

Taking science to the sky: applying cognitive science techniques to aviation

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Background

- In high-stakes multitasking operations such as aviation, operators experience increased cognitive demand, which can affect task performance (Watanabe & Funahashi, 2014; Kahneman, 1973).
- Molesworth and Estival (2015) showed pilots' verbal communication with air traffic control officers (ATC) was affected by various sources of increased demand.
- Was flight performance similarly affected, or could pilots prioritise aviation over communication?

Method

Seventeen pilots completed a flight task in a medium-fidelity flight simulator. Three scenarios were flown, each with a low- and high-load version.

- **Speech Rate:** ATC transmissions were spoken at standard speed (low) or double the recommended speed (high).
- **Information Density:** Each ATC transmission contained fewer than three (low) or four or more (high) information items.
- **Cognitive Workload:** Pilots were required to perform a mid-flight fuel calculation in the high-load condition.

Analysis

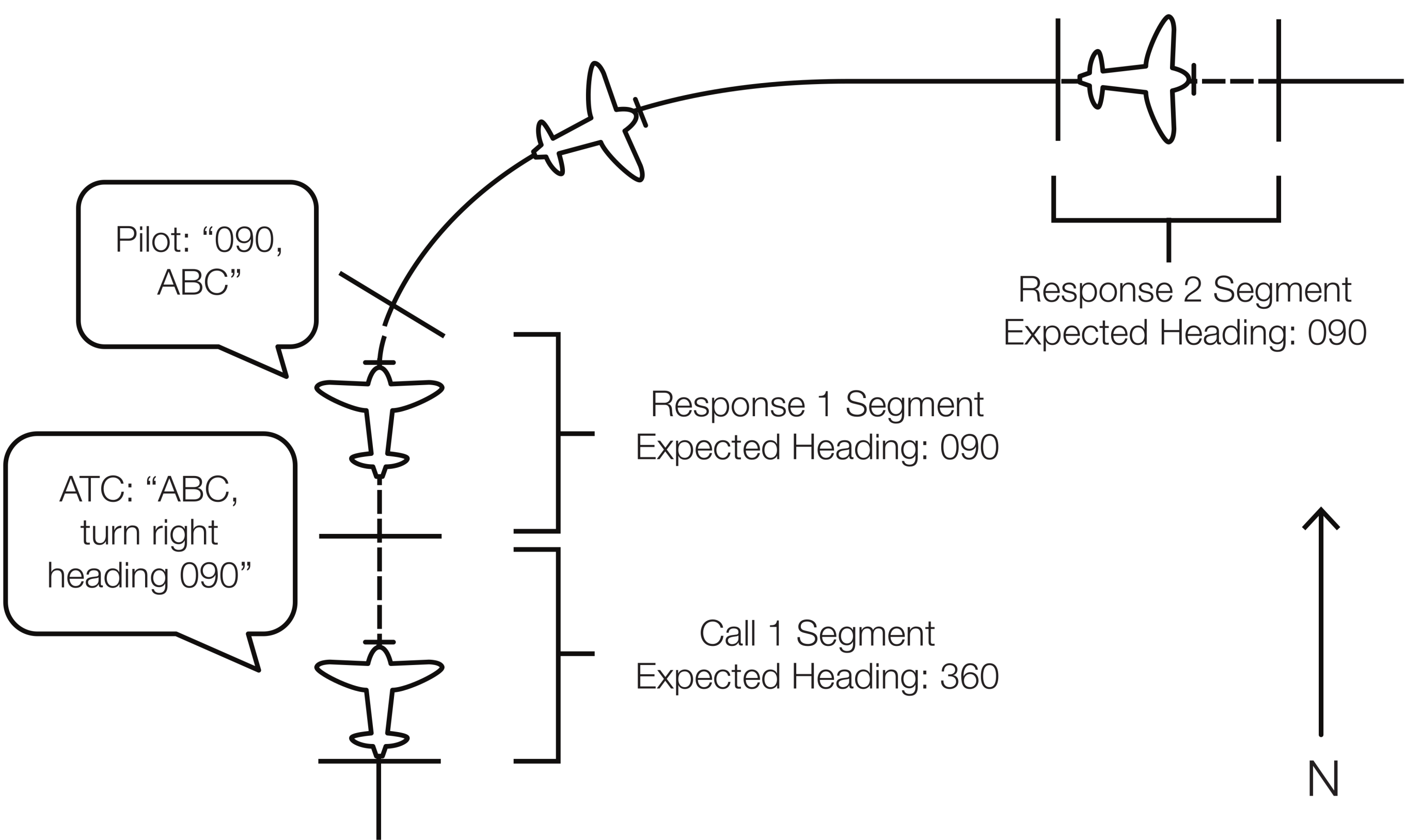


Figure 1. Example ATC call and pilot response

Results

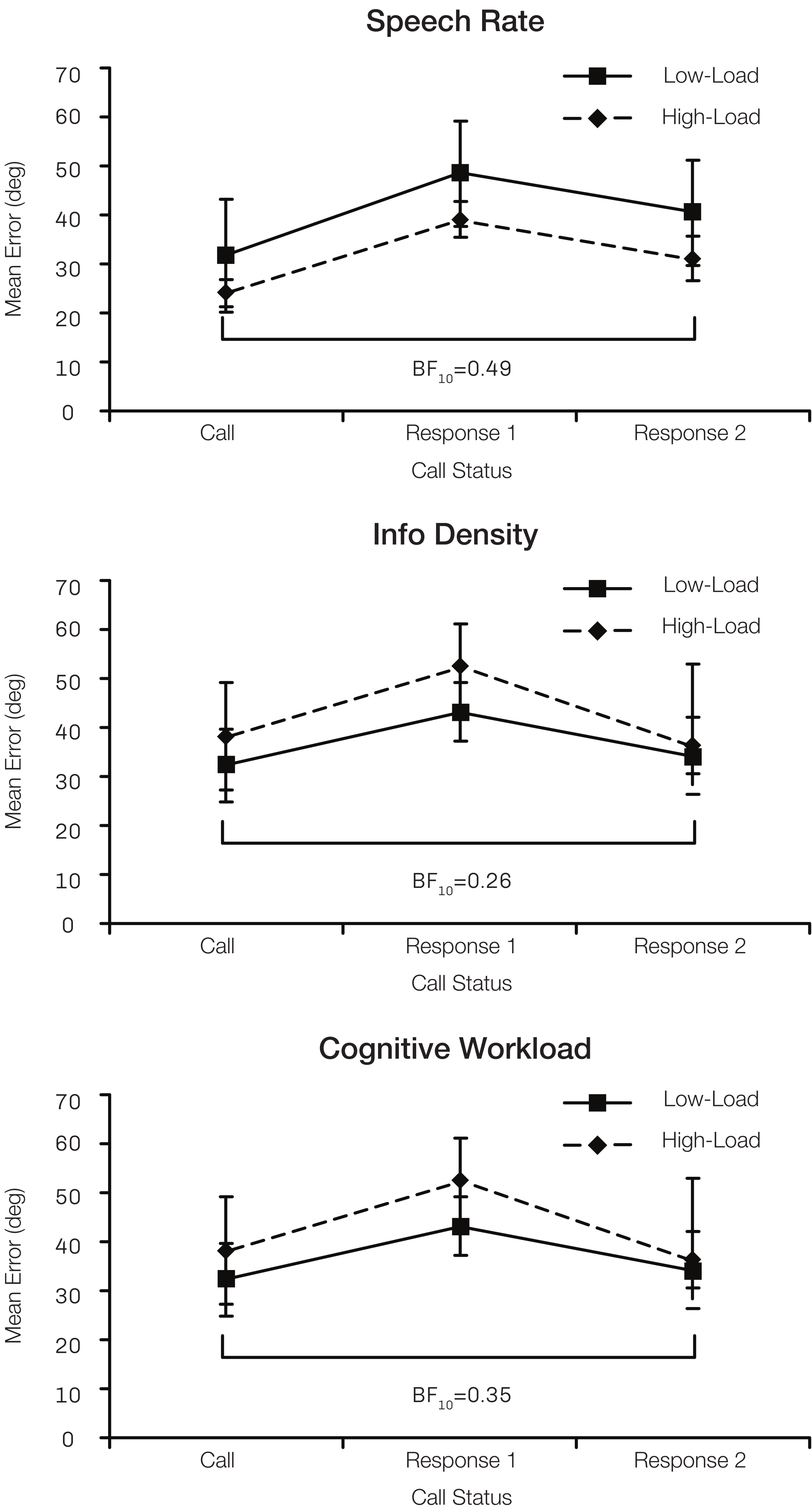


Figure 3. Mean heading error across flight scenarios during ATC calls and responses, with Bayesian *t*-test statistics

Discussion

- Pilots maintained high flight performance under various sources of load, even when communication was affected.
- Behavioural and statistical methodologies developed in cognitive psychology research (Thorpe, et al., 2020) enabled a richer analysis of this data.
- Our lab's cognitive analytic techniques can be applied to various real-world scenarios, in Army, Navy, and Air Force.

References

Kahneman, D. (1973). *Attention and Effort*. Englewood Cliffs, NJ: Prentice Hall.
Molesworth, B. R. C., & Estival, D. (2015). Miscommunication in general aviation: The influence of external factors on communication errors. *Safety Science*, 73, 73-79.
Thorpe, A., Innes, R., Townsend, J., Heath, R., Nesbitt, K., and Eidels, A. (2020). Assessing cross-modal interference in the detection response task. *Journal of Mathematical Psychology* 98.
Watanabe, K., & Funahashi, S. (2014). Neural mechanisms of dual-task interference and cognitive capacity limitation in the prefrontal cortex. *Nature Neuroscience*, 17(4), 601-611.

Heading Error (Current Heading = 360, Target Heading = 090)

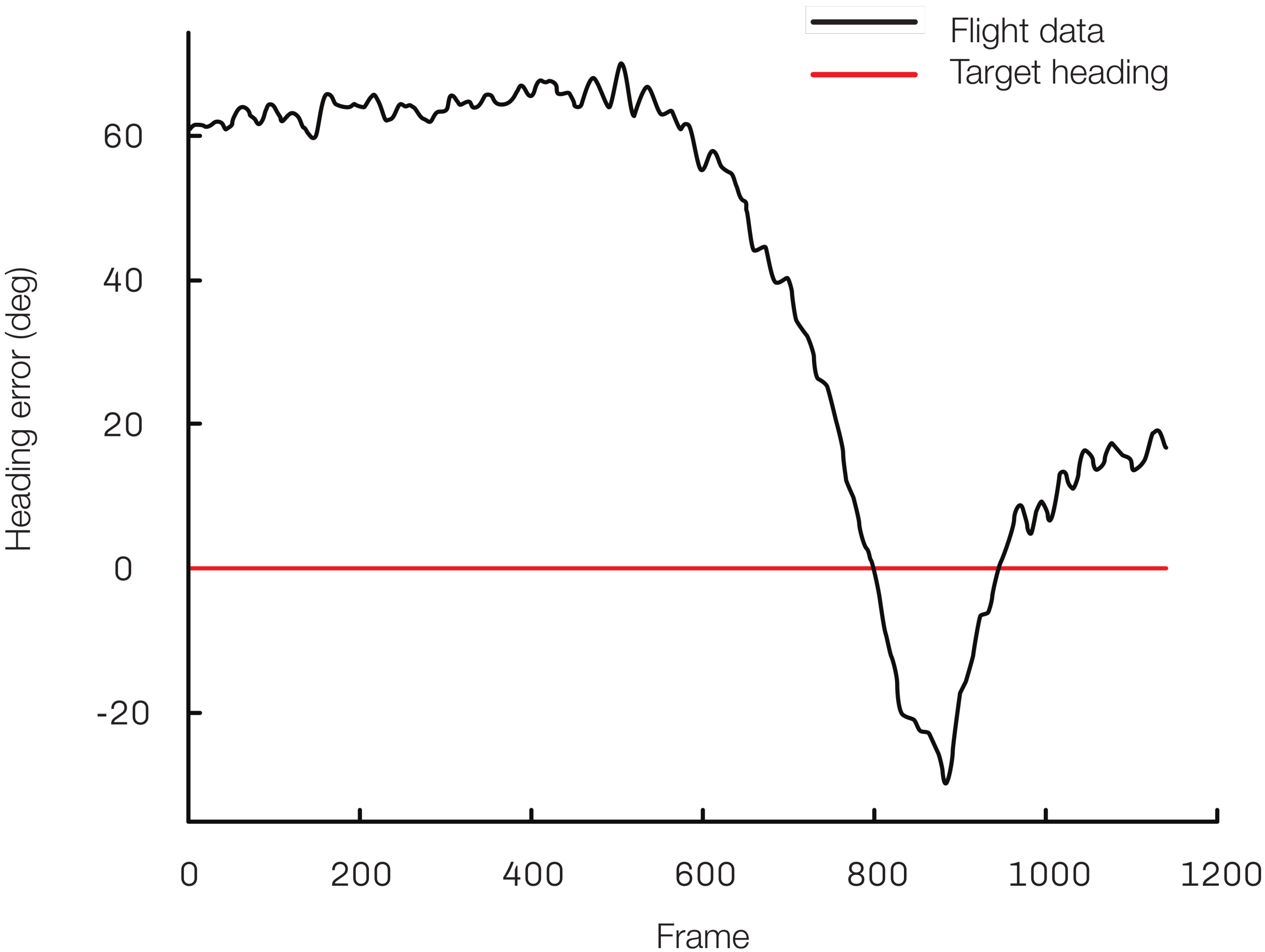


Figure 2. Time series of heading error (actual vs ideal heading) during a turn