HW3: Towards Predictive Communication : The Fusion of Large Language Models and Brain–Computer Interface

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The convergence of large language models (LLMs) with non-invasive brain–computer interfaces (BCIs) offers a transformative perspective on predictive communication for individuals with severe motor or language impairments. While traditional EEG-based spellers are constrained by slow typing speed, repetitive tasks, and limited capacity for semantic context, this paper highlights how advances in predictive writing systems can enhance BCI usability through contextual word completion, adaptive error correction, and dynamic stimulus adjustment.

Early pilot studies provide empirical support: GPT-2 and Transformer-XL substantially improved predictive accuracy and robustness compared to baseline models. The findings suggest that advanced LLMs can leverage semantic context to address limitations of neural signal decoding. Importantly, the integration of LLMs parallels human cognitive mechanisms of anticipation and error monitoring, positioning predictive text as both a technological and psychological analogue to natural communication.

Nevertheless, real-time processing demands and computational costs restrict clinical use, while hallucinations threaten reliability, underscoring the need for retrieval-augmented generation and error-related neural signals. Current research is beginning to explore how lightweight LLMs, noise-aware training, and user-specific calibration could improve feasibility, while experimental systems such as Neuro-GPT and Thought2Text illustrate ongoing efforts. Together, these insights frame LLM–BCI convergence as a promising frontier in adaptive neurotechnology.