Impact of Neck Support on Headrests for Enhancing Relaxation and Comfort

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SUMMARY

This study explores the impact of neck support in headrest design to enhance relaxation and comfort, particularly in autonomous vehicles. A dual-phase approach was employed for iterative development and evaluation of headrest prototypes, aiming to identify ergonomic improvements and optimise comfort for diverse user profiles. In the preliminary phase, the comfort of headrests from Peugeot 3008, Citroën C4, and DS7 Crossback vehicles was evaluated. Three headrest models were tested using subjective questionnaires (CP50 scale and body map) and objective biomechanical measurements, including pressure mapping, electromyography (EMG), and video recording. Five volunteers participated, performing activities such as napping and reading, while neck and shoulder muscle activity was assessed. In the second phase, the standard headrest was compared with two newly designed prototypes using the same protocol. Results showed that headrests with enhanced neck support significantly reduced neck muscle activity and increased head-to-headrest contact compared to classic designs. These findings highlight the need for redesigned headrests to improve onboard comfort in next-generation vehicles.

KEYWORDS

Neck support, headrests, relaxation, comfort, autonomous vehicles

Introduction

Comfort is a critical factor in vehicle design, as consumers increasingly prioritise long-term usability when selecting a car. Manufacturers strive to deliver comfortable products to maintain a competitive edge (Vink, 2004; Zenk et al., 2011). Among the key elements of vehicle ergonomics, neck support provided by headrests plays a pivotal role in maintaining proper posture, reducing muscle strain, and preventing discomfort or fatigue during extended use.

Previous research has examined the relationship between headrest design and comfort, focusing on factors such as shape, foam density, and adjustability (Bouwens et al., 2018; Franz et al., 2012a). These studies underscore the importance of ergonomic design in enhancing relaxation and comfort during long drives. However, there remains no consensus on the optimal headrest design to accommodate diverse body types and driving conditions.

This study aims to address these gaps by examining how headrest designs influence muscle activity and perceived comfort across varied user profiles. A comprehensive assessment approach was adopted, combining EMG, pressure mapping, and subjective questionnaires. The combination of these methods provides a multidimensional evaluation framework for a holistic evaluation of the user comfort.

Methods

This study evaluated the ergonomic comfort of headrests in two phases. The first phase assessed three existing headrests from the Peugeot 3008, Citroën C4 Picasso, and DS7 Crossback vehicles. Objective measures included EMG for neck and upper trapezius muscle activity and pressure mapping to assess the distribution and magnitude of support provided by the headrests. Subjective evaluations were collected via the CP50 scale and a custom comfort survey. Five participants, representing diverse anthropometric profiles (5th to 95th percentiles), were recruited for this phase.

Based on the findings of the first phase, two new prototype headrests were developed with enhanced neck support features. In the second phase, these prototypes were tested alongside the standard Peugeot 3008 headrest. The same protocol was applied, involving 20-minute sessions of reading and napping on each headrest. Participants provided subjective feedback immediately after each activity, and objective data were collected to ensure consistency.

Three participants from the original cohort participated in the second phase, while two withdrew due to scheduling conflicts. Anthropometric measurements were recorded again for consistency. EMG sensors and pressure mapping techniques were used to capture data on neck and shoulder muscle activity and the distribution of support. Statistical analyses were performed to compare these metrics across all tested designs. Figure 1 presents the headrests from the Peugeot 3008, Citroën C4 Picasso, and DS7 Crossback used in this study, along with the newly developed prototypes.

Figure 1: Headrests of the Peugeot 3008, Citroën C4 Picasso, DS7 Crossback and two newly developed prototypes

Results

The results indicate that headrests with adjustable features along the X-axis provided superior neck support compared to the standard models, which only offered Z-axis adjustability. Contact surface areas were significantly larger with the adjustable headrests, while the standard headrest exhibited higher pressure concentrations. All tested headrest models revealed limitations in providing sufficient neck contact and support.

EMG data suggested trends toward reduced neck muscle activity with the enhanced designs, though definitive conclusions were limited by the small sample size. The second phase demonstrated that the new prototypes significantly improved neck support and reduced muscle activity compared to the standard model.

Conclusion

This study highlights the necessity of designing headrests that prioritise both safety and comfort, particularly in the context of autonomous vehicles where prolonged seating is common. Headrests

with enhanced adjustability provide larger contact surfaces and reduced muscle activity, while standard models exhibited higher pressure. The newly developed prototypes demonstrated improved comfort and ergonomic support, underscoring their potential for next-generation vehicle designs.

While this study primarily focused on comfort and relaxation in headrest design, it is important to acknowledge the dual role of headrests in both comfort and occupant safety. The enhanced neck support in our prototype designs may have implications for safety performance, particularly in reducing head movement during rear-impact crashes. However, the present study did not include crash testing, and future research should investigate the impact of these designs on occupant safety in crash scenarios.

Furthermore, the small sample size in this study specially in balanced gender subjects presents limitations for generalisation of results. However, participants were selected to represent a broad range (5th to 95th percentiles) to enhance generalisability. Future studies with a larger sample size should aim to further explore gender-based variations in perceived comfort and biomechanical responses.

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