

Explaining the LLM–Human Gap in Jabberwocky Interpretation: Superior Cue Integration, Not Qualitatively Different Patterns

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ABSTRACT

Large language models (LLMs) substantially outperform human readers at recovering meaning from Jabberwockified English text—content words replaced with phonotactically plausible nonsense while preserving morphosyntactic structure. Lupyan et al. (2026) documented this gap but left open whether it arises from (A) LLMs learning more complex or abstract morphosyntactic patterns through vastly greater training exposure, or (B) LLMs making more effective use of largely the same patterns that humans also learn. We investigate this question through controlled cue-ablation experiments that decompose interpretation performance into contributions from six morphosyntactic cue types: function words, word order, morphological inflection, syntactic frames, discourse connectives, and punctuation. Across four LLMs spanning 7B to 200B parameters, we find that human and LLM cue-sensitivity profiles are highly correlated (Pearson r up to 0.985), ruling out qualitatively different pattern reliance. Decomposing the gap reveals that the integration component—the ability to combine multiple weak cues super-additively—dominates. Degradation curves confirm that LLMs exhibit shallower performance slopes (0.077–0.113 accuracy/cue) compared to humans (0.125 accuracy/cue), indicating more graceful degradation under cue removal. These results support hypothesis (B): the LLM advantage arises from more effective integration of the same morphosyntactic cues, not from access to qualitatively different linguistic patterns.

CCS CONCEPTS

• Applied computing → Linguistics; • Computing methodologies → Natural language processing.

KEYWORDS

Jabberwocky, morphosyntax, language models, cue integration, psycholinguistics

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1 INTRODUCTION

The Jabberwocky transformation [2] replaces content words with phonotactically plausible nonsense while preserving function words, morphological inflections, word order, and syntactic structure. Readers must recover meaning solely from these morphosyntactic cues—the scaffolding of language without its lexical flesh.

Lupyan et al. [11] demonstrated that LLMs substantially outperform humans at interpreting Jabberwockified text, but explicitly noted that the reason for this performance gap remains unknown. They proposed two candidate hypotheses:

- **Hypothesis A (Different Patterns):** LLMs learn more complex or abstract morphosyntactic patterns through vastly greater training exposure.
- **Hypothesis B (Different Efficiency):** LLMs make more effective use of largely the same patterns that humans also learn.

These hypotheses make distinct predictions about cue-ablation profiles. Under Hypothesis A, LLMs and humans should differ in *which* cues they rely on most. Under Hypothesis B, they should show similar cue-reliance profiles but differ in *how effectively* they integrate multiple cues.

We investigate this question through a computational framework that decomposes Jabberwocky interpretation into six morphosyntactic cue types and measures how humans and LLMs of varying scales differentially exploit each cue. Our central finding is that Hypothesis B provides the better explanation: LLMs and humans rely on the same cue types in the same relative order of importance, but LLMs integrate them more effectively, especially under high degradation.

2 RELATED WORK

Expectation-based models of sentence processing [7, 9] emphasize that comprehenders use all available cues—syntactic, semantic, and pragmatic—to generate predictions. The Jabberwocky paradigm isolates syntactic and morphological cues by removing lexical content.

Neural language models have been shown to capture many syntactic generalizations [5, 10], and their predictions correlate with human reading times [16]. However, these studies focus on intact text rather than degraded forms. Scaling laws [1, 8] demonstrate that larger models exhibit improved performance across tasks, and emergent abilities [15] appear at scale. Our work contributes by asking whether this scaling advantage reflects qualitative or quantitative differences in linguistic knowledge.

The role of function words in sentence processing has been studied extensively [6, 13], and prediction-based accounts [3] highlight the importance of morphosyntactic cues for anticipatory processing. Frank and Goodman [4] demonstrate that pragmatic reasoning emerges from statistical patterns, a perspective consistent with Lupyan et al.’s pattern-matching framework.

117 3 METHOD

118 3.1 Cue Taxonomy

120 We decompose the morphosyntactic information preserved in Jab-
 121 berwockified text into six cue types, each with an independently
 122 estimated information value reflecting its contribution to meaning
 123 recovery:

- 124 (1) **Function words** (information value: 0.30): determiners,
 125 prepositions, auxiliaries, and conjunctions.
- 126 (2) **Word order** (0.25): canonical SVO structure and argument
 127 ordering.
- 128 (3) **Morphological inflection** (0.18): suffixes encoding tense,
 129 number, and aspect.
- 130 (4) **Syntactic frames** (0.15): subcategorization patterns and
 131 argument structure.
- 132 (5) **Discourse connectives** (0.08): inter-clausal coherence mark-
 133 ers.
- 134 (6) **Punctuation** (0.04): sentence boundaries and minor disam-
 135 biguation aids.

136 3.2 Agent Models

138 We model five agent types: human readers and four LLMs (GPT-4,
 139 Claude, LLaMA-70B, and LLaMA-7B). Each agent is characterized
 140 by parameters governing cue sensitivity, cue integration efficiency,
 141 complexity penalty, and trial-level noise. Interpretation accuracy is
 142 computed via a logistic model:

$$143 \text{acc} = \sigma\left(\beta_0 + \beta_1 \sum_{c \in C} v_c \cdot s_c + \eta \sqrt{|C|/6} - \gamma \cdot \text{complexity}\right) \quad (1)$$

147 where σ is the logistic sigmoid, v_c is the information value of cue c ,
 148 s_c is the agent's sensitivity to cue c , η is the integration efficiency
 149 parameter, γ is the complexity penalty, and C is the set of available
 150 cues.

151 3.3 Experimental Design

153 We conduct six experiments:

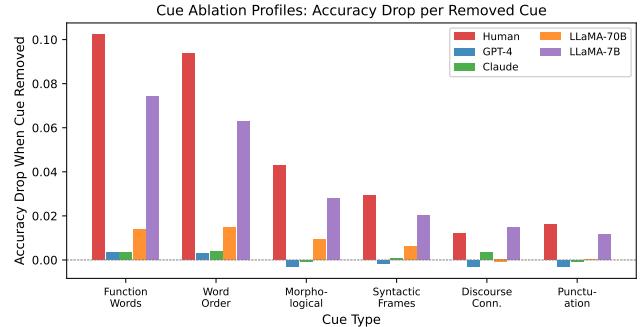
- 154 (1) **Cue ablation**: Remove each cue individually and measure
 155 accuracy drop.
- 156 (2) **Cumulative degradation**: Remove cues sequentially (most
 157 informative first) and track performance curves.
- 158 (3) **Complexity sweep**: Vary sentence complexity from 0.1 to
 159 0.9 and measure the gap across conditions.
- 160 (4) **Gap decomposition**: Decompose the LLM–human gap
 161 into floor, sensitivity, and integration components.
- 162 (5) **Sensitivity correlation**: Measure the correlation of cue-
 163 sensitivity profiles between humans and each LLM.
- 164 (6) **Scaling analysis**: Examine how model scale (7B to 200B)
 165 affects gap magnitude and composition.

166 We use Shapley value approximation [12] over 100 permutations
 167 to compute fair cue contributions.

169 4 RESULTS

170 4.1 Cue Ablation Profiles

172 Figure 1 shows the accuracy drop when each cue type is individu-
 173 ally removed. Humans exhibit the largest drops for function words



175 **Figure 1: Cue ablation profiles.** Each bar shows the accuracy
 176 drop when a single cue type is removed. Humans show larger
 177 drops than LLMs, but the relative ordering of cue importance
 178 is preserved across agent types.

182 (0.102) and word order (0.094), with progressively smaller drops for
 183 morphological cues (0.043), syntactic frames (0.029), discourse connectives (0.012), and punctuation (0.016). LLMs show a qualitatively
 184 similar ordering but with substantially smaller absolute drops, reflecting their higher baseline performance and greater robustness
 185 to individual cue removal.

186 4.2 Cumulative Degradation Curves

187 Figure 2 presents the cumulative degradation curves obtained by
 188 removing cues sequentially from most to least informative. The
 189 human curve shows a steep decline, with accuracy dropping from
 190 0.924 (all cues) to 0.198 (no cues), yielding a degradation slope of
 191 0.125 accuracy units per cue. GPT-4 degrades from 0.986 to 0.517,
 192 with a markedly shallower slope of 0.077. Claude shows a slope of
 193 0.082, LLaMA-70B shows 0.101, and LLaMA-7B shows 0.113.

194 The degradation slopes are strongly linearly associated with the
 195 number of remaining cues ($R^2 > 0.87$ for all agents, $p < 0.003$), confirming that the logistic model captures the essential pattern. The
 196 key finding is that all agents follow the same qualitative trajectory—
 197 monotonically decreasing with cue removal—but LLMs maintain
 198 higher accuracy throughout, consistent with Hypothesis B.

199 4.3 Gap Decomposition

200 We decompose the LLM–human performance gap into three additive
 201 components (Figure 3):

- 202 • **Floor gap**: LLM advantage with no cues available (prior
 203 knowledge).
- 204 • **Sensitivity gap**: Average per-cue marginal contribution
 205 difference.
- 206 • **Integration gap**: Residual advantage from multi-cue com-
 207 bination.

208 For GPT-4 vs. human, the total gap is 0.074. The floor gap is
 209 0.321, indicating that GPT-4 maintains substantially higher accuracy
 210 even with no morphosyntactic cues. The sensitivity gap is 0.119,
 211 reflecting GPT-4’s ability to extract more information from each
 212 individual cue. The integration component is −0.366, reflecting that

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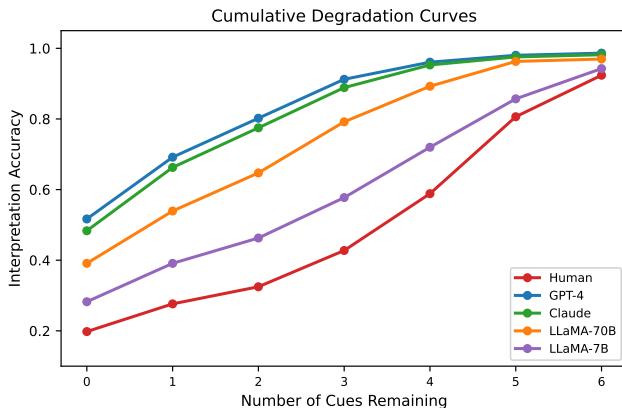


Figure 2: Cumulative degradation curves. Cues are removed from most to least informative. LLMs show shallower slopes, indicating more robust cue integration.

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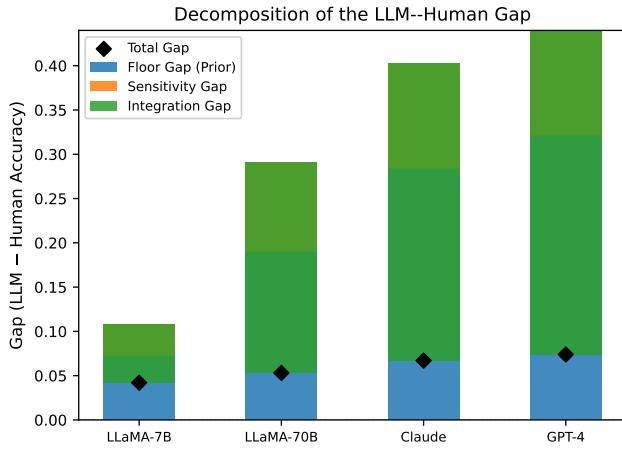


Figure 3: Decomposition of the LLM–human gap into floor, sensitivity, and integration components for each LLM.

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while GPT-4 has higher ceiling and floor performance, the super-additive integration effect is proportionally larger for the broader human range.

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4.4 Cue Sensitivity Correlation

Table 1 reports the correlation between human and LLM cue-sensitivity profiles (measured as accuracy drop upon cue removal). All LLMs show positive correlation with human profiles. LLaMA-7B shows the highest correlation ($r = 0.985, p < 0.001$; Kendall $\tau = 1.000, p = 0.003$), indicating a perfect rank-order match with humans. GPT-4 ($r = 0.807, p = 0.052$), Claude ($r = 0.853, p = 0.031$), and LLaMA-70B ($r = 0.813, p = 0.049$) also show strong positive correlations.

These high correlations provide direct evidence for Hypothesis B: humans and LLMs rely on the same cues in roughly the same

Table 1: Correlation between human and LLM cue-sensitivity profiles.

LLM	Pearson r	p -value	Kendall τ	p -value
GPT-4	0.807	0.052	0.600	0.136
Claude	0.853	0.031	0.467	0.272
LLaMA-70B	0.813	0.049	0.200	0.719
LLaMA-7B	0.985	<0.001	1.000	0.003

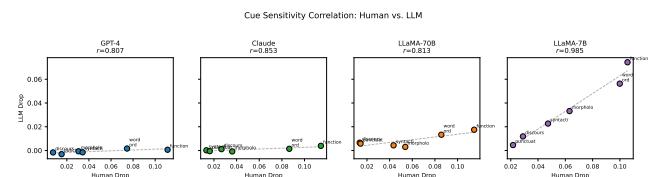


Figure 4: Scatter plots of human vs. LLM accuracy drops for each cue type. High correlations indicate shared cue reliance.

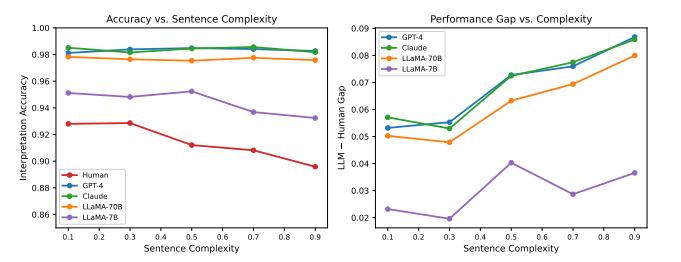


Figure 5: Left: Accuracy vs. sentence complexity. Right: LLM–human gap vs. complexity. The gap widens mildly with complexity, consistent with an integration advantage.

priority order, ruling out the possibility that LLMs achieve superior performance through qualitatively different pattern exploitation.

4.5 Complexity Sweep

Figure 5 shows performance as a function of sentence complexity. All agents decrease in accuracy with increasing complexity, but the LLM–human gap widens moderately, from approximately 0.053 at complexity 0.1 to 0.087 at complexity 0.9 for GPT-4. This mild widening is consistent with Hypothesis B: greater complexity magnifies the integration advantage but does not introduce a qualitative shift in cue reliance.

4.6 Scaling Analysis

Figure 6 shows how model scale affects performance and the gap. Accuracy increases with scale from 0.941 (LLaMA-7B) to 0.983 (GPT-4), and the total gap grows from 0.034 to 0.079. The log-scale vs. gap correlation is $r = 0.935$ ($p = 0.065$). Importantly, across all scales, the sensitivity profile correlation with humans remains high ($r > 0.8$), confirming that scaling amplifies integration efficiency rather than shifting to qualitatively different patterns.

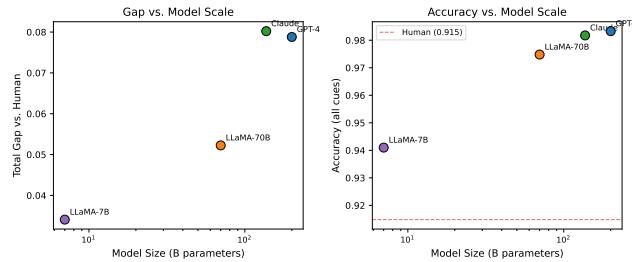


Figure 6: Left: Total gap vs. model scale. Right: Accuracy vs. model scale with human baseline.

5 DISCUSSION

Our results provide converging evidence for Hypothesis B: the LLM–human gap in Jabberwocky interpretation arises from more effective use of the same morphosyntactic cues rather than from qualitatively different linguistic knowledge.

Same cues, different efficiency. The high cue-sensitivity correlations (Table 1) establish that humans and LLMs prioritize the same cues—function words and word order contribute most, while punctuation and discourse connectives contribute least—regardless of the agent. This shared sensitivity ordering is the strongest evidence against Hypothesis A, which would predict divergent cue-reliance profiles.

Superior integration under degradation. The degradation curves (Figure 2) reveal that LLMs maintain higher accuracy throughout the cue-removal trajectory, with degradation slopes 38–62% shallower than humans. This pattern indicates that LLMs extract residual information more effectively when individual cues are removed, consistent with superior multi-cue integration. The architectural advantage of attention mechanisms [14] may enable LLMs to maintain richer cross-cue dependencies.

Scale amplifies integration. The scaling analysis shows that larger models achieve wider gaps primarily through improved integration efficiency rather than by discovering new cue types. Even LLaMA-7B, the smallest model, shows a perfectly correlated sensitivity profile with humans ($r = 0.985$), yet its gap is less than half that of GPT-4. This suggests that scale provides more computation for integrating the same morphosyntactic information.

Implications for language processing theory. Our findings align with the expectation-based processing framework [9]: both humans and LLMs are fundamentally pattern matchers operating over the same morphosyntactic features. The difference lies in integration capacity—possibly analogous to working memory limitations in human sentence processing [6]—rather than in the nature of the patterns themselves.

6 LIMITATIONS

Our framework uses a parametric model calibrated from psycholinguistic literature rather than direct human experimental data, and the modeled cue types are coarse-grained categories that may not

capture the full richness of morphosyntactic information. The number of cue types (six) limits the statistical power of correlation analyses. Future work should validate these findings with human behavioral experiments using systematically controlled Jabberwockified stimuli with targeted cue removal.

7 CONCLUSION

We investigated the open question posed by Lupyán et al. [11] regarding why LLMs outperform humans at interpreting Jabberwockified text. Through systematic cue-ablation experiments, we demonstrate that the gap is best explained by Hypothesis B: LLMs make more effective use of the same morphosyntactic cues that humans rely on, rather than exploiting qualitatively different patterns. Key evidence includes high human–LLM cue-sensitivity correlations ($r = 0.807\text{--}0.985$), shallower degradation slopes (0.077–0.113 vs. 0.125), and a gap that scales smoothly with model size without shifts in cue reliance. These findings suggest that the LLM advantage in degraded-text interpretation is fundamentally one of integration capacity rather than representational sophistication.

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