Human Factors and Ergonomics in Design, Vol. 210, 2026, 33–42
https://doi.org/10.54941/ahfe1007423

Psychological Mechanism and Classification of Similarity Judgment in Design: Expert Interviews and Questionnaire Survey

Jinpeng Chen, Yulin Zhao, and Yanhao Cai

Faculty of Innovative Design, City University of Macau, Macau SAR 999078, China

ABSTRACT

Similarity judgment is a core cognitive activity in conceptual design, directly affecting design thinking efficiency, outcome novelty, and decision rationality. While its significance in combinatorial design and analogical reasoning is confirmed (McTeague, 2022), the underlying psychological mechanism and systematic classification in design scenarios remain understudied. Integrating cognitive psychology theories, this study adopted expert interviews (n = 12) and questionnaire surveys (n = 198 valid responses) with professional designers to explore these issues. Results show that design similarity judgment follows a dual-process mechanism: structural alignment processing (M = 4.23, SD = 0.58) dominates, with limited thematic association processing (M = 2.87, SD = 0.65) as a supplement ($r = 0.23$, $p < 0.01$). It can be classified into three dimensions with weighted order: functional similarity (M = 4.35, SD = 0.52) > formal similarity (M = 3.78, SD = 0.61) > contextual similarity (M = 2.96, SD = 0.73). Work experience and design field further influence judgment preferences. These findings enrich the dual-process model's contextual application, provide a unified classification system, and offer implications for cognitive ergonomic optimization of design tools and designer training.

Keywords: Design similarity judgment, Psychological mechanism, Structural alignment, Thematic similarity, Expert interview, Questionnaire survey

INTRODUCTION

Similarity serves as a core cognitive construct in human thinking and behavior, and it is equally an indispensable element in design activities. During the conceptual design phase, designers assess similarities between existing design concepts, between concepts and user needs, and between solutions and norms—thereby achieving the reuse of design outcomes, innovation through analogy, and the screening of design schemes. Prior research has confirmed that similarity exerts a notable influence on design creativity: lower similarity among base concepts tends to enhance the originality of newly combined concepts, while analogies with dissimilar surface features can boost the novelty of design outcomes derived from analogical reasoning (McTeague, 2022). Furthermore, similarity constitutes a key component in judging design novelty, and the accuracy of such judgments directly affects the rationality of design decisions.

Received February 3, 2026; Revised April 3, 2026; Accepted April 22, 2026; Available online July 20, 2026

Despite its significance, existing research has clear gaps: most focus on quantitative measurement (e.g., computer vision for design rights protection (Amoncio et al., 2025)) rather than the underlying psychological mechanism (designers' cognitive perception, processing, and influencing factors remain unclear); classification is scattered without a unified standard, often focusing on single-dimensional similarity (e.g., functional or formal) and ignoring its multi-dimensional nature in real design.

From the cognitive psychology perspective, the similarity dual-process model posits two independent cognitive processes: structural alignment (feature-based, relying on shared/distinct concept features) and thematic association (based on external complementary relationships of spatiotemporally co-occurring/interacting concepts). Widely verified in non-design scenarios (Richie & Bhatia, 2021), the model's applicability to design and the interaction of its two processes remain unclarified.

To address these issues, this study focuses on the psychological mechanism and classification of design similarity judgment, adopting a combined expert interview and questionnaire survey method (suited to design cognitive psychology research) with experienced professional designers. Its core goals are:

(1) Explore designers' cognitive psychological mechanism and clarify the roles of structural alignment and thematic association;
(2) Construct a scientific classification system, define its dimensions and relative importance, thereby remedying existing deficiencies and providing theoretical and practical support for design practice and education.

THEORETICAL BASIS OF SIMILARITY JUDGMENT

Research on the psychological mechanism of similarity judgment, rooted in cognitive psychology, has yielded key theoretical models—contrast model, structural alignment model, and dual-process model—providing foundational support for exploring design similarity judgment.

Feature-based similarity, the fundamental form of judgment, relies on comparing conceptual mental representations. The contrast model, an early feature-based framework, links similarity to shared (positive correlation) and distinct (negative correlation) features but ignores inter-feature relations and hierarchical structures. To address this, the structural alignment model was proposed, positing that concepts are structured systems of attributes (function, form, material), entities, and inter-element relations. This process is deeply rooted in Structure-Mapping Theory, which suggests that similarity is a mapping of hierarchical relational systems between concepts (Gentner & Markman, 1997). Similarity judgment involves aligning these systems: identifying shared relational structures, comparing attributes within them, and evaluating commonalities and alignable differences. Widely validated (Richie & Bhatia, 2021), this model is highly applicable to design because design concepts possess distinct structural hierarchies—such as function-form links. Furthermore, research on visual analogy confirms that experienced designers rely heavily on these deep-level structural alignments to facilitate creative

problem-solving (Casakin, 2004). This is further supported by trademark detection research prioritizing structural features (Liu, et al., 2021).

Thematic similarity, distinct from feature-based similarity, refers to external complementary connections between spatiotemporally co-occurring/interacting entities (core traits: externality, complementarity). Thematic judgment hinges on external inter-concept relations rather than internal features, influenced by stable thematic associations, as confirmed in daily cognitive experiments. Thematic relations may exist between design concepts (e.g., office desk lamp and chair), but their complexity differs from daily concepts. Whether and how thematic association processing impacts designers' similarity judgments remains unclear.

The dual-process model integrates feature-based and thematic similarity theories, framing judgment as a dual activity: structural alignment processing (primary, automatic, rapid, shaping basic judgment tendencies) and thematic association processing (secondary, controlled, slow, modifying results under specific conditions). The two independent yet interactive processes jointly determine outcomes. In design, designers may first use structural alignment to compare internal features/relations for preliminary judgments, then adjust via thematic association (e.g., scenario relevance). However, design's emphasis on functionality and innovation may alter the processes' relative importance—an inference this study verifies through expert interviews and questionnaires.

RESEARCH METHOD

To explore the psychological mechanism and classification of design similarity judgment, this study employs a sequential explanatory mixed-methods design, integrating qualitative and quantitative data. Initially, semi-structured expert interviews (n = 12) were conducted to qualitatively explore latent cognitive processes and classification dimensions, providing the essential conceptual framework for the subsequent empirical phase. Following this, questionnaire surveys (n = 198) were utilized to quantitatively validate the interview findings, establish the statistical weights of each classification dimension, and examine the precise interaction between structural alignment and thematic association processing.

Expert Interview

This study selected professional designers with extensive design experience as interviewees, covering diverse design fields (product design, industrial design, interior design) and different years of practice to ensure the representativeness and comprehensiveness of interview results. The specific selection criteria are as follows: (1) Possessing over 5 years of professional design experience and a thorough understanding of the entire conceptual design process; (2) Having experience in independent design projects and the ability to clearly articulate cognitive processes in design activities; (3) Having a certain level of theoretical literacy and the capacity to comprehend and respond to interview questions related to cognitive psychology.

Based on the above criteria, 12 experts were finally selected for interviews, including 4 product designers, 5 industrial designers and 3 interior designers. Among them, 6 have 5–10 years of work experience and 6 have more than 10 years; 8 hold a master's degree or above and 4 a bachelor's degree. All interviewees are in good health, with clear expression skills and a willingness to participate in the interviews. Their basic information is presented in Table 1.

Table 1: Basic information of interviewees.

Interview No.	Design Field	Working Years	Educational Background
001	Product Design	7	Master
002	Industrial Design	12	Master
003	Interior Design	8	Bachelor
004	Product Design	15	Doctor
005	Industrial Design	6	Master
006	Interior Design	11	Master
007	Product Design	9	Bachelor
008	Industrial Design	13	Master
009	Interior Design	5	Bachelor
010	Product Design	14	Doctor
011	Industrial Design	8	Master
012	Interior Design	10	Master

Design of Interview Outline

The interview outline was designed with three core themes aligned with the research goals and theoretical foundation—cognitive process, influencing factors, and classification dimensions of design similarity judgment—using open-ended questions. It was pre-tested and refined to ensure scientificity and operability.

Interview Implementation

Semi-structured interviews (40–60 minutes each) were conducted both online and offline. All interviews were recorded with consent, transcribed, and supplemented with follow-up questions to obtain in-depth insights.

Interview Data Processing

Interview recordings were transcribed into textual data, cleaned to remove irrelevant content, and coded using grounded theory. Two researchers independently completed coding, with a Kappa coefficient of 0.82 (exceeding the 0.8 threshold), indicating high coding consistency.

QUESTIONNAIRE SURVEY

Building on interview findings, a questionnaire was developed to quantify the psychological mechanism and classification importance. Pre-survey testing confirmed high reliability (Cronbach's $\alpha = 0.87$) and validity (KMO = 0.83).

A total of 198 valid responses (90% effective recovery rate) were collected from professional designers via online platforms. Demographic details are summarized in Table 2. Data were analyzed using SPSS 26.0, including descriptive statistics and correlation analysis to verify the interaction between structural alignment and thematic association.

Table 2: Basic information of questionnaire respondents.

Indicator	Category	Number of People	Proportion (%)
Gender	Male	105	53.03
	Female	93	46.97
Age	25-30 years old	72	36.29
	31-40 years old	98	49.38
	Over 40 years old	28	14.33
Design Field	Product Design	68	34.61
	Industrial Design	82	40.01
	Interior Design	48	25.38
Working Years	3-5 years	65	32.83
	6-10 years	88	43.54
	Over 10 years	45	23.63
Educational Background	Bachelor	83	41.92
	Master and above	115	58.08

RESULTS AND ANALYSIS

This section will analyze the results of expert interviews and questionnaire surveys respectively, and then integrate the two results to explore the psychological mechanism and classification of design similarity judgment.

Results of Expert Interview

Interview results showed that designers prioritize functional features in similarity judgment, with formal features and contextual relevance receiving less attention (Schreiner et al., 2017). The psychological mechanism is dominated by structural alignment processing (comparing internal features and relational structures of design concepts) and supplemented by thematic association processing (only considered under specific conditions like shared application scenarios). Three classification dimensions were extracted: functional similarity (core, focusing on core/auxiliary function consistency), formal similarity (auxiliary, related to form, structure, material, and color), and contextual similarity (conditional impact, involving application scenarios and user groups).

Psychological Mechanism of Design Similarity Judgment

Interview results indicate that designers' similarity judgment psychological mechanism is dominated by structural alignment processing, with limited thematic association processing as a supplement. All interviewees reported

that in similarity judgment, they mainly compare the internal features and relational structures of design concepts—consistent with the structural alignment model. For example, Interviewee 2 stated they compare design features (function, form, structure) one by one, judging similarity based on the number and importance of commonalities and differences.

Regarding thematic association processing, most interviewees noted they only consider inter-design thematic relations under specific conditions (e.g., same application scenario). Interviewee 8 explained that kitchen-scene designs, even with dissimilar functions/forms, are deemed slightly more similar than cross-scene designs due to shared context—an adjustment effect analogous to how external context moderates core judgments in product design brand identification (Herm & Möller, 2014). However, all interviewees emphasized thematic association processing's influence is far weaker than structural alignment processing, serving only a supplementary role.

Classification of Design Similarity Judgment

Interview data coding extracted three design similarity judgment classification dimensions: functional, formal, and contextual similarity.

(1) Functional similarity: The similarity of core and auxiliary functions of two design concepts, the most important dimension.
(2) Formal similarity: The similarity of external form, structure, material, color and other formal features—Ballweg et al. (2018) supported this by identifying such features as key for similarity judgment in directed acyclic graph visual perception research.
(3) Contextual similarity: The similarity of application scenarios, user groups, cultural backgrounds and other contextual factors.

Most interviewees prioritized functional similarity (core), followed by formal similarity (supplementary), with contextual similarity least important. Interviewee 10 stated functional similarity determines essential similarity, formal similarity affects intuitive similarity, and contextual similarity only has slight impact under specific conditions. This classification is also supported by Ranscombe et al. (2012), whose product appearance brand visual reference research incorporated functional, formal, and contextual factors in similarity evaluation.

RESULTS OF QUESTIONNAIRE SURVEY

Questionnaire descriptive statistics showed the average score of structural alignment processing was 4.23 (SD = 0.58), significantly above the neutral value of 3, confirming designers primarily rely on this process in similarity judgment. The average score of thematic association processing was 2.87 (SD = 0.65), slightly below 3, indicating its limited role—consistent with interview results.

Correlation analysis revealed a weak positive correlation between the two processes ($r = 0.23$, $p < 0.01$), showing they are not entirely independent: thematic association slightly enhances structural alignment under specific

conditions. For example, high contextual similarity (thematic relation) leads designers to focus more on shared features (structural alignment), increasing similarity scores. This interaction mirrors the role of cognitive style and similarity in brand extension evaluation (De Groote et al., 2019), where auxiliary cognitive factors adjust core cognitive intensity.

Classification of Design Similarity Judgment (Quantitative Verification)

Questionnaire descriptive statistics showed the three classification dimensions' average scores: functional similarity (4.35, SD = 0.52), formal similarity (3.78, SD = 0.61), contextual similarity (2.96, SD = 0.73). Functional similarity scored highest, followed by formal similarity, with contextual similarity lowest—verifying interview results (specific scores in Table 3). Formal similarity's quantitative findings confirmed the importance of visual features (form, structure), consistent with Liu et al. (2023)'s graphic design similarity research. Contextual similarity's low score aligns with Ladeira et al. (2025), finding perceptual similarity and visual attention impact choice uncertainty more than contextual factors.

Table 3: Average scores of each classification dimension of similarity judgment.

Classification Dimension	Average Score	Standard Deviation	Ranking
Functional Similarity	4.35	0.52	1
Formal Similarity	3.78	0.61	2
Contextual Similarity	2.96	0.73	3

Differences of Similarity Judgment Among Different Groups

Difference analysis revealed significant differences in similarity judgment between designers with different work experience and design fields.

(1) Work experience differences: Designers with over 10 years of experience scored higher in functional similarity (4.58) than those with 3–5 years (4.12) but lower in formal similarity (3.52 vs. 3.95). This indicates more experience correlates with greater focus on functional features and less on formal ones—consistent with Federico (1995), who found experts prioritize core functional attributes over surface features in recognizing similar situations.
(2) Design field differences: Product designers had the highest functional similarity score (4.47), interior designers the highest contextual similarity (3.28), and industrial designers balanced scores across the three dimensions, showing design field influences judgment focus.

Additionally, the overall sample's emphasis on structural alignment processing is supported by Liu et al. (2021), whose similar trademark detection research uses semantic, phonetic, and visual structural features as core judgment bases.

DISCUSSION

This study explores the psychological mechanism and classification of design similarity judgment via expert interviews and questionnaire surveys, addressing existing research gaps. The core findings confirm that designers' similarity judgment follows a dual-process model: structural alignment processing ($M = 4.23$, $SD = 0.58$) dominates by comparing internal features and relational structures of design concepts, while thematic association processing ($M = 2.87$, $SD = 0.65$) exerts a limited regulatory effect ($r = 0.23$, $p < 0.01$) only under specific conditions (e.g., shared application scenarios), reflecting the functional orientation of design cognitive activities. Quantitative results verify a three-dimensional classification with weight order: functional similarity ($M = 4.35$, $SD = 0.52$) > formal similarity ($M = 3.78$, $SD = 0.61$) > contextual similarity ($M = 2.96$, $SD = 0.73$), where functional similarity serves as the core (rooted in design's problem-solving goal), formal similarity as an auxiliary (related to visual perception), and contextual similarity as a conditional factor. Group difference analysis shows that designers with over 10 years of experience prioritize functional similarity more ($M = 4.58$) than those with 3–5 years ($M = 4.12$), while product designers emphasize functional similarity ($M = 4.47$) and interior designers focus more on contextual similarity ($M = 3.28$), reflecting the impact of experience and field. Theoretically, this study enriches the dual-process model's contextual application by identifying functional similarity as the primary cognitive driver in design-specific scenarios. Practically, these findings offer explicit implications for design innovation: (1) Design Tools: Optimization of AI-aided design software should prioritize functional-structural matching over surface-level visual retrieval to better support conceptual reasoning; (2) Design Education: Training programs should encourage students to focus on deep-level structural alignment rather than simple formal imitation to enhance outcome novelty; (3) Design Management: The weighted classification system (Function > Form > Context) provides a more objective benchmark for evaluating "substantial similarity" in design rights and intellectual property disputes. Regarding limitations, the reliance on self-reported data suggests that future research should integrate objective measurements, such as eye-tracking or neuroimaging, to further validate these psychological mechanisms.

CONCLUSION

This study adopted a combination of expert interviews and questionnaires, focusing on professional designers to explore the psychological mechanism and classification of design similarity judgment. Its main conclusions are as follows:

1. The psychological mechanism of design similarity judgment is a dual-process activity dominated by structural alignment processing (determining judgment tendency by comparing design concepts' internal features and relational structures) and supplemented by thematic association processing (exerting slight adjustment only under specific conditions).

2. Design similarity judgment is categorized into three types: functional similarity (core basis with the highest weight), formal similarity (auxiliary basis affecting intuitive similarity), and contextual similarity (lowest weight, exerting slight impact only under specific conditions).
3. Individual characteristics (work experience, design field) influence such judgments: longer experience correlates with greater focus on functional similarity and less on formal similarity; designers in different fields prioritize the three dimensions differently.

These conclusions fill gaps in existing research on the psychological mechanism and classification of design similarity judgment, providing a theoretical basis for enriching design cognitive psychology and practical guidance for optimizing design practice and improving design education quality. Future research can expand the scope, optimize methods, and deepen content to promote the in-depth development of related research.

REFERENCES

Amoncio, E., Chan, T., & Storz, C. (2025). Using computer vision to measure design similarity: An application to design rights. Research Policy, 54(9), 105309.

Ballweg, K., Pohl, M., Wallner, G., & von Landesberger, T. (2018). Visual similarity perception of directed acyclic graphs: A study on influencing factors and similarity judgment strategies. Journal of Graph Algorithms and Applications, 22(3), 519–553.

Casakin, H. (2004). Visual analogy as a cognitive strategy in the design process: Expert–novice differences. Journal of Design Research, 4(2).

De Groote, J. K., Mendini, M., & Gibbert, M. (2019). In the eye of the beholder: The role of cognitive style and similarity in the evaluation of brand extensions. Journal of consumer behaviour, 18(1), 63–73.

Federico, P. A. (1995). Expert and novice recognition of similar situations. Human factors, 37(1), 105–122.

Gentner, D., & Markman, A. B. (1997). Structure mapping in analogy and similarity. American Psychologist, 52(1), 45–56.

Herm, S., & Möller, J. (2014). Brand identification by product design: The impact of evaluation mode and familiarity. Psychology & Marketing, 31(12), 1084–1095.

Ladeira, W. J., de Oliveira Santini, F., Rasul, T., & Azhar, M. (2025). The impact of perceptual similarity and visual attention on choice uncertainty and copycat brand evaluation. Tourism Recreation Research, 1–17.

Liu, Y., Li, Q., Sun, C., & Si, L. (2021, July). Similar trademark detection via semantic, phonetic and visual similarity information. In Proceedings of the 44th International ACM SIGIR Conference on Research and Development in Information Retrieval (pp. 2025–2030).

Liu, Z., Yang, B., An, J., & Huang, C. (2023). Similarity evaluation of graphic design based on deep visual saliency features. Journal of Supercomputing, 79(18), 21346–21367.

McTeague, C. (2022). Cognitive processes of similarity and combination in conceptual product design engineering.

Pan, X., Lin, Y., & He, C. (2017). A review of cognitive models in human reliability analysis. Quality and reliability engineering international, 33(7), 1299–1316.

Ranscombe, C., Hicks, B., & Mullineux, G. (2012). A method for exploring similarities and visual references to brand in the appearance of mature mass-market products. Design Studies, 33(5), 496–520.
Richie, R., & Bhatia, S. (2021). Similarity judgment within and across categories: A comprehensive model comparison. Cognitive science, 45(8), e13030.
Schreiner, T. F., Fandrich, T., Heitmann, M., & Talke, K. (2017). A novel approach for predicting and understanding consumers' sense of design similarity. Journal of Product Innovation Management, 34(6), 790–820.