

Cognitive invitation mechanisms of textual gaps in popular science discourse

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Abstract: Drawing on Iser's response-inviting structure as an analytical framework, this study examines the English popular science text "More Bioengineering Experiments to Save the World" from a reader-oriented interpretive perspective to investigate how textual gaps operate in popular science discourse. The analysis reveals that semantic gaps in the title, logical discontinuities, and evidential gaps in the body of the text constitute a multilevel structure of cognitive invitations. At the same time, the negation of cognitive premises, genre expectations, and the presupposition of scientific certainty forms a compound mechanism of negation. Together, these mechanisms create a progressive chain of invitations that encourages readers to move from passive information reception to active meaning-making. The proposed analytical approach based on cognitive gaps extends the explanatory scope of the response-inviting structure to popular science discourse.

Keywords: Iser; response-inviting structure; cognitive gaps; negation; popular science discourse; text interpretation

1 Introduction

The effectiveness of reading popular science discourse does not necessarily increase with information density. Excessively detailed explanations of mechanisms can cause cognitive overload and diminish engagement, whereas insufficient information may prevent readers from developing a coherent understanding. From the perspective of text interpretation, effective popular science texts often leave information strategically unstated, creating manageable cognitive gaps that invite readers to complete meaning actively and achieve deeper cognitive engagement through inference.

Research on English popular science discourse remains relatively limited and has focused primarily on writing techniques [1], discourse functions [2-3], and teaching and translation [4-5]. Less attention has been paid, from the perspective of readers' meaning-making, to what texts leave unwritten: how informational gaps and omissions in expression contribute to the generation of meaning. In terms of theoretical application, research on the response-inviting structure has concentrated largely on literary texts; systematic analyses of popular science expository discourse have yet to be identified. Against this background, the present study examines "More Bioengineering Experiments to Save the World" to identify types of gaps that can be recognized through linguistic markers and to explore how gaps and negation work together to invite readers' participation in meaning-making.

2 Theoretical foundations and analytical framework

2.1 Iser's concepts of blanks and negation

In *The Act of Reading*, Iser (1980) proposes that a text is not a closed, self-sufficient container of meaning, but an

open structure permeated by blanks and negation [6]. Blanks are connections of meaning that remain implicit and require readers to supply them actively; they are a central force driving meaning-making. Negation disrupts and revises readers' existing cognitive structures and genre expectations, opening up space for new perspectives. The two are intertwined, forming a dynamic network that invites readers to participate in the generation of meaning.

In discussing the response-inviting structure of scientific texts, Zhu Liyuan (1988) argues that their thought-provoking quality lies not in structural blanks, but in the intellectual value of their propositions [7]. This claim applies to specialized academic texts characterized by rigorous logic and informational completeness. Popular science discourse, however, translates scientific content for a general audience and necessarily simplifies or omits technical derivations to balance communicative efficiency with readability. From the reader's perspective, this produces distinctive structural gaps in understanding. Rather than addressing authors' writing strategies, this study makes an interpretive argument: the transformation of academic texts into popular science texts gives rise to new structural gaps at the textual level, and these gaps constitute a central mechanism through which popular science discourse invites reader participation.

In addition to blanks, Iser introduces the concept of vacancies, referring to interruptions in meaning that arise when readers shift between different textual schemata. The object of analysis here is a short popular science text with a single principal narrative schema and no complex shifts between schemata. Iser's concept of vacancies is therefore not applied separately; the relevant structural gaps are discussed within the general framework of blanks.

2.2 Cognitive gaps: conceptual delimitation

Iser's concept of blanks is rooted in literary aesthetic experience, in which the possibilities for filling gaps in meaning are open and plural. Popular science discourse, by contrast, refers to objective scientific facts, so meaning is subject to relatively determinate standards of knowledge. From an interpretive perspective, this study therefore defines gaps in popular science discourse as cognitive gaps and specifies three conditions. First, textual objectivity: a gap is an identifiable absence of a connection in meaning, signaled by linguistic forms rather than by arbitrary associations arising from a reader's personal background. Such signals include indefinite quantifiers, modal verbs, abrupt breaks in paragraph structure, and conspicuous absences of supporting evidence. Second, cognitive orientation: these gaps invite inference constrained by scientific logic rather than unrestricted aesthetic imagination. Third, analytical caution: descriptions of reader responses represent analytically constructed pathways grounded in textual structure, rather than assertions about actual reading experiences.

2.3 Analytical framework

On this basis, the study develops a three-level framework of "gaps–negation–synergistic effects". The analysis of gaps addresses three textual features: semantic gaps in the title, causal leaps in the logical organization of the body, and evidential gaps. The analysis of negation examines disruptions of reader expectations at three levels: cognitive premises challenged in the opening paragraph, genre expectations, and the presupposition of scientific certainty. Finally, the analysis considers how gaps and negation operate synergistically in terms of their interpretive effects.

3 Gap-based mechanisms of cognitive invitation in popular science discourse

The text analyzed in this study, "More Bioengineering Experiments to Save the World", was adopted in a provincial senior high school English teaching competition. Approximately 184 words long, it has a clear structure and advances the central proposition that microbial engineering can reshape the foundations of industrial production. It comprises two main sections, on wastewater treatment (approximately 101 words) and cancer treatment (approximately 44 words). The opening introduces the problem of conventional industry's dependence on energy resources, and there is no separate concluding paragraph. While conveying basic information, the text leaves several cognitive nodes unexplained. Drawing on the

framework established above, the following analysis systematically examines its gaps and cognitive invitation mechanisms at different structural levels.

3.1 Gaps and invitations at the level of the title

In the reading process, the title is the first point of engagement with meaning and the initial level of the response-inviting structure. In the main title, "More" functions as an indefinite quantifier whose reference remains semantically unresolved: neither the basis of comparison nor the quantitative and categorical boundaries are specified. This constitutes the first identifiable semantic gap in the text. As reading proceeds, readers may naturally expect the body to clarify retrospectively what "More" refers to. Yet the body never provides an explicit basis of comparison. The semantic expectation opened by the title thus remains unresolved, continually prompting readers to ask what "more" means.

The two subheadings, "Transforming Waste Water" and "Fighting Cancer", likewise adopt minimalist structures. They identify only the technological object and the direction of action, omitting the means, mechanisms, and outcomes. This low information density creates cognitive tension and provides an impetus for readers to move from the headings into the body of the text.

3.2 Gaps in logical organization and reader agency in inference

At the textual level, gaps in the logical organization of the body take two forms: logical discontinuities and evidential gaps. In terms of interpretive effects, both provide readers with the space and agency to make inferences.

3.2.1 Logical discontinuities

The cancer treatment section presents three statements: (a) *Clostridium* targets tumors and replicates within them; (b) the bacteria can be engineered as drug-delivery vehicles; and (c) nineteenth-century historical observations associate bacterial infection with tumor regression. The transition from (b) to (c) lacks an explicit mediating link: the text neither explains why bacterial infection might lead to tumor regression nor clarifies the continuity between historical observations and modern technology. No cohesive marker connects the statements, leaving readers to establish their logical relationship during interpretation. Readers with relevant background knowledge may draw on frameworks such as immune activation or oncolytic bacteria to bridge the gap; those without specialized knowledge can still recognize a logical connection that the text has not developed. By omitting information rather than presenting a complete exposition, the text both limits its length and leaves room for meaning-making by readers willing to investigate further.

3.2.2 Evidential gaps

The argumentative structures of the two sections are markedly asymmetrical. The wastewater treatment section includes two sets of contemporary experimental evidence, from Logan's team and Sam Houston University, whereas the cancer treatment section ends with nineteenth-century historical observations and supplies no modern experimental data. Without speculating about authorial intention, this study considers the interpretive effects of this feature. The evidential gap has two functions. First, it creates a discrepancy between expectations and the information provided, encouraging readers to inquire beyond the text into subsequent research developments and extending reading beyond textual boundaries. Second, it permits a cautious interpretation: technologies still under investigation are not presented as established conclusions, an effect consistent with the principle of rigor in science communication.

3.3 Negation and the disruption of reader expectations

Whereas gaps concern connections of meaning within the text, negation concerns interactions between the text and readers' external cognitive structures. Iser characterizes negation as the partial negation of conventional norms, which stimulates readers' capacity for reflection. From an interpretive perspective, the text's mechanisms of negation operate at three levels.

3.3.1 Negation of cognitive premises

The first sentence of the opening paragraph, "The prospect of industrial production doesn't depend on oil drills and mines, but on biology," contains the explicit negation marker "doesn't depend on... but on...". This forms a clear negation–replacement structure that directly challenges readers' default assumption that industrial production depends on oil extraction and mining, introducing "biology" as a source of cognitive tension. This is the principal point of activation of the text's response-inviting structure: only when readers' existing understanding is unsettled does a need arise to investigate information subsequently left unstated, allowing gaps at different levels to function as invitations.

3.3.2 Negation of genre expectations

Drawing on previous reading experience, readers generally expect popular science expository texts to conform to genre conventions of balanced examples, structural completeness, and a conclusion that returns to the main theme. The text systematically departs from these expectations in its structure. First, the two main sections differ substantially in length and argumentative density: the former includes background information, explanations of mechanisms, and two sets of contemporary experimental data, whereas the latter offers only a historical retrospective as supporting evidence. Second, the text stops abruptly after the cancer treatment paragraph, without a summarizing conclusion, producing an open ending.

Viewed as a whole, this open ending is not an isolated textual feature; it echoes the semantic gap introduced by "More" in the title. "More experiments" points to an ongoing and unfinished state, and the openness of the ending returns to this incompleteness. Together, they establish an overarching structure of open-ended invitation that encourages readers to move beyond the text and integrate meaning independently.

3.3.3 Negation of the presupposition of scientific certainty

In conventional popular science reading, readers often assume that texts will present definitive conclusions in an authoritative voice. This text unsettles that assumption through modal wording. In "could be engineered", the modal verb places the technology within a framework of possibility. The phrase "even 19th century reports described" combines historical reference with indirect evidence, falling short of the contemporary empirical evidence readers may expect. Together, these expressions support an interpretation of science as a process of exploration rather than a body of settled conclusions. They perform a function of negation by departing from readers' expectations of certainty.

4 Conclusion

4.1 Findings

Through a systematic analysis from the perspective of text interpretation, this study reaches three principal conclusions. First, the text constructs a multilevel system of cognitive gaps. Unresolved semantics in the title form gaps at the initial level, while logical discontinuities and evidential gaps in the body form gaps at the logical level; together, they constitute a system of cognitive invitations in popular science discourse. Second, negation operates through a compound mechanism. The negation of cognitive premises, genre expectations, and the presupposition of scientific certainty works at progressively deeper levels, disrupting different kinds of assumptions and creating space for meaning-making. Third, gaps and negation produce synergistic effects. They form a progressive chain of invitations and intersect at key textual nodes, jointly encouraging readers to move from passive information reception toward active meaning-making.

4.2 Contributions

The study makes three main contributions. Theoretically, it extends the scope of the response-inviting structure by proposing the concept of cognitive gaps for popular science discourse, adapting the theory to this domain. Methodologically, it develops an approach to the discourse analysis of gaps grounded in linguistic markers. By maintaining textual objectivity and analytical caution, this approach provides a model for related research. Practically, it reveals, from a

reader-oriented perspective, how gaps in popular science discourse contribute to meaning-making, offering new possibilities for teaching popular science reading.

4.3 Pedagogical implications

The analysis has three implications for teaching popular science reading in senior high school English. First, instructional objectives should shift from information extraction to meaning-making, guiding students to attend to what a text leaves unstated and fostering critical reading awareness. Second, reading instruction can follow a three-stage sequence of "identifying gaps—examining negation—inferring meaning", transforming cognitive gaps into resources for inquiry. Third, teachers can draw on the educational potential of popular science texts to develop students' thinking, helping them understand the exploratory nature of science while advancing both language development and scientific reasoning.

4.4 Limitations

This study analyzes only one short text, and the generalizability of its conclusions requires validation against a wider corpus. Its account of readers' meaning-making remains a theoretical construction at the textual level and does not incorporate empirical reader-response data. Future research could broaden the corpus or use methods such as think-aloud protocols to examine readers' actual cognitive processes.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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