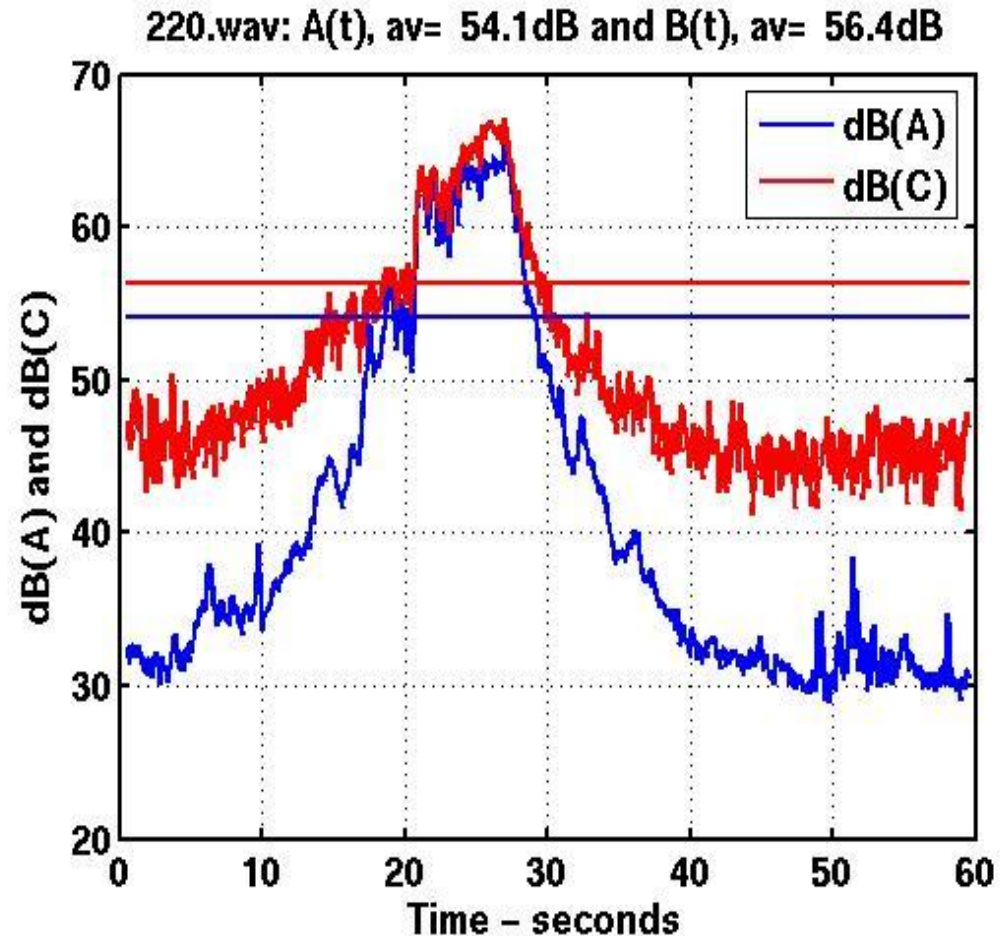
Other Noise Effects

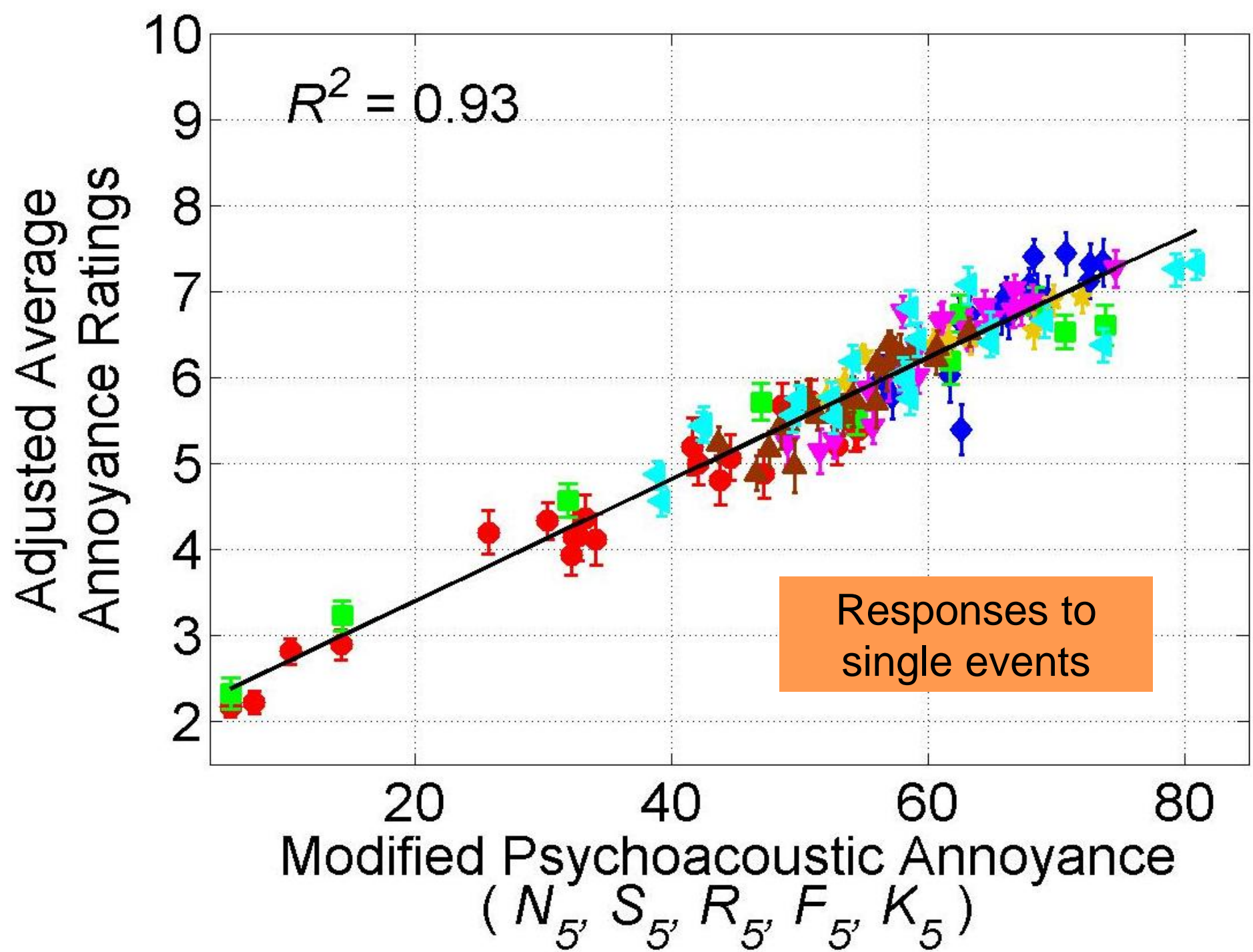
- Task interference including speech disturbance
 - **Annoyance Factors: number, intermittency, frequency, times of quiet, length of times of quiet.**
 - **Detectable, attention grabbing**
- Affect on cognitive abilities & learning
 - Short and long term effects
 - Children, older people

What noise characteristics most particularly affect these?

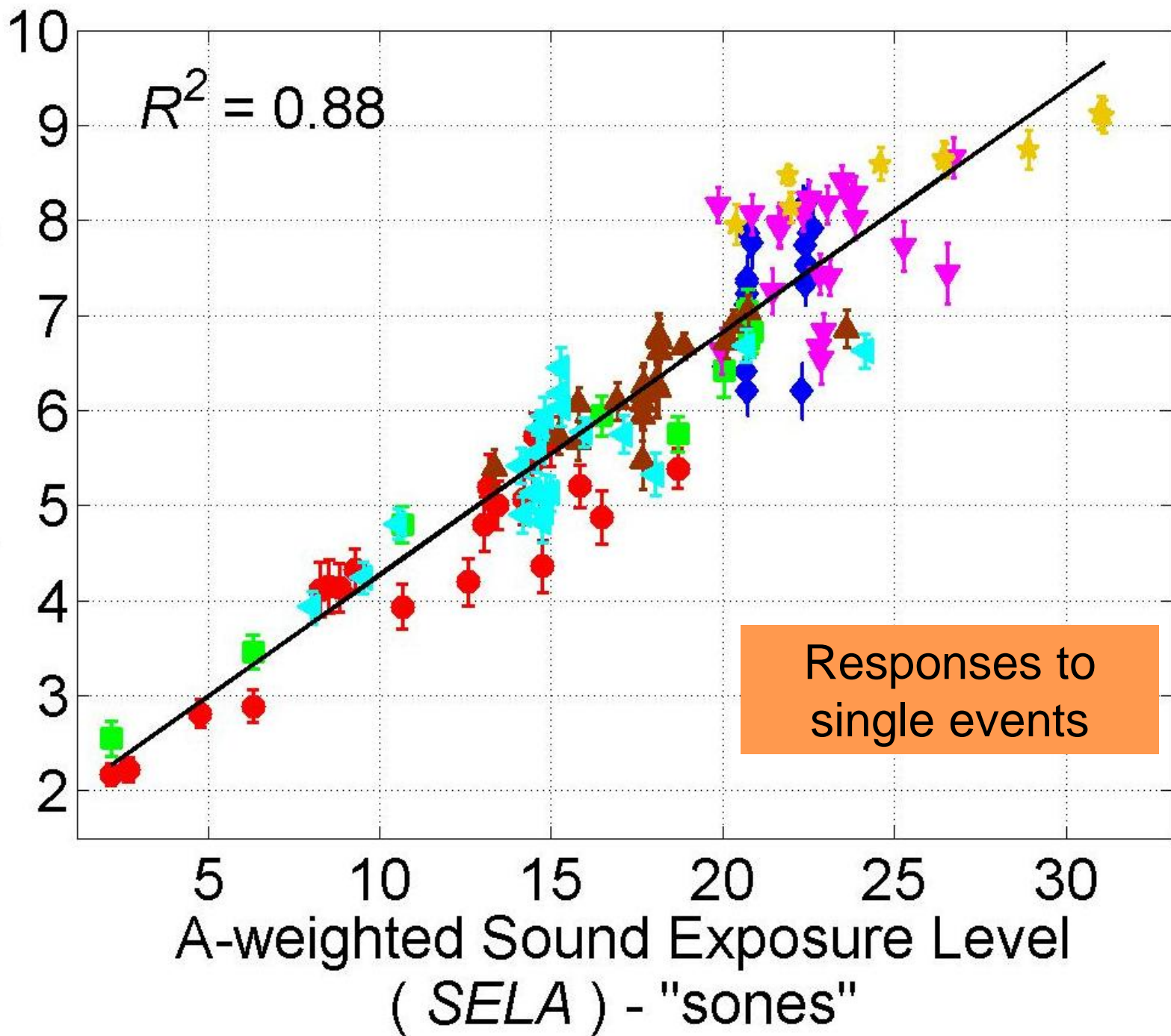
Aircraft Noise Metrics in Use

- Based on A-weighted sound pressure level (not the same as loudness)
- Levels change during an event
- Spectral content can change, too
- A metric that reflects perceived level (loudness) in all circumstances, a good idea?





Adjusted Average Annoyance Ratings



Sleep Disturbance & Sound Characteristics

- Peak Levels
- Rate of Change of Loudness at Onset
- Spectral Characteristics
- Time of Night
-

Bridging the Gap - Cumulative Metrics

Responses to
Single Events



Metrics: more
than level &
better measures
of level

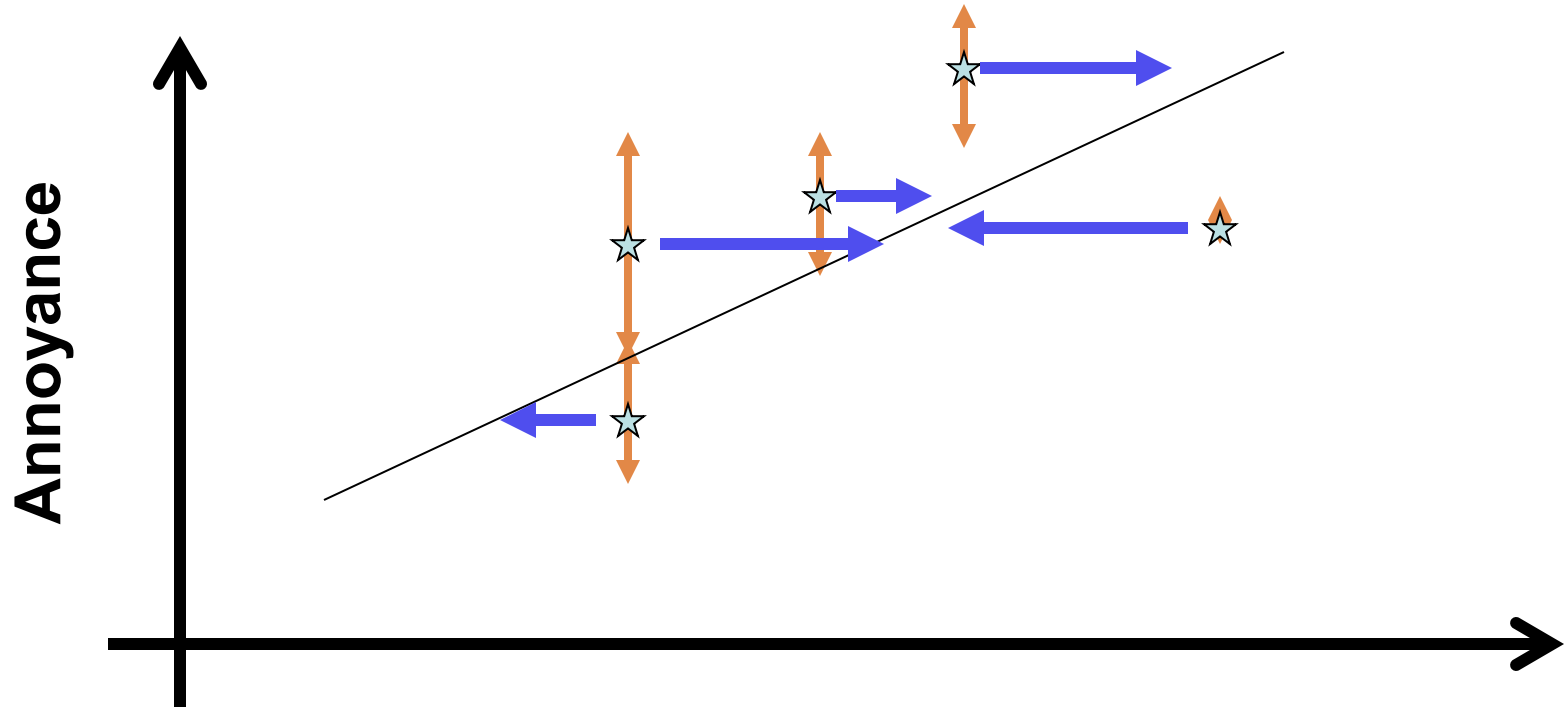


Responses to Multiple
Exposures Over Long
Periods of Time



1. Can we improve on Ldn?
2. Should we include non-noise related input ?
3. How can we test new theories on aircraft noise annoyance modeling?

Can We Improve on Ldn?



Noise Metric of Choice
Is it sensitive enough?

The Need For Data

Noise data from previous surveys , if available, is inadequate to test out new annoyance models

- Information required for simulation of noise exposure generally unavailable
- Noise predictions do not generate sounds that you can listen to & therefore desired inputs to more advanced models of sound perception are currently unavailable
- Inconsistencies on annoyance scales, survey set up and protocols
- Inadequate data to quantify important context effects.....???

The Need to Share Data

- No ONE survey/study is going to answer all questions, too big a task to do many at once
- Want to be able to take results from one survey and compare with results from other surveys
- New ideas arising from current research should be tested out on existing survey data, provided those data sets are sufficient for exploration
- Such a data base provides a common test ground to compare (and confirm) performance of different models/theories

Notes on Data

- Need for commonly accepted methodologies and measurement, recording and archiving protocols
- Need to collect raw data (sounds, e.g.,) to enable as much exploration as possible.
- Collecting only noise metrics currently in use inhibits (prohibits) exploration
- Need to be inclusive → enable add-on studies, follow-up studies
- Need a home for this data and a process for sharing

Data Collection - Many New Opportunities

- Now easier than ever to make measurements and transmit
- Transducers easier to use and measurements easier to do - now possible to do “objective” measurements with a large number of people
- Total noise exposure measurement possible: work, commuting, home, neighborhood, entertainments, etc.
- People’s opinions shared freely on the web - can you track noise impact by analyzing web activity? (B.L. Bhaduri, Oak Ridge NL)
- Easy to communicate

To Make Progress

- Decisions must be data driven
- Theories are only good if they can be used to explain observations
- We should not be afraid of doing more complicated calculations
- More complicated models are good if they can explain things that simpler models cannot
- One can make more informed decisions on simplification when a more complicated and accurate model is available
- Complicated models can produce perfectly understandable outputs