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Designing for the Brain: The EPA Framework for Translating Cognitive Evidence Into Design Decisions

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ABSTRACT

Human-Centered design depends on understanding how people perceive, remember, and respond to information, yet translating cognitive research into practical interface decisions often risks oversimplifying scientific evidence. This work-in-progress proposes the Evidence–Principle–Application (EPA) Framework to express and qualify evidence-to-design inferences without treating psychological findings as deterministic rules. Drawing on a selective synthesis of 31 sources across attention, perception, memory, emotion, and agency, EPA structures design reasoning across five connected stages: evidence, interpretation, candidate principle, application, and boundary condition. A constructed subscription-cancellation walkthrough demonstrates the rationale for separating review from commitment and keeping decision-critical consequences visible at the moment of commitment. A competing immediate-action design with reliable undo illustrates how changing a system assumption alters the resulting interface recommendation. EPA is positioned alongside Questions, Options, and Criteria (QOC) and Claims Analysis as a design-rationale representation, with Motivation, Engagement, and Thriving in User Experience (METUX) offering a complementary need-based perspective. Future empirical evaluation should isolate the commitment sequence from information placement and assess user comprehension, error rates, effort, and framework utility for practitioners.

Keywords: Cognitive ergonomics, Cognitive science, Evidence-to-design traceability, User agency, METUX, Human-centered design

INTRODUCTION

Translating cognitive research into interface decisions requires more than identifying a relevant psychological mechanism. Designers must judge whether an empirical finding applies to a particular task, what design choice it supports, and which contextual conditions could undermine that choice. This paper examines how the Evidence–Principle–Application (EPA) Framework makes these judgments explicit without treating research findings as deterministic interface rules.

Foundational critiques by Bruer (1997) and Bowers (2016) question unsupported bridges from neuroscience to applied interventions. Similarly, Howard-Jones (2014) documents persistent neuromyths, while Plassmann et al. (2012) discuss opportunities and methodological limits in consumer neuroscience. Together, these cautions support separating what empirical

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evidence establishes from the contextual interpretation designers add. Neural or cognitive evidence should not be invoked as rhetorical authority where behavioral or task-specific evidence is more directly relevant.

This paper contributes a structured five-stage record for expressing and qualifying evidence-to-design inferences, paired with an analytical walkthrough showing how competing cognitive demands, system assumptions, and ethical constraints shape an interface specification. While abbreviated as EPA for memorability, the full operational pathway spans five connected stages grouped across three functional phases: the Evidence Phase (Evidence and Interpretation), the Principle Phase (Candidate Principle), and the Application Phase (Application and Boundary Condition).

Established design-rationale methods, including Questions, Options, and Criteria (QOC; MacLean et al., 1991) and scenario-based Claims Analysis (Carroll and Rosson, 1992), effectively document design choices and trade-offs. EPA builds on this tradition by foregrounding the provenance of cognitive evidence, the contextual inference linking that evidence to an interface, and the explicit boundary condition under which that inference may fail.

BACKGROUND AND RELATED RESEARCH

Research on selective visual attention encompasses biased competition (Desimone and Duncan, 1995), computational salience modeling (Itti and Koch, 2001), goal-directed and stimulus-driven attention (Corbetta and Shulman, 2002), and distraction under perceptual load (Lavie, 2005). In interface design, these accounts motivate examining whether visual prominence serves the user's immediate goal rather than assuming that greater salience inherently improves interaction.

Perceptual organization is informed by syntheses of Gestalt grouping and figure–ground organization (Wagemans et al., 2012a; Wagemans et al., 2012b), visual clutter research (Rosenholtz et al., 2007), and perceptually informed visualization guidelines (Ware, 2020). Grouping and contrast motivate candidate layouts, though their effectiveness remains contingent on the specific task, display context, and user population.

Working-memory models (Baddeley, 2012) and capacity estimates (Cowan, 2001) motivate reducing unnecessary retention demands during multi-step interactions. Crucially, the approximately four-chunk capacity estimate is conditional on stimulus characteristics and prior knowledge rather than a fixed interface item-count rule. Relatedly, cognitive load theory (Sweller, 1988) and multimedia learning research (Mayer and Moreno, 2003; Mayer, 2024) address processing demands during instruction; transferring these findings to general transactional interfaces requires contextual validation.

Emotion and cognition interact closely (Pessoa, 2008), and emotional relevance modulates attentional capture (Vuilleumier, 2005). Accounts of processing fluency (Reber et al., 2004) and aesthetic appreciation (Leder et al., 2004; Chatterjee and Vartanian, 2014) indicate that visual experience depends on prior knowledge, meaning, and context. Perceptual fluency and

attractiveness do not by themselves guarantee comprehension, operational safety, or ethical acceptability.

Self-determination theory identifies autonomy, competence, and relatedness as basic psychological needs (Deci and Ryan, 2000), which the METUX model applies to digital experience (Peters et al., 2018). Parallel scholarship emphasizes human control (Shneiderman, 2020) and examines manipulative dark patterns (Gray et al., 2018; Mathur et al., 2019). EPA's agency dimension aligns with autonomy while foregrounding informed consent, visible consequences, reversibility, and resistance to deceptive interface patterns.

CONCEPTUAL DEVELOPMENT AND ANALYTIC LENSES

Conceptual development of the EPA Framework draws on a selective synthesis of 31 cited sources published between 1988 and 2024, informed by literature-review guidance (Snyder, 2019) and integrative-review methodology (Whittemore and Knafl, 2005). The bibliography encompasses foundational cognitive scholarship alongside methodological and design-rationale publications. Sources were selected for their theoretical prominence, potential interface implications, and clear illustration of transfer boundaries beyond their original experimental contexts.

The five dimensions—attention, perception, memory, emotion, and agency—were selected as provisional analytic lenses for recurring challenges in visual communication and interaction design. Attention, perception, memory, and emotion address how people process and respond to information, whereas agency addresses informed, voluntary action. Agency is included deliberately because cognitive efficiency alone does not ensure meaningful choice.

The five-stage record separates the underlying research account from its proposed contextual implications, candidate guidance, interface implementation, and boundary limitations. This conceptual organization emphasizes theoretical credibility, relevance to design, restrained inference, and boundary awareness.

Subscription cancellation is used as a constructed walkthrough scenario because it brings discoverability, commitment sequencing, information visibility, and reversibility into sharp focus. Competing interface alternatives are specified to expose conflicts among those requirements and to demonstrate how changing system assumptions alters the resulting design recommendation.

THE EVIDENCE–PRINCIPLE–APPLICATION FRAMEWORK

EPA structures the transition from research to design through five connected judgments mapped across its three namesake pillars: Evidence (Pillar 1 – Evidence) identifies an empirical finding or theoretical account and its provenance; Interpretation (Pillar 1 – Evidence) explains its relevance to the target task and notes what the source does not directly establish; Candidate Principle (Pillar 2 – Principle) formulates conditional design guidance; Application (Pillar 3 – Application) specifies an inspectable interface decision; and Boundary Condition (Pillar 3 – Application) records the

limitation, trade-off, or contextual assumption that could require revision. This sequence separates what research establishes from what designers infer and implement.

Table 1: Overview of candidate translations across the five analytic dimensions.

Dimension / Evidence	Interpretation and Candidate Application	Boundary Condition
Attention (Desimone and Duncan, 1995; Itti and Koch, 2001; Corbetta and Shulman, 2002; Lavie, 2005)	Prominence redirects focus. Prioritize task-relevant actions and information through clear visual hierarchy.	High salience may distract from secondary details or manipulate choice; task relevance varies by user goal.
Perception (Wagemans et al., 2012a; Wagemans et al., 2012b; Rosenholtz et al., 2007; Ware, 2020)	Perceptual organization clarifies relationships. Group related settings and use distinguishable visual encodings.	Grouping heuristics do not replace empirical accessibility verification and population-specific usability testing.
Memory (Baddeley, 2012; Cowan, 2001; Sweller, 1988; Mayer and Moreno, 2003; Mayer, 2024)	Retaining intermediate information burdens working memory. Externalize relevant details and chunk related content.	Persistent visible content may increase display clutter, whereas progressive disclosure may hide essential terms.
Emotion (Pessoa, 2008; Vuilleumier, 2005; Reber et al., 2004; Leder et al., 2004; Chatterjee and Vartanian, 2014)	Affective tone and fluency influence appraisal. Provide respectful feedback and transparent explanations.	Specific messages require testing; interfaces must not shame, pressure, or use fluency to conceal risk.
Agency (Deci and Ryan, 2000; Peters et al., 2018; Shneiderman, 2020; Gray et al., 2018; Mathur et al., 2019)	Meaningful control requires intelligible, voluntary choices. Disclose consequences prior to commitment and allow reversal.	Technical reversal is not always feasible; excessive confirmation steps may become an obstructive barrier.

The starting point of an EPA record is the user's decision: what the person intends to accomplish, what information the choice requires, and what consequences follow from an error. An EPA record distinguishes empirical findings from theoretical accounts and design guidance, explains their relevance to the task, and identifies the conditions that would require reconsideration of the recommendation.

RELATIONSHIP TO EXISTING FRAMEWORKS

QOC represents a design space through explicit questions, options, and evaluation criteria (MacLean et al., 1991), while Claims Analysis articulates positive and adverse consequences of artifacts within user scenarios (Carroll and Rosson, 1992). For subscription cancellation, both methods can express concerns regarding discoverability, informed choice, error prevention, and effort. EPA complements these representations by providing dedicated

structure for research provenance, transfer inference, candidate guidance, implementation, and boundary conditions.

METUX provides a complementary macro-level perspective by organizing autonomy, competence, and relatedness across adoption, interface, task, behavior, life, and society (Peters et al., 2018). Whereas METUX evaluates psychological need support and wellbeing outcomes, EPA operates at the micro-level of individual evidence-to-design inferences. Because a cognitively clear interface can still be coercive, EPA's agency lens incorporates autonomy considerations alongside explicit checks on consent, disclosure, and reversibility.

WORKED DECISION: SUBSCRIPTION CANCELLATION

Scenario and Assumptions

Consider a paid digital subscription in which cancellation stops the next billing renewal while access continues until the current paid period ends, with no early-termination fee. For the primary scenario, reinstatement on identical grandfathered terms is not guaranteed. The user's goal is to end renewal after verifying the effective date and financial consequences. Proposal C deliberately alters the reversibility assumption to examine how a changed system capability shifts the interface recommendation.

Initial Proposal and Competing Alternatives

Proposal A (Bundled Baseline) applies a simplified attention rationale: place a high-contrast "Cancel subscription" button prominently in account settings and execute cancellation immediately upon activation. Decision details are placed behind an optional "Learn More" link to keep the screen uncluttered. While optimizing discoverability and step count, this design introduces risks of accidental execution and commitment before the user has reviewed material consequences.

Proposal B (Primary Staged Proposal) keeps the cancellation path discoverable in account settings but labels the initial action "Review Cancellation." Activating it opens a single review screen displaying the effective date, next-renewal effect, access end date, and any applicable financial terms. A clearly labeled "Confirm Cancellation" control commits the action, paired with a neutral "Keep Subscription" exit option free of guilt language, misleading emphasis, or preselection. A final receipt states the resulting account status.

Proposal C (Changed System Assumption) displays the concise consequence summary directly in account settings, executes cancellation immediately upon activation, and provides a reliable undo control on the receipt view that restores the subscription on identical terms. Proposal C tests whether immediate execution becomes defensible when material consequences are disclosed inline in advance and cancellation can be dependably reversed. Under that changed system capability, the rationale for Proposal B's separate confirmation screen weakens. Repeated retention screens are excluded across all alternatives as an ethical constraint.

Table 2: Comparison of constructed subscription-cancellation flow alternatives.

Alternative	Schematic Interaction Flow
Proposal A: Bundled Baseline	Account settings → immediate cancellation → receipt. Essential consequences are placed behind an optional "Learn more" link.
Proposal B: Primary Staged Proposal	Account settings → Review cancellation → visible consequence summary → Confirm cancellation → receipt.
Proposal C: Changed System Assumption	Account settings with inline consequence summary → immediate cancellation → receipt + reliable undo on identical terms.

EPA Record 1: Discoverability Does Not Justify Immediate Execution

1. **Evidence (Pillar 1).** Biased competition and goal-directed versus stimulus-driven attention accounts describe how task relevance and visual prominence shape selection (Desimone and Duncan, 1995; Corbetta and Shulman, 2002). These basic cognitive sources do not directly compare transactional cancellation workflows or establish the effect of a confirmation screen.
2. **Interpretation (Pillar 1).** A user pursuing cancellation must be able to locate the entry action without friction. However, visually locating an option and authorizing a consequential account change are distinct interaction requirements.
3. **Candidate Principle (Pillar 2).** Make the cancellation path visually discoverable, but separate decision entry from final commitment when material consequences have not yet been reviewed, and action reversal is uncertain.
4. **Application (Pillar 3).** Replace Proposal A's immediate-execution control with Proposal B's "Review Cancellation" entry action leading to one concise consequence summary screen with neutral "Confirm Cancellation" and "Keep Subscription" options.
5. **Boundary Condition (Pillar 3).** The trade-off is adding one step to prevent accidental or uninformed commitment, bounded by the ethical constraint that confirmation must not degrade into an exit barrier. Under the primary scenario assumptions, Proposal B is preferred over Proposal A. Under Proposal C's changed assumptions—inline consequence disclosure and reliable undo—the extra confirmation step is no longer required.

EPA Record 2: Reduced Clutter Does Not Justify Hiding Critical Consequences

1. **Evidence (Pillar 1).** Working-memory research establishes constraints on temporary retention and manipulation (Baddeley, 2012; Cowan, 2001), while visual-clutter research addresses competition in dense displays

(Rosenholtz et al., 2007). Neither body of research specifies the optimal granularity of cancellation disclosures.

2. **Interpretation (Pillar 1).** Requiring users to open a secondary panel, retain billing dates and terms in memory, and return to commit imposes avoidable retention demands. Conversely, displaying exhaustive contract text inline hinders visual search. The key design question is which information must be visible at the moment of commitment.
3. **Candidate Principle (Pillar 2).** Keep decision-critical consequences visible directly beside the commitment action; reserve progressive disclosure for supplementary policy explanation rather than terms required to understand the action.
4. **Application (Pillar 3).** Proposal B displays the renewal effect, cancellation effective date, and access end date inline on the review screen, while Proposal C displays the same concise summary inline before the immediate action. Longer policy clauses remain accessible via clearly labeled secondary links.
5. **Boundary Condition (Pillar 3).** A concise summary risks omitting rare contractual exceptions or increasing visual density when pricing tiers are complex. Verification must confirm that users accurately identify relevant dates, charges, and benefit changes; if an exception causes misunderstanding, the visible summary must be expanded even at the cost of visual simplicity.

DISCUSSION, LIMITATIONS, AND FUTURE RESEARCH

The subscription-cancellation walkthrough highlights a central principle in evidence-informed design: a defensible interface specification depends not only on the cognitive mechanism invoked, but also on the contextual, technical, and ethical conditions under which it is applied. Moving from Proposal A to Proposal B modifies two distinct specification variables: commitment sequence (immediate vs. staged review) and information placement (optional link vs. inline visibility). Proposal C demonstrates that when essential consequences are visible inline and dependable undo is engineered into the service, immediate execution remains defensible. By recording these dependencies explicitly, the EPA Framework renders the reasoning behind an interface specification open to inspection and revision.

Several methodological limitations bound this work-in-progress. First, the 31 cited sources represent a selective, illustrative synthesis rather than a reproducibly screened systematic review. Furthermore, the five analytic dimensions overlap and omit other relevant human factors processes, including psychomotor control, language processing, social cognition, and long-term adaptation. Generalizing laboratory findings to diverse user populations and high-stakes operational domains requires empirical verification, and ethical safeguards require normative judgment and stakeholder participation rather than inference from cognitive mechanisms alone.

Second, the walkthrough specifications represent analytical proposals rather than tested prototypes. Future empirical evaluation should separate commitment sequence from information placement—for example, through

a factorial prototype study varying action sequence (immediate vs. review-before-commit) and consequence visibility (inline vs. optional disclosure) while holding reversal capability constant, and examining reliable undo as a separate system factor. Dependent measures should include user comprehension of dates and charges, accidental commitment rates, intentional completion, task effort, and accessibility.

Third, EPA does not supply a validated psychometric instrument, automated scoring rubric, or causal model of wellbeing, and should accompany established usability, accessibility, and human-centered design practices. Future classroom and comparative practitioner studies should test whether designers using EPA document research assumptions more consistently, identify unsupported inferences, and recognize ethical or accessibility trade-offs more effectively than with existing design-rationale methods, while evaluating inter-reviewer agreement and documentation effort.

CONCLUSION

The Evidence–Principle–Application (EPA) Framework offers a structured design-rationale representation for documenting how cognitive science informs interface decisions. Rather than translating psychological findings into rigid design rules, EPA distinguishes empirical evidence, task interpretation, candidate principles, interface applications, and contextual boundary conditions. As demonstrated in the subscription-cancellation walkthrough, visual discoverability does not by itself justify immediate commitment, and reducing display clutter does not justify concealing decision-critical consequences. Explicitly recording the cognitive, technical, and ethical dependencies behind interface specifications makes design reasoning transparent, inspectable, and adaptable when system assumptions change.

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