Objective: The aim of this study was to compare continuous versus bandwidth haptic steering guidance in terms of lane-keeping behavior, aftereffects, and satisfaction.

Background: An important human factors question is whether operators should be supported continuously or only when tolerance limits are exceeded. We aimed to clarify this issue for haptic steering guidance by investigating costs and benefits of both approaches in a driving simulator.

Methods: Thirty-two participants drove five trials, each with a different level of haptic support: no guidance (Manual); guidance outside a 0.5-m bandwidth (Band1); a hysteresis version of Band1, which guided back to the lane center once triggered (Band2); continuous guidance (Cont); and Cont with double feedback gain (ContS). Participants performed a reaction time task while driving. Toward the end of each trial, the guidance was unexpectedly disabled to investigate aftereffects.

Results: All four guidance systems prevented large lateral errors (>0.7 m). Cont and especially ContS yielded smaller lateral errors and higher time to line crossing than Manual, Band1, and Band2. Cont and ContS yielded short-lasting aftereffects, whereas Band1 and Band2 did not. Cont yielded higher self-reported satisfaction and faster reaction times than Band1.

Conclusions: Continuous and bandwidth guidance both prevent large driver errors. Continuous guidance yields improved...
performance and satisfaction over bandwidth guidance at the cost of aftereffects and variability in
driver torque (indicating human--automation conflicts). Application: The presented results are useful
for designers of haptic guidance systems and support critical thinking about the costs and benefits of
automation support systems.

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