

Breaking the Brain-Computer Interface Ceiling: Discovering a New Paradigm for Brain-Machine Communication That Enables Noninvasive Interfaces to Reach Invasive-Class Communication Speed

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Your mind works perfectly, but your body will not let you speak. Millions with Amyotrophic Lateral Sclerosis, stroke, or paralysis live trapped inside working minds. Today's brain-computer interfaces (BCIs) manage 5 words-per-minute (WPM): forty seconds to say "I love you" while the moment passes. Implants reach real speeds but require brain surgery and cost over \$100,000. I discovered a new paradigm for brain-machine communication: resolving intent directly, instead of spelling messages out letter by letter. I validated this using \$1,800 of consumer electroencephalography hardware and compared it against conventional decoding across 111 randomized, counterbalanced trials on identical hardware, with all effects independently replicated on a larger naive cohort. My system surpassed the field's 30-year ceiling of 15 WPM, achieving 65 WPM versus 3 WPM on a conventional speller — a 20-fold improvement — with 23-fold lower time-per-message (10.7s vs 242.2s, $q < 0.001$) and 43-fold intent-amplification (Cohen's $d = 2.9$, $q < 0.001$), a new metric quantifying meaning conveyed per brain signal. A double dissociation then confirmed fundamentally different mechanisms: traditional effort scales with message length ($\beta = 0.72$, $q < 0.001$) but is blind to intent ambiguity ($\beta = -0.02$, $q = \text{NS}$), while my system is blind to length ($\beta = 0.28$, $q = \text{NS}$) and scales with ambiguity instead ($\beta = 0.45$, $q < 0.01$). Speed now depends on how ambiguous a thought is, not how long the sentence is. The Six Laws of Intent Resolution I derived from information theory formalize this for any bandwidth-limited interface — broadly reshaping biomedical engineering, and making every existing BCI, prosthetic, and beyond, dramatically more efficient. A new foundation for how humans and machines communicate, and a voice for the voiceless.

Awards Won:

Second Award of \$2,400