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Mechanisms underlying disfluency effects: a systematic review

Tsigeman E.S.¹

¹ National Research University Higher School of Economics Saint-Petersburg, Saint-Petersburg, Russia

Abstract

Introduction. Although some studies link disfluency – the subjective experience of difficulty in processing information – to cognitive and metacognitive benefits, empirical findings remain inconsistent, often showing null or negative effects, while theoretical explanations remain fragmented. **Objective.** The aim of this review was to systematize and clarify the mechanisms through which disfluency influences cognitive, metacognitive, and behavioral outcomes. **Methods.** A systematic review of 110 empirical studies was conducted. **Results.** Five key mechanisms were identified: (1) disfluency as a metacognitive cue, (2) disfluency as a signal of cognitive engagement, (3) processing-based changes, such as compensatory processing, (4) affective and hedonic marking, and (5) moderation by naïve theories. The most robust effect concerns metacognitive illusions: disfluency lowers judgments of learning without affecting actual memory performance. Cognitive benefits emerge only under specific conditions, such as high working memory capacity or motivation, whereas many high-quality studies report no disfluency effects at all. **Conclusions.** The field needs to move toward mechanism-specific research. To support this direction, the review presents a library of manipulations and control conditions, as well as recommendations for empirically testing precise theoretical predictions.

Keywords: disfluency, mechanisms of disfluency, metacognition, judgement

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Механизмы эффекта не-беглости: систематический обзор

Цигеман Э.С.¹

¹ Национальный исследовательский университет «Высшая школа экономики» Санкт-Петербург, Санкт-Петербург, Россия

Аннотация

Введение: хотя ряд исследований связывает не-беглость (субъективное переживание трудности обработки информации) с когнитивными и метакогнитивными преимуществами, эмпирические данные остаются противоречивыми: часто фиксируются нулевые или негативные эффекты, а теоретические объяснения фрагментарны. **Цель:** систематизировать и уточнить механизмы влияния не-беглости на когнитивные, метакогнитивные и поведенческие показатели. **Методы:** проведен систематический обзор 110 эмпирических исследований. : выделены пять ключевых механизмов: (1) метакогнитивная подсказка, (2) сигнал когнитивной вовлеченности, (3) процессуальные изменения (например, компенсаторная обработка), (4) аффективное и гедонистическое маркирование, (5) модерация наивными теориями. Наиболее устойчивым эффектом являются метакогнитивные иллюзии: не-беглость снижает оценки усвоения материала, не влияя на фактическое запоминание. Когнитивные преимущества проявляются лишь при определенных условиях (например, высокой емкости рабочей памяти или мотивации), тогда как многие качественные исследования не выявляют эффектов не-беглости вовсе. **Выводы:** необходим переход к исследованиям, ориентированным на конкретные механизмы. Для поддержки этого направления в работе представлена библиотека манипуляций и контрольных условий, а также рекомендации по эмпирической проверке точных теоретических предсказаний.

Ключевые слова: не-беглость, механизмы не-беглости, метапознание, суждение

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Introduction

Processing fluency — the subjective experience of ease during mental operations — has generated substantial interest as a factor influencing cognition [Oppenheimer, 2008]. Research distinguishes perceptual (e.g., visual clarity), linguistic (e.g., pronounceability), conceptual (e.g., categorical coherence), retrieval (e.g., ease of memory access), and encoding (e.g., ease of initial information uptake) types of fluency. Despite their diverse origins, these “tribes” produce a unified subjective signal routinely used as an implicit cue in judgement, decision-making, and metacognition.

The counterpart to fluency is disfluency — the experience of cognitive difficulty — has been proposed to reduce confidence in learning [Pieger et al., 2017; Rawson, Dunlosky, 2002] and trigger adaptive shifts in cognitive strategy, including more deliberate processing, increased cognitive control, and sharper attentional focus [Oppenheimer, 2008; Pieger et al., 2016, 2017; Seufert et al., 2017]. Such shifts have been linked to improved analytical reasoning [Alter et al., 2007], reduced causal illusions [Díaz-Lago, Matute, 2019], enhanced long-term retention [Diemand-Yauman et al., 2011; French et al., 2013], diminished interference [Oliveira et al., 2023], and greater resistance to distraction [Halin, 2016]. Disfluency has also been associated with changes in distance judgements [Alter, Oppenheimer, 2008], perceptions of product innovativeness [Sung et al., 2022], judgements of hazardousness [Song, Schwarz, 2009] or security [Park et al., 2016] and aesthetic judgements [Ball, Threadgold, Marsh et al., 2018]. In line with these findings, disfluency has been proposed as a desirable difficulty in education, a concept assuming that introducing additional effort can improve learning outcomes [Bjork, 1994]. However, the originator of this concept later rejected disfluency as a desirable difficulty, concluding it is ineffective for long-term retention and transfer of knowledge [Bjork, Yue, 2016].

Yet numerous studies, including two meta-analyses [Meyer et al., 2015; Xie et al., 2018], have cast doubt on the robustness of the disfluency effect on cognition (cf. [Weissgerber, Brunmair, Rummer, 2021]). They suggest the effect is confined to a narrow set of conditions [Ball, Threadgold, Solowiej et al., 2018; Berezner, Gorbunova, 2024; Wetzler et al., 2021], heavily dependent on specific moderators [Kühl, Eitel, 2016], or potentially absent altogether, with observed findings reflecting statistical noise rather than a reliable phenomenon [Dunlosky, Mueller, 2016; Eitel et al., 2014; Sirota et al., 2021]. Similar doubts

exist for metacognition: reductions in judgements of learning (JOLs) appear only under specific conditions [Ilic, Akbulut, 2019; Magreehan et al., 2016]. Even not all judgements are affected: linguistic fluency showed no effect on risk perceptions in a replication [Bahnik, Vranka, 2017]. In short, the disfluency literature is characterised by marked heterogeneity and uncertainty about whether, when, and why disfluency exerts reliable effects.

Despite this, disfluency remains influential across education [Diemand-Yauman et al., 2011], creativity [Jia et al., 2023], aesthetics [Ball, Threadgold, Marsh et al., 2018], marketing [Sundar et al., 2019], real estate [Agarwal et al., 2019], and social cognition [Olszanowski et al., 2018]. This broad engagement and continued investment in disfluency as a theoretical and applied tool make the lack of a unified mechanistic account especially consequential.

Problem of current research

Existing reviews, while valuable, do not fill this gap. Narrative syntheses have categorised disfluency types [Alter, Oppenheimer, 2009b], noted moderators without specifying mechanisms [Kühl et al., 2014; Oppenheimer, Alter, 2014], or focused narrowly on specific outcomes (e.g., aesthetic judgements; [Reber, Schwarz, Winkielman, 2004]). Kühl and Eitel [Kühl, Eitel, 2016] primarily summarise findings from a narrow selection of studies from a special issue and do not incorporate important evidence published before or after that issue. Similarly, Berezner and Gorbunova [Berezner, Gorbunova, 2022] provide only a non-systematic overview of findings from a small number of studies. Meta-analyses are also limited: Meyer et al. [Meyer et al., 2015] focus solely on reasoning, Xie et al. [Xie et al., 2018] restrict their analysis to recall. Consequently, no prior systematic review has explicitly mapped, classified, or evaluated the empirical support for the mechanisms proposed to link disfluency to cognition, metacognition, or judgement.

The present review addresses this gap. We systematically identified the mechanistic accounts invoked in the empirical disfluency literature, developed a taxonomy to organise them, and assessed the empirical support for each. Our aim is not to declare a single winner, but to provide researchers with a map of the theoretical landscape. By making explicit the theoretical commitments that shape experimental design and interpretation, we hope to move the field beyond demonstrations that disfluency can work towards a more mature science of when, why, and for whom it does. Accordingly, this review

addresses four research questions:

- (1) What effects of disfluency on cognitive processing, metacognition, and judgement have been reliably observed in empirical research?
- (2) What theoretical mechanisms have been proposed to explain these effects?
- (3) To what extent is each proposed mechanism supported or challenged by empirical evidence?
- (4) What methodological and theoretical directions could future research take to clarify whether, when, and how disfluency produces reliable effects?

Method

We conducted a systematic literature review in accordance with the PRISMA 2020 guidelines [Page et al., 2021]. Screening and data management were performed using Rayyan [Ouzzani et al., 2016], a web-based platform designed to support transparent and collaborative systematic review workflows.

Search strategy

Due to limited institutional access to subscription-based databases (e.g., Scopus, Web of Science), we used two open-access academic discovery platforms: OpenAlex and ResearchRabbit. Open-Alex provides coverage comparable to that of Web of Science and Scopus [Culbert et al., 2025]. To ensure sensitivity to the core construct, we used a single keyword, “disfluency”, in titles, abstracts and keywords. This approach prioritised precision over recall by targeting studies that explicitly engaged with disfluency as a phenomenon. ResearchRabbit was employed to expand retrieval through citation-based discovery: we seeded the search with a foundational paper in the field [Alter et al., 2007] to identify conceptually and bibliographically related works via co-citation and semantic similarity networks. To capture the full conceptual evolution of disfluency, from its theoretical origins in fluency research to contemporary empirical work, we applied no date restrictions. This decision reflects our goal of mapping the breadth and development of pro-posed mechanisms across time, rather than focusing on a narrow temporal window.

Both searches were conducted on November 2, 2025.

Eligibility criteria

We included peer-reviewed experimental empirical journal articles published in English or Russian. Conference proceedings, preprints, theses, dissertations, book chapters, and non-empirical commentaries and reviews were excluded, as well

as non-experimental studies. Our inclusion strategy prioritised breadth to ensure representation of diverse methodological approaches and theoretical perspectives on disfluency.

All retrieved records were imported into Rayyan [Ouzzani et al., 2016]. Duplicates were removed automatically using Rayyan’s built-in deduplication tool and verified manually. A single reviewer screened all records by title and abstract for eligibility. Full-text assessment and data extraction were conducted on all retained studies.

Data extraction and synthesis

Manual data extraction focused on the following key domains: (1) study identification and context, including title, authors, year of publication, journal, volume, issue, pages, DOI; (2) disfluency manipulation, including the specific independent variable, disfluency type as per Alter and Oppenheimer classification [Alter, Oppenheimer, 2009b] or the subjective experience of ease with which people process information, reliably influences people’s judgments across a broad range of social dimensions. Experimenters have manipulated processing fluency using a vast array of techniques, which, despite their diversity, produce remarkably similar judgmental consequences. For example, people similarly judge stimuli that are semantically primed (conceptual fluency, presence of a manipulation check (subjective or objective), and description of the fluent control condition; (3) methodological characteristics, including study design (between- or within-participant), sample size (N), statistical approach (e.g., NHST, Bayesian), power analysis, and preregistration status; (4) outcome variables, categorised into three domains: cognitive performance outcomes (e.g., recall, reasoning), metacognitive judgements and control (e.g., JOLs, confidence), affective, evaluative, and social outcomes (e.g., liking, trust); (5) proposed mechanisms, captured both as verbatim descriptions from the original text and classified into standardised theoretical categories; (6) boundary conditions (test expectancy, naive theories) that were tested or discussed as limiting factors; (7) empirical support for the disfluency effect, categorised by outcome domain (cognition, metacognition, or judgement/evaluation).

Results

Search results

The initial search identified 3,496 records. After duplicate removal and screening, 110 empirical studies

met inclusion criteria and were retained for indepth analysis (see Fig. 1 for the PRISMA flow diagram). See the full list of papers in online Appendix, <https://doi.org/10.6084/m9.figshare.31821274> [Tsigeman, 2026].

Overview of studies

Of the 110 studies, perceptual disfluency (e.g., font, contrast, blurring) was the most frequently investigated form ($n = 81$), followed by conceptual

($n = 12$), linguistic ($n = 2$), transcription ($n = 2$), and encoding ($n = 1$); the remainder examined multiple types.

Regarding outcomes, 77% of studies assessed cognitive performance (e.g., memory, reasoning), 51% included metacognitive outcomes (e.g., JOLs, confidence), and 41% measured affective, evaluative, or social judgements (e.g., attractiveness, trustworthiness). Designs were evenly split: 39% within-participants, 39% between-participants, and

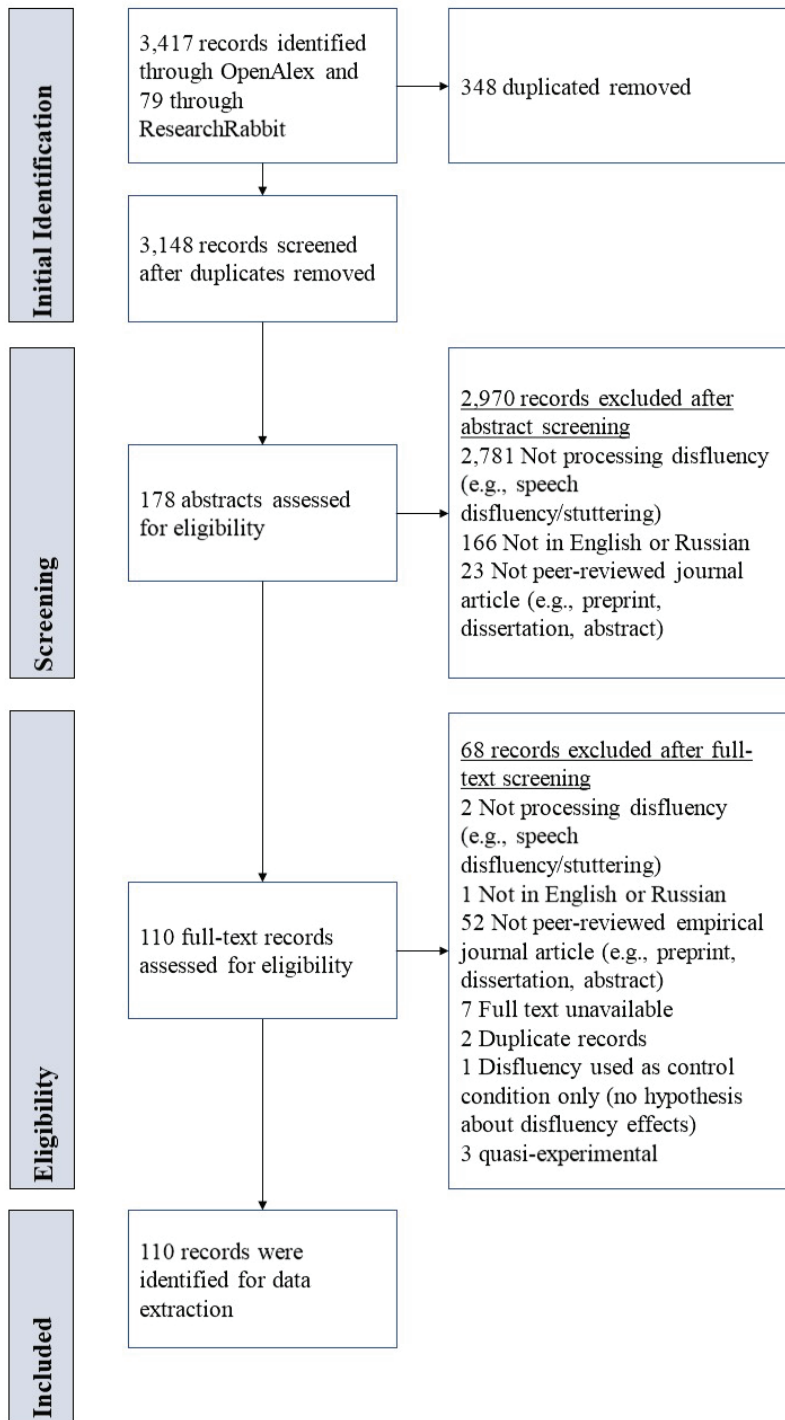


Fig. 1. A PRISMA flowchart of the screening process and results. / **Рис. 1.** Блок-схема PRISMA, описывающая процесс скрининга и его результаты.

21% mixed or hybrid.

Methodological rigor varied considerably. Sample sizes ranged from 15 to over 5,000 participants. Notably, 27% of studies lacked a manipulation check. Statistically, 87% relied exclusively on NHST, while only 12% used Bayesian methods. Preregistration was rare, reported in just 9% of studies.

Quality of empirical evidence for and against effects of disfluency

We first summarise the observed effects of disfluency reported across the 110 studies in our sample (see Table 1 for classification by outcome type). A preliminary examination of methodological rigor across these literatures suggests a pattern: studies reporting null effects tended to be methodologically more rigorous. They were more often preregistered, included a priori power analyses, and complemented NHST with Bayesian methods. In contrast, studies reporting positive or conditional effects more frequently relied on unverified manipulations, had low preregistration rates, and lacked power analysis. This observation raises the possibility that publication bias, flexibility in analysis, and low statistical power may have contributed to the prevalence and magnitude of reported disfluency benefits.

The evidence for disfluency's effects on affective and social judgement is consistent across studies, but the near-total absence of preregistration and power reporting in this subfield suggests that effect sizes may be overestimated. The metacognitive monitoring literature stands out for its replicability: disfluency consistently lowers judgments of learning (JOLs) across studies. However, it is often unclear whether this effect is driven by the subjective experience of disfluency. Many studies lack manipulation checks to confirm that disfluency was actually induced. Instead, lower JOLs may reflect participants' naive theories (e.g., the illusion that larger fonts enhance memory) or relative contrast effects in within-participant designs, rather than processing difficulty. Furthermore, while metacognitive monitoring changes, this rarely translates into metacognitive control (e.g., allocating more study time). Without this regulatory step, the functional impact of disfluency on actual cognitive performance remains questionable.

Finally, two smaller, distinct lines of research describe additional effects. Labour-in-vain studies show that disfluency can increase time on task without improving learning, demonstrating that difficulty alone is insufficient. Neural habituation research points to a distinct mechanism: disfluency arising from prolonged exposure and operating through

synaptic depression. These two studies represent a separate line of inquiry, and conclusions regarding this direction must remain tentative given the small sample.

Proposed mechanisms and empirical evidence

When authors did not explicitly articulate a mechanism, we inferred it from the introduction and discussion. Most studies invoked multiple mechanisms simultaneously, reflecting a tendency to blend rather than isolate theoretical accounts. The labels and definitions were developed for this review to enhance conceptual clarity, building upon prior classifications: Geller and Peterson [Geller, Peterson, 2021], for example, contrasted the metacognitive and compensatory processing accounts, both subsumed within our framework. We do not claim our categories are exhaustive or mutually exclusive, but offer them as a pragmatic starting point for formulating testable hypotheses and designing experiments that contrast competing accounts. Accordingly, we draw on both the introductory framing and reported findings to synthesise the empirical evidence and assess how well it aligns with each proposed mechanism.

Metacognitive cueing

The most frequently invoked account (69 studies), the Metacognitive Cueing framework, proposes that (dis)fluency is a subjective feeling that serves as a metacognitive signal about the state of the cognitive system. Individuals rely on this signal to diagnose their own learning and memory, which can lead to metacognitive illusions, such as mistaking fluency for durable learning [Rhodes, Castel, 2009]. However, this same signalling process can also facilitate metacognitive calibration: disfluency lowers confidence and prompts regulatory investment. As Pieger et al. [Pieger et al., 2017, p. 291] observe, “disfluency improves monitoring accuracy by reducing overconfidence.

A robust body of work supports this account. The foundational demonstration by Reber and Schwarz [Reber, Schwarz, 1999] established that perceptual fluency inflates truth judgements via a sense of familiarity. This logic — using subjective ease as an inferential cue — has since been generalised: fluency drives metacomprehension judgements independently of comprehension [Rawson, Dunlosky, 2002] and informs self-regulated learning behaviours, such as restudy choices [Rhodes, Castel, 2008]. Critically, multiple studies reveal a consistent metacognitive illusion: disfluent items receive lower JOLs despite equal or better recall

**Table 1 / Таблица 1**

Summary and methodological characteristics of analysed disfluency studies / Краткое описание и методологические характеристики проанализированных исследований не-беглости

Outcome / Результат	N of studies (experiments; participants) / Кол-во исследова- ний (эксперимен- тов; участников)	Primary manipulations / Основные манипуляции	Key dependent variables / Ключевые зависимые переменные	Methodological rigour / Методологическая строгость	Evidential assessment / Оценка эмпирической поддержки
Null effects	22 studies (55 exps; 14,379 pp)	Perceptual; linguistic; conceptual	Cognition (retention, reasoning); metacognition (JOLs, cognitive load)	Manipulation checks: 17 Power: 9 a priori (.80–.99) Preregistration: 7 Bayesian analysis: 6	High-quality null evidence challenges robustness of any effects.
Positive effects on cognition	26 studies (81 exps; 5,846 pp)	Perceptual; conceptual; transcription; linguistic; embodied	Cognition (comprehension, inference, recall, recognition, reasoning, transfer); metacognition (JOLs, confidence)	Manipulation checks: 15 Power: 6 a priori, 3 post hoc Preregistration: 1 Bayesian analysis: 2	Evidence is methodologically heterogeneous, often underpowered, and lacks transparency, making positive effects unreliable.
Conditional effects on cognition	10 studies (19 exps; 2,427 pp)	Perceptual; linguistic	Cognition (recognition, recall, comprehension, transfer, retention; metacognition (JOLs, cognitive load)	Manipulation checks: 6 Power: 5 a priori (.80–.95), 1 post hoc Preregistration: 2 Bayesian analysis: 2	Effects emerge only under boundary conditions (e.g., low test expectancy, high WMC, incremental mindset).
Affective/social judgement effects	21 studies (79 exps; 7,717 pp)	Perceptual; conceptual; linguistic	Affective, evaluative and social (liking, beauty, truth judgements, risk perception)	Manipulation checks: 15 Power: 3 a priori + 1 post hoc Preregistration: 0 Bayesian analysis: 1	A consistent pattern exists (disfluency signals risk/distance), but low methodological rigour (e.g., no preregistration) suggests effect sizes may be inflated.
Conditional judgement effects	6 studies (13 exps; 3,141 pp)	Perceptual; conceptual	Affective, evaluative and social (satisfaction; liking; attractiveness; interest; purchase intentions)	Manipulation checks: all Power: 1 a priori Preregistration: 0 Bayesian analysis: 0	Effects are moderated by individual differences, and the evidence base suffers from low statistical power and a lack of preregistration.

Metacognitive monitoring effects	16 studies (47 exps; 3,080 pp)	Perceptual; encoding; conceptual	Metacognitive (JOLs); Cognitive (recall, recognition)	Manipulation checks: 13 Power: 5 a priori Preregistration: 0 Bayesian analysis: 2	Robust JOLs reduction, but may be driven by relative contrast rather than processing difficulty, and rarely translate to adaptive control.
Conditional meta-cognitive effects	4 studies (19 exps; 1,638 pp)	Perceptual; conceptual; embodied	Metacognitive (JOLs, perceived comprehension); Cognitive (recall, reasoning; comprehension)	Manipulation checks: all Power: 2 post hoc (.49–.80) Preregistration: 0 Bayesian analysis: 0	Effects are restricted to specific subgroups (e.g., incremental theorists) and do not translate into objective improvements in cognitive performance.
Labour-in-vain	3 studies (6 exps; 420 pp)	Perceptual; conceptual	Cognitive (recall, reading behaviour); metacognitive (perceived difficulty)	Manipulation checks: all Power: 1 a priori Preregistration: 0 Bayesian analysis: 0	Evidence confirms that increased time-on-task does not equate to deeper processing or improved learning outcomes.
Neural habituation (prolonged exposure → disfluency → impaired recognition)	2 studies (6 exps; 188 pp)	Conceptual	Recognition memory	Manipulation checks: 0 Power: 0 Preregistration: 0 Bayesian analysis: 1	Mechanistically distinct (synaptic depression); isolated theoretical strand. Not comparable to mainstream fluency research.

Notes. exps — experiments, pp — participants. / Примечания. exps — эксперименты, pp — участники.



[Ardıç, Besken, 2022; Ball et al., 2014; Besken, Mulligan, 2013, 2014; Ebersbach et al., 2023; Susser et al., 2013; Yue et al., 2013].

However, the cue use is context-dependent. First, fluency effects on JOLs primarily appear in within-subjects designs [Magreehan et al., 2016; Susser et al., 2013]. Moreover, disfluency can improve monitoring accuracy (e.g., calibration) without affecting recall [Pieger et al., 2016, 2017, 2018], but only when fluent material precedes disfluent material, highlighting the role of contrast. It is also attribution-dependent: the effect reverses when disfluency can be attributed to irrelevant external factors rather than the material itself or one's own competence [Oppenheimer, Frank, 2008]. Finally, reliance on this cue stems from two distinct sources: the actual subjective experience of difficulty and naive beliefs about how difficulty affects learning. Both can produce identical metacognitive illusions, sometimes even prior to actual stimulus exposure [Ardıç, Besken, 2022; Besken, 2018]. Consequently, while the effect is robust under specific conditions, its interpretation remains contested because empirical studies frequently conflate these two distinct pathways.

Diagnostically, if this account is primary, disfluency should affect JOLs even when objective performance is unchanged.

Cognitive engagement signal

The second mechanism (54 studies), the Cognitive Engagement Signal, posits that disfluency signals that the current heuristic mode is insufficient, triggering a shift from fast, intuitive processing (System 1) to slow, analytical processing (System 2) [Evans, 2003; Kahneman, 2011]. As Sundar et al. [Sundar et al., 2019, p. 17] note, disfluency “reduces the impact of heuristics, defaults, and peripheral cues.” Unlike Metacognitive Cueing, which adjusts the evaluation of one's learning state, this mechanism alters the cognitive procedure itself.

Consistent with a shift to System 2, early work showed that disfluency improves reasoning [Alter et al., 2007] and reduces self-disclosure by triggering risk-focused deliberation [Alter, Oppenheimer, 2009a]. Further evidence of this analytical engagement is seen across domains: Sundar et al. [Sundar et al., 2019] found disfluency increases awareness of missing information; Spears et al. [Spears et al., 2018] found enhanced utilitarian moral reasoning; and Baldwin et al. [Baldwin et al., 2020] reported reduced framing effects. Spears et al. [Spears et al., 2018] ruled out time-on-task, affect, and construal-level explanations. In aesthetics, visual disfluency triggers effortful

meaning-making, with liking contingent on successful interpretation [Ball, Threadgold, Marsh, et al., 2018; Graf, Landwehr, 2017].

Yet engagement is neither automatic nor universally beneficial. Lehmann et al. [Lehmann et al., 2016] showed its benefits depend on working memory capacity; Tracy et al. [Tracy et al., 2023] found disfluency reduced “bullshit receptivity” only among those high in cognitive reflection. Geller and Peterson [Geller, Peterson, 2021] identified test expectancy as a key boundary condition. The mere expectation of a memory test inherently shifts metacognitive control and prompts active encoding strategies, thereby overriding the influence of disfluency cues. Bahník [Bahník, 2019] demonstrated that extreme disfluency does not necessarily trigger analytic deliberation, but can serve as a cue for rapid heuristic rejection, leading to faster decisions.

Collectively, these studies indicate that disfluency functions as a conditional trigger for deeper processing, but its efficacy hinges on individual differences, task structure, and cue diagnosticity. The account is supported by convergent evidence, yet positive findings often come from studies with low preregistration rates and unverified manipulation checks (see Table 1), suggesting the mechanism may reflect a context-contingent strategy rather than a general mode-shift.

Diagnostically, if this account is primary, disfluency should improve performance on tasks that benefit from analytic override (e.g., syllogistic reasoning), but not on tasks already requiring deep processing.

Processing-based account

The third mechanism (32 studies), the Processing-Based account holds that disfluency directly alters the quality or trajectory of cognitive processing through mechanisms such as extended time-on-task, heightened perceptual focus, increased arousal, or compensatory top-down recruitment (e.g., semantic, phonological feedback). For instance, Medimorec, Young, and Risko [Medimorec et al., 2017, p. 4] proposed that disfluency “allowed more time for lexical processes to unfold.” Other researchers suggest that when perceptual input is degraded, the system draws more heavily on higher-level knowledge structures [Geller et al., 2018; Hirshman et al., 1994; Susser et al., 2013] or that disfluency attracts more attention due to distinctiveness [Sungkhasettee et al., 2011] or fosters heightened perceptual focus [Sanchez, Naylor, 2018]. Together, these studies position disfluency as a catalyst for qualitative shifts in encoding.

Early work by Hirshman et al. [Hirshman et al., 1994] established that perceptual interference enhances memory by forcing a compensatory shift from low-level visual features to higher-level phonological and lexical processing. This was refined by Rosner et al. [Rosner et al., 2015] and Geller et al. [Geller et al., 2018], who linked disfluency to conflict monitoring. Disfluency also was shown to alter processing through temporal extension, attentional orienting [Diachek, Brown-Schmidt, 2022], and resource competition reducing mind-wandering [Faber et al., 2017].

These effects are highly sensitive to transfer-appropriate processing: memory benefits emerge only when the cognitive processes stimulated during disfluent encoding align with the specific demands of the retrieval test [Weissgerber, Reinhard, 2017], but fail when the nature of the encoding and retrieval tasks are mismatched [Cui, Liu, 2022]. Geller et al. [Geller et al., 2025] recently specified the mechanism as stage-dependent: benefits arise only when disfluency disrupts later lexical/semantic stages.

Thus, while disfluency can alter encoding, the account comprises heterogeneous mechanisms whose efficacy hinges on representational level, test format, and processing stage with little effort to dissociate them.

Diagnostically, if this account is primary, disfluency effects should be mediated by objective behavioural markers of altered encoding (e.g., reading time, fixation duration), not merely by subjective reports.

Affective and hedonic marker

Particularly relevant to aesthetics and marketing is the Affective and Hedonic Marker account (20 studies). It posits that fluency is inherently experienced as positive (pleasant and “good”), whereas disfluency evokes negative affect (aversion or threat). As Ball et al. [Ball, Threadgold, Marsh, et al., 2018, p. 5] formulated “the experience of fluent processing feels subjectively good at an affective level.” Because these affective responses are often (mis)attributed to the stimulus itself [Reber et al., 2004], fluency enhances liking and aesthetic preferences via affective transfer [Motyka et al., 2016], whereas disfluency triggers broad devaluation [Olszanowski et al., 2018]. This mechanism is central to the mood-as-information model [Schwarz, 2002, 2013]: individuals simplify evaluative tasks by implicitly asking, “How do I feel about it?” and default to treating their affective state as a reaction to the target, unless specifically called into question. Consequently, downstream effects on judgements of truth, beauty, or quality are not driven by cognitive analysis but by this affective reaction [Christensen et al., 2020]. Together, these findings

position affect as the primary mediator of fluency’s influence in evaluative and aesthetic contexts.

The account originates with Reber, Winkielman, and Schwarz [Reber et al., 1998], who showed that fluency enhances liking, concluding that “perceptual fluency is affectively positive.” This extends to social cognition: Claypool et al. [Claypool et al., 2012] found fluent faces were more likely categorised as ingroup members, with liking mediating the effect. This affective signal also operates implicitly to regulate cognitive effort: Oliveira et al. demonstrated that fluency and semantic conflict produce additive effects on cognitive control, suggesting that the monitoring system integrates distinct sources of ease or difficulty into a unified affective cue indicating whether top-down control mechanisms are required [Oliveira et al., 2023].

However, disfluency is not universally negative: Sung et al. [Sung et al., 2022] showed it can evoke interest when interpreted as a signal of novelty. Thus, to test this affective mechanism, individual interpretations must be taken into account. By default, people assume their feelings are a reaction to the target. However, if individuals realise the difficulty stems from an irrelevant source (e.g., a poor font), they discount this affective signal, and the fluency effect vanishes. Diagnostically, if this affective account is primary, two conditions must be met: (a) fluency should enhance liking even for meaningless stimuli, and (b) this effect should be eliminated when the affect is attributed to an external source. Consequently, validating this mechanism requires explicitly checking for such misattribution. Accounting for this interpretive step explains the boundary conditions where fluency effects disappear, confirming that affect is a powerful but highly context-dependent driver of evaluation.

Naïve theory moderator

A smaller cluster (10 studies) conceptualises (dis)fluency through the Naïve Theory Moderator account: its meaning is constructed through individuals’ lay beliefs about what ease or difficulty signifies in a given context. The same disfluent experience can lead to opposing judgements depending on interpretation. As Thompson and Ince [Thompson, Ince, 2013, p. 229] explain, “disfluency influences judgements through the specific attributions consumers give to subjective effort, and these attributions depend on the naïve theory associated with the subjective feeling of effort.” This interpretive process determines whether (dis)fluency is even integrated into judgement at all [Olszanowski et al., 2018; Park, Ryu, 2025]. Rather than exerting fixed influence, (dis)fluency serves as



raw experiential input filtered through culturally shaped explanatory frameworks.

Miele and Molden [Miele, Molden, 2010] provided foundational evidence: entity theorists viewed disfluent text as evidence of limited ability, while incremental theorists saw it as a sign of developing understanding. This was extended by Miele et al. [Miele et al., 2011] to JOLs, where the same effort led entity theorists to predict worse recall and incremental theorists better recall — but only when effort was self-paced, highlighting source attribution. Similarly, Jia et al. [Jia et al., 2023] found that incremental theorists persisted longer in insight problem-solving, interpreting disfluency as a call for effort. Skulmowski and Rey [Skulmowski, Rey, 2021] showed disfluent pathogen images were judged more credible via “effort means accuracy” beliefs; Thompson and Ince [Thompson, Ince, 2013] found disfluency increased perceived agent skill pre-consumption but reversed post-consumption; Christensen et al. [Christensen et al., 2020] found fluency enhanced beauty but its effect on creativity depended on source; Walter et al. [Walter et al., 2021] proposed disfluency can enhance persuasion when audiences hold “important messages require effort” beliefs.

The account’s strength is predicting opposing outcomes from identical stimuli. However, effects depend on source attribution being salient, and the literature remains small, with risk of circularity if naïve theories are inferred post-hoc.

Diagnostically, if this account is primary, the same disfluent stimulus should produce opposite evaluative effects depending on which naïve theory is primed (e.g., “difficult = poorly written” vs. “difficult = sophisticated”).

Integrative accounts

A growing body of research demonstrates that multiple mechanisms operate simultaneously or sequentially. Thompson et al. [Thompson et al., 2013] integrated the Metacognitive Cueing and Cognitive Engagement accounts by showing both rely on fluency to regulate System 2 thinking, but at different levels: answer fluency (ease of generating a response) drives trial-by-trial meta-cognitive monitoring and the “feeling of rightness,” whereas perceptual fluency (ease of reading) triggers a global sense of unease prompting additional analytic processing. Graf and Landwehr [Graf, Landwehr, 2017] achieved this theoretically through their Pleasure–Interest (PIA) Model, which posits two parallel routes to aesthetic liking: automatic processing fluency directly drives aesthetic pleasure, whereas the controlled resolution of

disfluency drives aesthetic interest. Complementing this, Menninghaus et al. [Menninghaus et al., 2025] demonstrated empirical integration via conjoint statistical modelling: when ease of processing and syntactic complexity are analysed simultaneously, they independently and positively predict literary appreciation, indicating that fluency and cognitive challenge can jointly enhance aesthetic evaluation. Park, Herr, and Kim [Park et al., 2016] showed Naïve Theory moderates Metacognitive Cueing in product perceptions. Lai and Zhang [Lai, Zhang, 2021] used eye-tracking to demonstrate that perceptual disfluency enhances transfer via Cognitive Engagement, improves JOL calibration via Metacognitive Cueing, and guides attention via Processing-Based mechanisms. Seufert et al. [Seufert et al., 2017] identified an inverted-U relationship between disfluency and learning, with moderate disfluency boosting performance through engagement and metacognitive allocation. Belke et al. [Belke et al., 2015] dissociated automatic affective responses for fluent portraits from deliberate elaboration for mastery portraits.

These integrated frameworks propose that the five mechanisms are interacting layers of response, not competing explanations. The critical question is therefore not which mechanism operates, but under what conditions each dominates and how they combine. In the following section, we offer recommendations for shifting the field from demonstrations of effect towards systematic theory testing.

Recommendations for future inquiry

First, rigorous methodology must become standard: all studies should include clear control conditions and implement manipulation checks, either subjective (e.g., perceived difficulty) or objective (e.g., reading time, naming latency), to verify that the intended disfluency was successfully induced [Dunlosky, Mueller, 2016]. We provide a comprehensive library of validated manipulations and corresponding checks to support this goal (<https://doi.org/10.6084/m9.figshare.31821274>). Second, open science practices are essential. Given the prevalence of underpowered studies and mixed replications, pre-registration and a priori power analyses should be adopted to ensure transparency and reduce bias. Third, future work must explicitly account for boundary conditions now well-established in the literature, including individual differences (e.g., working memory capacity, cognitive reflection, mindset) and procedural factors (e.g., test expectancy, retention interval, task structure).

Critically, researchers should formulate precise,

mechanism-driven predictions. For the Metacognitive Cue mechanism, studies should dissociate metamemory from actual performance and manipulate attribution to isolate inferential use of fluency. For the Cognitive Engagement Signal, experiments should contrast tasks requiring heuristic vs. analytic processing and include measures of reasoning depth, while controlling for affect and time-on-task. The Processing-Based Account demands fine-grained process measures, such as eye-tracking, drift-diffusion modelling, or EEG, to detect shifts in encoding dynamics independent of metacognitive interpretation. To isolate the Affective and Hedonic Marker, researchers should measure immediate valence and test whether effects persist when affective transfer is blocked. Finally, the Naïve Theory Moderator requires experimental manipulation of lay beliefs to demonstrate that the same disfluency experience yields opposite judgements based solely on interpretive frameworks.

By embracing these principles, the field can move from documenting inconsistent effects towards building a coherent, predictive science of how and why fluency shapes human cognition.

Discussion

This review synthesised the theoretical landscape of disfluency and mapped empirical evidence for its effects on cognition, metacognition, and judgement. Rather than judging whether “disfluency works,” our goal was to clarify how it might operate, under what conditions, and why findings diverge, highlighting both the field’s conceptual richness and methodological fragmentation.

Our analysis shows disfluency is not unitary but interpreted through at least five distinct theoretical lenses. Critically, most studies invoke multiple mechanisms simultaneously without isolating them. This blending, while reflecting conceptual complexity, likely contributes to inconsistent replications and theoretical ambiguity.

By disentangling these accounts and cataloguing their empirical support, we aim to foster more precise hypotheses and experimental designs. To support this shift, we provide the most extensive library of disfluency manipulations to date.

Despite these complexities, disfluency continues to attract attention across applied domains, including education, marketing, aesthetics, and social cognition. The present review suggests that practical utility cannot be assumed uniformly: whether disfluency

proves beneficial depends critically on the mechanism invoked, operationalisation, and boundary conditions. Applied interventions should therefore adopt theoretically grounded, context-sensitive approaches tailored to the intended outcome.

This review has limitations. First, study selection and data extraction were conducted by a single reviewer, a limitation reflecting practical constraints rather than methodological preference. To mitigate subjectivity, we employed strict eligibility criteria, used Rayyan for transparent screening, and iteratively verified extracted data against original sources. Second, our search was limited to open-access platforms (OpenAlex and ResearchRabbit) due to institutional restrictions. While OpenAlex rivals Web of Science in coverage [Culbert et al., 2025], it may miss regionally published work. Nonetheless, our broad temporal scope (1988–2025) and inclusion of 110 studies suggest core discourse is captured. Third, using only the keyword “disfluency” risks omitting analogous terms (e.g., “processing difficulty”). This was partially offset by ResearchRabbit’s semantic and citation-based discovery, which retrieves conceptually related work regardless of terminology. Future multi-database reviews will refine this landscape further.

In sum, this review highlights the need to move beyond binary efficacy questions toward investigations of mechanism, context, and individual difference. The central questions are not simply whether disfluency influences cognition, but which type, for whom, under what conditions, and through which process. Adopting open science practices, theoretical specificity, and methodological rigour will be essential for advancing the field.

Supplement Materials

Additional information about methods, materials, results, etc. available online Tsigeman, Elina (2026). Appendix materials for Mechanisms underlying disfluency effects: a systematic review paper. Figshare. Online resource. <https://doi.org/10.6084/m9.figshare.31821274.v1>

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Information about authors

Tsigeman Elina Sergeevna. PhD Student, junior researcher at the Social and Cognitive Informatics Laboratory, National Research University Higher School of Economics Saint-Petersburg, ul. Sedova, d. 55к2, 192171 Saint-Petersburg, Russia. ORCID: <https://orcid.org/0000-0002-7966-5982>
E-mail: etsigeman@hse.ru

Conflict of Interest

The authors declare no conflict of interest.

Сведения об авторах

Цигеман Элина Сергеевна. Аспирант, младший научный сотрудник, лаборатория соци-



альной и когнитивный информатики, Национальный исследовательский университет «Высшая школа экономики» Санкт-Петербург, ул. Седова, д. 55к2, 192171 Санкт-Петербург, Россия.

ORCID: <https://orcid.org/0000-0002-7966-5982>

E-mail: etsigeman@hse.ru

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