

Visual Communication of Point-Line-Plane Elements in Sustainable Apparel Design: An Ergonomics-Informed Study

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ABSTRACT

This study investigates how point, line, and plane configurations in clothing design influence visual perception related to ergonomic relevance. Rather than approaching ergonomics through physical wear testing, the research focuses on how structural and compositional elements are visually interpreted by viewers as indicators of comfort, stability, and bodily support. An image-based quantitative research design was adopted, using a structured questionnaire to evaluate perceptual responses to selected garment images representing varied configurations of point, line, and plane elements. A total of 384 valid responses were collected from participants aged 18-45, and the data were analysed using descriptive statistical methods. The findings indicate that specific visual arrangements consistently direct attention toward structurally significant regions of the body, such as the waist and upper torso, and are associated with perceptions of balance, containment, and support. These perceptual tendencies suggest that visual structure plays a meaningful role in shaping ergonomic interpretation, even in the absence of physical interaction with the garment. By framing point, line, and plane as perceptual carriers rather than purely formal or decorative elements, the study contributes to an expanded understanding of ergonomics in apparel design as a visually mediated construct. The research offers a design-oriented perspective that bridges visual composition and ergonomic awareness, providing a foundation for future studies integrating dynamic stimuli, embodied evaluation, cross-cultural analysis, and sustainability-informed design strategies.

1. INTRODUCTION

The design of contemporary apparel increasingly requires consideration beyond visual aesthetics, emphasizing the interaction between garments and the human body. As individuals demand clothing that supports mobility, comfort, and well-being, designers face the challenge of integrating these functional requirements with formal expression. While aesthetic innovation has traditionally dominated fashion design, the lack of systematic incorporation of ergonomic principles may compromise the wearer's experience. Ergonomics provides a theoretical framework for understanding the relationship between human anatomy, movement, and designed artefacts, with the aim of supporting comfort, efficiency, and usability (Pheasant & Haslegrave, 2018). In clothing design, ergonomic principles are implemented through the human-clothing-environment system, which emphasizes comfort, adaptability, and physiological appropriateness (Pan,

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2020). Previous studies have shown that garments designed according to ergonomic criteria can enhance wearer comfort, support natural movement, and improve overall satisfaction during wear (Liu, 2019). These findings highlight the importance of incorporating user-centered considerations into the design of everyday apparel, where comfort and wearability are as critical as aesthetic quality.

The structural elements of point, line, and plane constitute a core analytical framework within fashion design, mediating both visual and functional outcomes. Points often serve as focal details or functional anchors; lines define silhouettes and guide visual attention through seams, pleats, or stitching; and planes form the primary surfaces that interact with body geometry. Xu (2015) conceptualized the human body as a three-dimensional configuration of points, lines, and planes, providing a theoretical basis for aligning garment composition with anatomical structures. Further, Yang (2018) emphasized that garment geometry should correspond with natural drape and movement patterns to optimize both visual coherence and physical comfort. Through strategic manipulation of these elements, designers can guide perception, influence body proportion, and reinforce structural coherence while maintaining wearer comfort.

Despite these theoretical insights, empirical investigations linking point–line–plane composition with wearer perception and ergonomic performance remain limited. Most studies in fashion design address visual composition independently of embodied experience, whereas ergonomics research typically focuses on specialized or functional garments rather than everyday apparel. This gap underscores the need to examine how compositional strategies influence wearer perception, comfort, and usability in the context of modern fashion.

To address this gap, the present study employs a quantitatively oriented, image-based perceptual research design grounded in visual content analysis of garment composition. Visual analysis is used to identify and categorize point, line, and plane elements as compositional features, which then inform the construction of standardized visual stimuli for perceptual evaluation. Building on this foundation, a quantitative survey approach is applied to examine how these compositional configurations influence perceived comfort, body awareness, and aesthetic preference. By integrating visual-analytical structuring with user-centered perceptual assessment, this study seeks to generate evidence-based insights into the relationship between aesthetic composition and ergonomic perception in contemporary apparel design.

2. LITERATURE REVIEW

Ergonomics provides a foundational framework for human-centered apparel design, emphasizing the interaction between clothing and the wearer's body. It integrates physiological, cognitive, and organizational dimensions to enhance comfort, usability, and overall well-being (IEA, n.d.). From a physiological perspective, clothing design relies on human body parameters to satisfy functional needs, while psychological factors guide the use of color, line, shape, and texture to fulfill aesthetic and emotional requirements (Zhang & Fang, 2015). Advances in anthropometric databases and digital human modeling now allow designers to simulate postures and movements before garment production, improving fit and motion compatibility (Chaffin et al., 2006). These developments highlight the inseparable link between ergonomic principles and design decisions in apparel.

Comfort is a primary objective in ergonomic clothing design, encompassing both physical ease and psychological satisfaction. Flexible waistbands in summer dresses or cotton-Lycra blends in undergarments demonstrate how material selection and structural design support wearer comfort (Pan, 2020). Beyond comfort, health considerations influence design choices: tight or restrictive garments can impede movement, reduce skin ventilation, and compromise physiological development (Pan, 2020). Safety is also critical, as garments may need to prevent injury or increase visibility through protective fabrics, reflective elements, or structural features (Pan, 2020). Together, these factors illustrate that ergonomic clothing design must balance functional performance with the wearer's well-being.

The visual and structural elements of point, line, and plane function as fundamental compositional tools through which ergonomic intentions are materialized in clothing design. Within the logic of formal beauty, point elements operate as localized compositional units that establish visual rhythm and structural reference points within a garment, contributing to perceptual order rather than acting as primary load-bearing structures (Liu, 2008). Line elements, manifested through seams, darts, and construction lines, define the garment silhouette while supporting structural alignment and facilitating ergonomic fit by guiding force transmission along the body (Liu et al., 2019). Plane elements, represented by garment panels and surface components, form the primary spatial interface between clothing and the body, enabling pressure distribution, structural stability, and surface continuity that are essential to ergonomic performance (Jiang & Chen, 2022). Through the coordinated configuration of these elements, clothing design mediates between visual composition and functional requirements, allowing aesthetic clarity and bodily support to be addressed simultaneously.

Beyond their structural function, point, line, and plane elements facilitate kinematic adaptability. Lines and planes can be strategically placed to accommodate limb movement, maintain fit during dynamic activity, and allow garments to respond to posture changes (Vechev et al., 2022). Simulation-based approaches ensure that garment geometry preserves both form and function during motion (Chen et al., 2024). By embedding movement-aware design constraints at early stages, designers can anticipate strain patterns and optimize flexibility, illustrating how compositional elements actively mediate between static form and dynamic human activity.

These elements also play a crucial role in shaping perception and psychological comfort. Surface patterns and graphic motifs, organized through point, line, and plane configurations, guide attention, manipulate perceived proportions, and create optical effects that influence body image (Luo & Wu, 2021). Vertical lines can elongate the body, while strategically placed points or planes can emphasize or de-emphasize specific areas (Li, 2018; Lim et al., 2018). In this way, compositional design not only supports physical ergonomics but also mediates the wearer's visual and emotional experience, bridging objective structure with subjective perception.

Finally, adaptive configuration strategies extend these principles by allowing garments to respond to individual wearer needs. Modular or parametric arrangements of points, lines, and planes, particularly when combined with additive manufacturing or digital feedback systems, enable iterative adjustments based on comfort, movement, and visual preference (An & Kim, 2021; Kermavnar et al., 2021). This adaptive approach reinforces the reciprocal relationship between wearer requirements and design configurations, creating garments that are ergonomically responsive, aesthetically coherent, and user-centered.

In summary, the integration of ergonomic principles with point, line, and plane compositional logic provides a comprehensive framework for contemporary apparel design. By aligning structural, perceptual, and adaptive strategies, designers can produce garments that satisfy the physiological, psychological, and aesthetic needs of wearers, demonstrating the inseparable link between human-centered design and visual composition. This perspective also suggests a pathway for translating visual composition principles into practical, human-centered design decisions.

3. METHODOLOGY

This study employs an image-based quantitative research design to examine how compositional configurations of point, line, and plane elements in clothing design influence user perception. The analysis focuses on visual and structural configurations of garments, while material performance and physical wear testing fall outside the scope of the study. This approach is appropriate for investigating perceptual and cognitive responses to clothing form, as prior research in visual perception has demonstrated that controlled visual stimuli can reliably elicit evaluative and embodied judgments related to form, balance, and aesthetic organisation (Arnheim, 1974).

User perception serves as the primary analytical outcome of the study. In line with research on clothing ergonomics and visual evaluation, perceptual responses are examined in relation to comfort-related impressions, perceived body configuration, and overall aesthetic response. These dimensions reflect how viewers visually interpret garment composition in terms of bodily accommodation, spatial alignment, and visual appeal, rather than physical wearing experience. Focusing on perception allows the study to investigate how compositional logic is cognitively and visually interpreted at the design level.

Perceptual data were collected through an online questionnaire incorporating curated garment images as visual stimuli. The images were selected to represent clear configurations of point, line, and plane elements, as well as their integration within garment structures. All images were sourced from official runway photographs published by Vogue and were presented in a consistent format within the same online questionnaire interface to minimize contextual variation in visual judgment. By standardising image presentation, the study seeks to reduce the influence of extraneous visual factors such as background, scale, or viewing context, thereby allowing participants' responses to be primarily guided by compositional features.

The survey was administered to participants from Mainland China aged between 18 and 45 years. A total of 384 valid responses were collected, comprising undergraduate students, postgraduate students, and working professionals. The questionnaire was distributed online, and participation was voluntary and anonymous. Ethical approval was obtained from Universiti Teknologi MARA, and all participants were informed that the data would be used solely for academic research purposes.

Quantitative analysis was conducted using SPSS software. Descriptive and inferential statistical techniques were applied to examine patterns of perceptual response and to explore relationships between compositional configurations and reported evaluations. In the analysis, point, line, and plane elements were not treated as isolated features but were considered as relational components within integrated visual compositions. This approach is consistent with Gestalt-oriented perspectives on visual perception, which emphasise holistic interpretation over fragmented feature assessment (Arnheim, 1974).

To facilitate consistent reference to the visual stimuli throughout the analysis, each garment image was assigned an internal code. The prefix indicates the dominant compositional element, with "P" denoting point-based motifs, "L" denoting line-based motifs, and "PL" denoting plane-based motifs. The numerical portion then serves as a unique identifier within each category. This structured coding system enables clear and efficient cross-referencing between the visual features of the stimuli and participant responses, reducing ambiguity and eliminating the need for repetitive visual descriptions in the text. By standardising how the images are referred to throughout the analysis, this approach also supports clearer reporting of trends and patterns in perceptual responses. The overall research procedure and analytical framework of the study are summarised in Fig. 1.

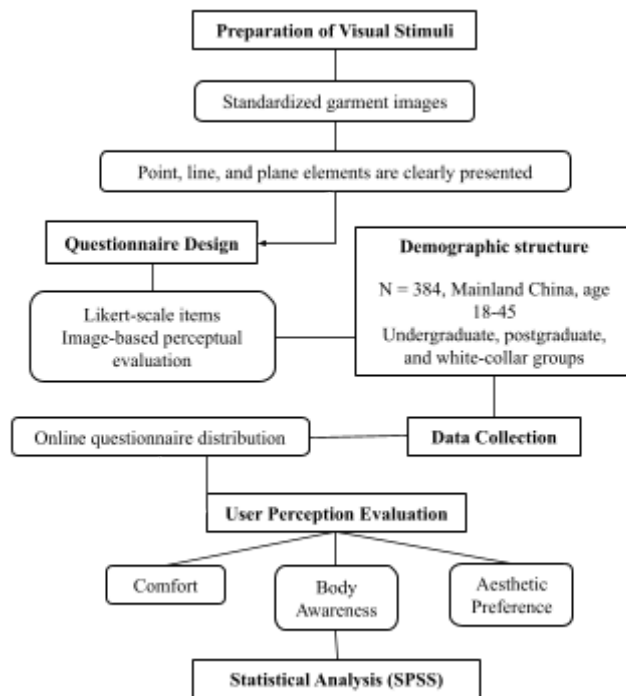


Fig. 1. Research framework and quantitative procedure for evaluating user perception of point, line, and plane elements in clothing design

Source: Author, 2026

4. ANALYSIS AND FINDINGS

This chapter presents the quantitative findings derived from the image-based perceptual evaluation, focusing on how point, line, and plane compositional elements in clothing design are visually interpreted by users. The analysis emphasizes perceptual tendencies rather than causal explanation, with results reported descriptively to reflect patterns of visual judgment and ergonomics-related perception elicited by controlled garment images.

As an initial indicator of perceptual engagement, participants were asked whether they consciously attend to point, line, and plane features when viewing garments. A substantial majority of respondents (75.5%) reported that they do notice such compositional elements during visual evaluation, while 18.2% indicated otherwise. This result suggests that points, lines, and plane are not merely implicit design constructs but are perceptually accessible to most viewers in image-based clothing assessment contexts, affirming their relevance in visual evaluation tasks. Moreover, the high rate of affirmative responses underscores the cognitive salience of these formal elements in shaping first-impression judgments of garment imagery. Accordingly, the following analyses examine how these visual elements are differentially perceived and selected across the presented garment stimuli.

4.1 Perceived Comfort Focus across Garment Zones

Participants were asked to identify the body areas they associate most strongly with perceived comfort when visually evaluating garments. For upper garments, the waist (74.2%) emerged as the most frequently selected area, followed by the

shoulders (67.2%) and hips (62.8%). For lower garments, the hips received the highest selection rate (73.4%), with the hemline (60.9%) and waist (59.6%) also prominently identified.

These findings indicate that visual judgments of comfort are closely associated with specific garment zones rather than the garment as a whole. Participants consistently focused on areas such as the waist, shoulders, and hips, suggesting that visual emphasis on structural support, movement accommodation, and balance cues is central to perceived comfort. Importantly, these selections reflect perceived comfort focus rather than physical wearing experience, reinforcing the influence of visual structure on ergonomic interpretation. This pattern highlights how compositional features can direct attention toward regions that imply functional relevance, even in the absence of direct tactile interaction, underscoring the cognitive role of visual cues in shaping ergonomic expectations.

4.2 Perceptual Preferences for Compositional Elements in Clothing

Participants were asked to indicate their visual preferences for garments characterized predominantly by point-, line-, and plane-based compositional elements (see Table 1). Among the point-oriented images, Image P21 received the highest selection rate, accounting for 40.1% of responses. Within the line-based category, Image L28 was most frequently selected, with 47.1% of participants indicating preference. In contrast, the plane-dominant Image PL05 recorded a comparatively lower selection rate of 35.4%.

These findings indicate that, within the set of visual stimuli presented, garments incorporating clearly perceptible point elements or pronounced linear organization attracted higher selection frequencies than compositions dominated primarily by planar surfaces. In the case of point-based configurations, repetition and relative positioning allow individual elements to be perceived as visual reference points within the overall composition, enhancing navigability and focal clarity for the viewer. Rather than indicating absolute preference, the distribution reflects relative perceptual prominence under controlled viewing conditions, where compositional clarity and visual guidance may shape immediate judgments. This pattern suggests that visual distinctiveness and structural legibility play a meaningful role in how respondents scan and evaluate garment imagery. Additionally, it underscores the potential influence of elemental contrast in facilitating rapid perceptual discrimination in image-based assessments.

Table 1. Distribution of participant selections for visual stimuli representing point, line, and plane elements

Image Code	Visual Contents	Visual Element Type	Selection Count and Percentage
P21	 Fig. 2 Source: Ellery, SS2016 https://www.vogue.com.cn/shows/ellery/2016-ss-RTW/	Point-based (repetitive point aggregation)	154 (40.1%)

L28

Line-based (directional
linear repetition)

181 (47.1%)

Fig. 3

Source: Véronique Leroy, SS2016
<https://www.vogue.com.cn/shows/Veronique-Leroy/2016-ss-RTW/>

PL05

Plane-based
(surface-dominant
composition with integrated
point-line elements)

136 (35.4%)

Fig. 4

Source: CHENGXIAOQIN, FW2017
<https://fashion.ifeng.com/c/7sxHz3DP9ZY>

4.3 Perceptual Responses to Formal Beauty Principles in Clothing Composition

Visual responses to compositional principles commonly associated with formal beauty were examined through images representing symmetry, harmony, proportion, repetition, gradation, and visual emphasis. Across these items, images combining point, line, and plane elements consistently received higher selection rates than those dominated by a single element type (see Table 2).

In particular, images representing gradation and visual emphasis recorded the highest selection frequencies, each exceeding 60% of responses. Images illustrating harmony and proportion also received relatively high levels of agreement, while symmetry and repetition showed slightly lower, yet still prominent, selection rates.

Rather than ranking aesthetic principles, these findings suggest that users respond more strongly to compositions in which multiple elements are integrated to create visual coherence and perceptual guidance. The results highlight the perceptual effectiveness of combined compositional strategies in eliciting favorable visual judgments related to structure and appearance.

Table 2. Visual Stimuli and Selection Frequencies Associated with Formal Beauty Principles

Image Code	Visual Contents	Formal Beauty Principal Type	Selection Count and Percentage
P14	 Fig. 5 Source: Roberto Cavalli, FW2024 https://www.vogue.com.cn/shows/roberto-cavalli/2024-aw-RTW/	Symmetry (Line & Plane)	213 (55.5%)
PL37	 Fig. 6 Source: Unknown, SS2018 https://www.telegraph.co.uk/fashion/milan-fashion-week	Harmony (Point & Plane)	228 (59.4%)
P15	 Fig. 7 Source: Calvin Klein Collection, FW2013 https://www.vogue.com.cn/shows/calvin-klein-collection/2013-aw-RTW/	Proportion-Golden Ratio (Point & Line & Plane)	217 (56.5%)

PL36



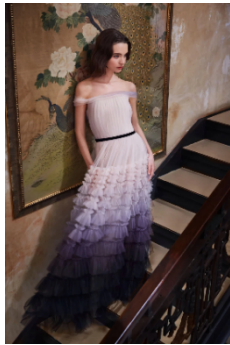
Repetition (Point & Line)

214 (55.7%)

Fig. 8

Source: Basso & Brooke, SS2006
<https://www.vogue.com/fashion-shows/spring-2006-ready-to-wear/basso-brooke>

PL31



Gradation (Plane & Line)

233 (60.7%)

Fig. 9

Source: Marchesa Notte, SS2020
<https://www.marchesa.com/en-my/collections/resort-2020>

PL25



Emphasis (Line & Plane)

232 (60.4%)

Fig. 10

Source: Altuzarra, FW2014
<https://www.vogue.com.cn/shows/altuzarra/2014-aw-RTW/>

4.4 Integrating Perceptual Patterns toward Design-Relevant Insights

Taken together, the findings reveal consistent perceptual patterns across compositional preference, visual attention, comfort-related focus, and responses to formal beauty principles. Users demonstrated heightened sensitivity to point and

line elements, identified specific garment zones as visually critical for comfort perception, and responded favorably to integrated compositional arrangements.

These patterns suggest that visual structure plays a significant role in shaping ergonomic-related judgments, even in the absence of physical interaction. Rather than isolating individual design features, participants appeared to interpret garments holistically, responding to how compositional elements organize visual flow, emphasize key body areas, and suggest comfort through structure and balance.

The results provide an empirical foundation for translating perceptual feedback into design considerations, particularly in everyday apparel contexts where visual assessment often precedes physical wear. How these perceptual tendencies may inform concrete design strategies is further addressed in the subsequent discussion section.

5. DISCUSSION

This study demonstrates that visual composition alone can elicit structured perceptual judgments related to comfort, balance, and bodily accommodation in clothing design. By isolating point, line, and plane configurations within controlled visual stimuli, the findings support the premise that ergonomic perception is not limited to physical wear experience but can be inferred through visual structure.

The results highlight the role of compositional logic as a mediating layer between aesthetic appearance and perceived functionality. Rather than responding to garments as undifferentiated wholes, participants appeared to anchor their judgments to visually salient zones and compositional cues, suggesting that ergonomic perception is closely tied to how structural information is visually organized. This reinforces Gestalt-oriented perspectives, which emphasize holistic yet structured interpretation in visual cognition.

Importantly, the study positions formal beauty principles not as abstract aesthetic criteria, but as operative mechanisms through which visual clarity, balance, and proportion support perceptual stability. Within an image-based evaluation context, such principles appear to facilitate the translation of visual information into comfort-related and ergonomic interpretations.

The design outcomes presented in this study serve as illustrative responses to these perceptual patterns rather than as independent evaluative objects. Their inclusion demonstrates how quantitative perceptual insights may inform garment development without displacing analytical focus from user perception. In this sense, design functions as a means of synthesis, bridging empirical findings and practical application.

Overall, this study highlights the methodological contribution of integrating visual analysis, perceptual data, and design translation within a single framework. This approach offers a structured pathway for examining how compositional elements in clothing design shape user perception, providing a basis for future research that further explores the relationship between visual structure and ergonomic meaning.

Table 3. Design Prototypes Developed in Response to Perceptual Findings

No	Design Works	Design Descriptions
1	 Fig. 11 Source: Author, 2025  Fig. 12 Source: Author, 2025	This design integrates focal points and directional elements to achieve structural balance and visual containment. Visual emphasis is placed on the waist and upper torso, corresponding to participant-reported comfort zones and key structural areas. The composition highlights silhouette clarity and incorporates adjustable features, supporting perceived stability and ergonomic comfort.
2	 Fig. 13 Source: Author, 2025	This design employs curved lines, paneling, and color-blocking to guide visual flow and create slimming effects. The waist and side torso are visually accentuated, aligning with participants' preferences for body contouring. Structural tailoring ensures silhouette clarity, while accessory placement and compositional lines subtly divert attention to balance visual proportion.

3



Fig. 14

Source: Author, 2025

This design prioritizes freedom of movement and perceptual adaptability through transformable structures and layered elements. The waist and torso serve as primary zones for adjustment, allowing the wearer to modulate fit and proportion. Visual cues from lines and planes support dynamic shaping, while the overall silhouette maintains clarity and conveys lightness, comfort, and individualized aesthetic control.



Fig. 15

Source: Author, 2025



Fig. 16

Source: Author, 2025

6. CONCLUSION

This study examined how point, line, and plane elements in clothing design influence visual perception, comfort-related attention, and compositional judgment. The findings indicate that compositional features can guide visual focus toward structurally and ergonomically significant zones, and that integrated arrangements of these elements enhance the clarity of visual flow, proportional balance, and perceived bodily accommodation. By considering point, line, and plane as carriers of perceptual meaning, the study highlights that ergonomic and comfort-related cues are accessible through visual analysis, complementing existing understandings of human-centered design (Pan, 2020).

Importantly, the study positions formal beauty principles not as abstract aesthetic criteria, but as operative mechanisms through which visual clarity, balance, and proportion support perceptual stability. Within an image-based evaluation context, such principles appear to facilitate the translation of visual information into comfort-related and ergonomic interpretations.

The design prototypes developed in response to these perceptual patterns demonstrate practical applications of these insights, showing how focal points, directional lines, and planar surfaces can be orchestrated to achieve both aesthetic appeal and adjustable ergonomic functionality. These examples illustrate the potential for translating visual-perceptual data into wearable garments that accommodate individual differences in body shape and comfort preference.

Several boundaries define the scope of this study. The reliance on static imagery limits interpretation to visual perception rather than actual wear experience, and the sample represents a specific cultural and age context. These limitations clarify the study's scope without diminishing its contribution, providing a foundation for future research that could incorporate dynamic stimuli, embodied trials, or cross-cultural comparison.

Overall, the research provides an evidence-based framework linking visual composition with ergonomic perception, demonstrating that structured design elements can inform user-centered apparel development, support adaptive and enduring design solutions, and offer a methodological approach for integrating perceptual data into clothing design practice.

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CONFLICT OF INTEREST STATEMENT

The author declares that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

AUTHORS' CONTRIBUTIONS

Zhu Ziwei: Conceptualisation, methodology, formal analysis, investigation, data curation, and writing—original draft.

Asliza Aris: Conceptualisation, supervision, validation, and writing—review & editing.

Hasma Ahmad: Methodology, validation, and writing—review & editing.

ETHICS STATEMENT

This study was reviewed and approved by the Research Ethics Committee of Universiti Teknologi MARA (UiTM) (Approval No: REC/08/2024, PG/MR/429).

All procedures involving human participants were conducted in accordance with institutional ethical standards and the principles of the 1964 Helsinki Declaration. Informed consent was obtained from all participants, and data anonymity was strictly maintained throughout the study.

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