

AGE-FRIENDLY CROSS-MEDIA PUBLICATION DESIGN FOR GRANDPARENT-GRANDCHILD CARE: A COMPARATIVE STUDY OF ELDERLY MEDIA BEHAVIOR

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ABSTRACT

Against the backdrop of China's deep aging society and the prevalence of grandparent-led intergenerational childcare, grandparents' demand for scientific parenting knowledge continues to rise. However, existing parenting media suffer from inadequate age-friendly adaptation and limited formats. Current research mostly focuses on age-friendly modification of single media types, lacking systematic cross-media collaborative design frameworks and targeted studies for intergenerational childcare scenarios. This is a conceptual study that takes Universal Design Theory and Cognitive Aging Theory as its analytical framework. This study employs literature research, comparative analysis and theoretical deduction methods. It sorts out the physiological and cognitive traits as well as media usage behaviors of the elderly under China's socio-cultural context, summarizes media use constraints from perception, cognition and emotion dimensions, and systematically compares age-adaptive design features of print and digital media from information presentation, interaction logic and scenario adaptation perspectives. The conceptual study reveal that Chinese seniors live in a hybrid media ecosystem dominated by traditional media and supplemented by digital media. Print media has prominent advantages in low cognitive load, high fault tolerance and emotional identification, while digital media shows potential in multi-sensory information supplementation, scenario-based interaction and real-time content updating. The synergistic complementarity of the two forms the core logic of age-friendly cross-media design. This study extracts five key influencing factors and proposes a conceptual framework for age-friendly cross-media publication design, which provides theoretical basis and practical guidance for developing age-friendly cross-media publications tailored to intergenerational childcare scenarios.

Keywords: Age-Friendly Design, Cross-Media Publication, Cognitive Aging, Universal Design, Intergenerational Childcare

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INTRODUCTION

China has entered a deeply aging society. According to data released by the National Bureau of Statistics of China, citizens aged 60 and above accounted for over 22% of the total population by the end of 2024, and the scale of this age group is projected to exceed 370 million, accounting for more than 24% of the national population by 2040 (Yang, 2023). Demographic structural changes, coupled with the shrinking family size and the mainstream dual-income household pattern, have made intergenerational childcare one of the primary parenting modes in urban China. Relevant surveys indicate that grandparents participate in daily grandchild care in 57.8% of urban Chinese families, shifting their role from auxiliary caregivers to core co-caregivers within the household childcare system (Ji, 2022). However, current parenting media products mainly target young parents, failing to fully accommodate the physiological degeneration and cognitive behavioral traits of the elderly, which creates remarkable media adaptation barriers for grandparents when acquiring parenting knowledge. From the perspective of media supply, traditional printed parenting materials commonly feature small font sizes and dense information with obscure professional terminology, which cannot match seniors' deteriorated vision and decelerated information processing speed. Meanwhile, digital parenting platforms and mobile applications are designed with complex interfaces and lengthy operation paths, as well as frequent pop-up disturbances, which further widen the digital divide and intensify technology anxiety among the elderly (Xu et al., 2022). The inherent drawbacks of single media formats have become increasingly prominent, while cross-media publications that integrate the in-depth reading strengths of print media and multi-sensory interactive merits of digital media can deliver more inclusive knowledge access channels for senior citizens.

Although existing studies have accumulated basic findings in three independent fields: age-friendly design, elderly media behavior, and transmedia storytelling, disciplinary fragmentation creates multiple research voids without systematic solutions tailored to intergenerational childcare scenarios in Chinese cities, accompanied by obvious theoretical and practical limitations. Theoretically, Universal Design, Inclusive Design and the SRK cognitive aging model belong to human factors engineering and geriatric psychology respectively, while Transmedia Storytelling originates from communication studies. These four core theoretical systems have long evolved in isolation without an integrated analytical framework (Jenkins, 2006; Rasmussen, 1983; Story et al., 1998). Domestic research on age-friendliness mostly focuses on public spaces and physical products for the aged, with rare attempts to integrate multiple theories into publication media design for parenting purposes (Bai et al., 2021; Zhao, 2012). Empirically, most studies treat all seniors over 60 as a homogeneous group, failing to conduct targeted research on the specific subgroup of grandparents undertaking grandchild care (Chen, 2022). Comparative studies on aging societies in China, Japan and South Korea mention media usage disparities but lack refined analysis of media demands under China's "4-2-1" inverted family structure (Nakagawa et al., 2021; Cheng, 2024). Classic cross-media prototypes are developed for teenagers instead of older adults, without optimizing interaction logic based on cognitive aging characteristics (Yang et al., 2023). Practically, existing parenting media only adopt superficial single-medium optimizations such as font enlargement and simplified mobile interfaces, which cannot resolve the separation between systematic static printed knowledge and real-time digital scenario demands, and fail to ease intergenerational cognitive conflicts over childcare (Jia, 2024). These multilayered gaps mean existing theoretical tools cannot fully explain seniors' media usage dilemmas, and current practical schemes cannot satisfy collaborative family childcare needs. Therefore, this study constructs an integrated analytical framework based on dual foundations of Universal Design and SRK Model combined with Transmedia Narrative, which bears irreplaceable theoretical innovation and practical value.

Targeting the above multilayer research gaps, this study generates four distinct, operable core innovative outcomes:

- 1) Construct an integrated novel conceptual analysis model: Combine Universal Design, Inclusive Design, SRK Cognitive Aging Model and Transmedia Storytelling to form a complete conceptual framework of age-friendly cross-media publications for urban Chinese intergenerational childcare scenarios, filling the research gap of interdisciplinary theoretical integration.
- 2) Establish a three-dimensional comparative analysis system for print and digital media: Take information presentation, interaction logic and scenario adaptation as core dimensions, adopt the Seven Principles of Universal Design and three-tier SRK cognitive task classification as evaluation standards, and form standardized assessment tools for media age-adaptive comparison that can be reused by subsequent relevant research.
- 3) Extract hierarchical age-friendly design criteria: Summarize five decisive influencing factors including cognitive load, sensory accessibility, operation fault tolerance, scenario adaptability and emotional identification based on comparative results, and formulate stratified age-friendly design standards for different user groups and usage scenarios.
- 4) Deliver full practical design specifications for cross-media publications: Clarify the "print-dominant, digital-supplemented" collaborative design strategy, and provide concrete actionable design norms covering printed manual content architecture, simplified digital interaction, scenario matching and intergenerational sharing functions, which can be directly applied by publishing and design industries to develop age-appropriate childcare publications.

Research Objectives

- 1) To investigate the media use behaviors of older adults in the context of grandparental childcare.
- 2) To compare printed media and digital media based on the principles of Universal Design.

LITERATURE REVIEWS

Core Theoretical System of Age-Friendly Design

The theoretical framework of age-friendly design is jointly constructed by Universal Design and Inclusive Design, where Universal Design supplies universal design principles and Inclusive Design reveals the internal cognitive rules of elderly users.

Proposed by Story, Mace and other American scholars in 1998, Universal Design holds that products and environments should be usable for all people without special customized reconstruction (Story et al., 1998). It consists of seven core principles: Equitable Use, Flexibility in Use, Simple and Intuitive Use, Perceptible Information, Tolerance for Error, Low Physical Effort, Size and Space for Approach and Use. Distinct from barrier-free design targeting groups with disabilities, Universal Design advocates full-population inclusiveness and delivers clear evaluation dimensions for age-adapted media design. Originating from the UK, Inclusive Design adopts a user-centered design methodology. It proposes diversified flexible strategies to cover groups excluded by conventional design, emphasizing user participation and iterative optimization, which fits the heterogeneous demand traits of elderly populations (Keates & Clarkson, 2003).

Cognitive Aging Theory lays the psychological foundation for age-friendly design. Studies on cognitive aging suggest that human cognitive capacity undergoes progressive degeneration after entering old age, manifested as declined sensory perception, contracted working memory, slower information processing, weakened selective and divided attention, and diminished anti-interference ability (Yang et al., 2023). Fluid intelligence such as logical reasoning declines markedly, whereas crystallized intelligence including accumulated life knowledge remains relatively stable. Based on cognitive aging research, Rasmussen put forward the SRK (Skill-Rule-Knowledge) three-level cognitive behavioral model, which categorizes human cognitive

tasks into skill-based operations, rule-based judgments and knowledge-based decision-making; higher tiers bring heavier cognitive loads (Rasmussen, 1983). This model provides clear optimization directions for media interaction design: age-friendly schemes ought to convert operating tasks into skill-based and rule-based items to cut down cognitive consumption caused by knowledge-based reasoning.

Domestic and International Research on Elderly Media Usage Behaviors

A wealth of literature has probed media adoption patterns among Chinese seniors. Domestic empirical research shows that the elderly in China live within a hybrid media ecosystem where traditional print and television media maintain high penetration and credibility as primary authoritative knowledge sources, while digital media gain rapid popularity with limited depth of use. As of 2022, the number of Chinese internet users aged 60 and above exceeded 119 million, yet most seniors only use digital products for social contact and short-video entertainment, with extremely low utilization of knowledge-learning applications (Xu et al., 2022).

Segmented research focusing on intergenerational childcare indicates that grandparents rely heavily on life experience when acquiring parenting knowledge. They hold higher trust in printed publications and offline face-to-face communication, yet show low acceptance of fragmented digital information. Their digital operation capacity mostly derives from reverse guidance by adult children, limited to basic functions such as QR code scanning and video calls, while they lack learning motivation and competence for complex applications (Chen, 2022). Most existing literature on the digital divide adopts a macro perspective, with few refined design-oriented studies targeting the segmented intergenerational childcare context, and systematic research integrating cross-media coordination is still insufficient.

Research Progress on Cross-Media Publications and Age-Friendly Design

Jenkins proposed Transmedia Storytelling Theory in 2006, which states that a complete and continuous narrative world can be built across multiple media carriers, with each medium undertaking irreplaceable functions to deliver immersive reading experiences to audiences (Jenkins, 2006). Driven by digital technologies, cross-media publications have become an innovative publishing format that integrates printed texts, audio-visual clips and interactive programs to balance systematic in-depth learning and diversified sensory experience.

Existing cross-media technology prototypes provide reverse reference for this study. Typical cases such as Sony MagicPAPER and Pulp Nonfiction verify the technical feasibility of paper-digital interaction, but both have obvious age-friendliness limitations (Figure 1, Figure 2): Magic PAPER relies on dedicated projection equipment with high cost and restricted usage scenarios; Pulp Nonfiction targets educational entertainment scenarios for young users without considering seniors' cognitive traits. Neither is suitable for daily home intergenerational childcare scenarios, which confirms that age-friendly cross-media design must control technical thresholds and take users' existing habits as the starting point.

In general, existing academic achievements fail to systematically integrate Universal Design, Cognitive Aging Theory and Transmedia Narrative Theory, and lack targeted design research on Chinese grandparents engaged in childcare, creating prominent theoretical and practical research gaps.

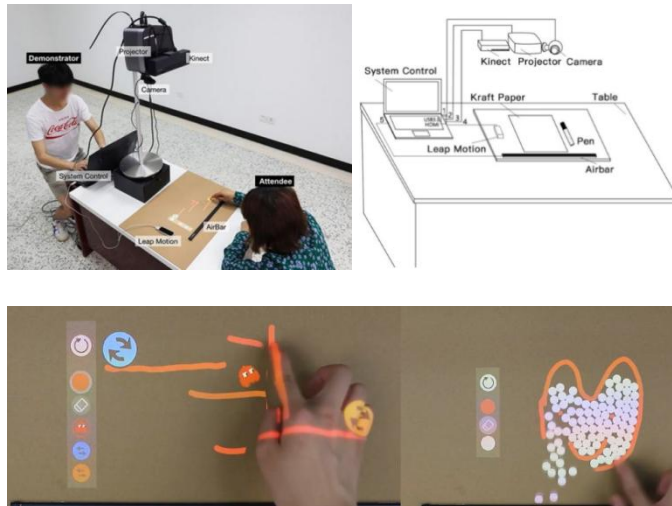


Figure 1 Magic PAPER Operation Interface



Figure 2 Pulp Nonfiction Interactive

Synthesis of Representative Studies

To clearly present the research context and gaps, this study systematically sorts out representative literature in the field, as shown in Table 1) To address the research gap, this study constructs a multi-level integrated analytical framework, connecting the four core theories in a hierarchical logic: Universal Design provides top-level evaluation principles and macro judgment criteria for the age-adaptive performance of media products; the SRK Cognitive Aging Model offers a micro cognitive decomposition tool, which can quantify the cognitive load of different media interaction tasks and guide targeted optimization; Inclusive Design runs through the whole research as a user-centered stance, ensuring the design covers elderly groups with different digital literacy and ability levels; Transmedia Storytelling Theory supplies the structural logic of cross-media collaboration, which is adjusted and adapted in combination with the cognitive characteristics of the elderly. The four theories form a complete analytical chain from macro principles to micro mechanisms, from user stance to media form, which jointly support the construction of the conceptual framework.

Table 1 Summary of Representative Studies in Age-Friendly Design and Cross-Media Publishing

Author / Year	Core Theory	Method	Key Findings	Research Limitations
Story et al., 1998	Universal Design	Theoretical construction	Proposed seven principles of Universal Design, establishing a universal evaluation framework for inclusive design for all populations	No refined media design dimensions targeting cognitive characteristics of the elderly; lack of cross-scenario adaptability
Keates & Clarkson, 2003	Inclusive Design	Theoretical deduction	Proposed modular inclusive design method, emphasizing user participation and iterative optimization	No actionable application paths for specific life scenarios such as intergenerational childcare
Rasmussen, 1983	SRK Cognitive Model	Human factors analysis	Divided human cognitive tasks into skill-based, rule-based and knowledge-based levels with clear cognitive load differences	No targeted application in media interaction design combined with cognitive aging features
Jenkins, 2006	Transmedia Storytelling	Case analysis	Proposed cross-platform collaborative narrative framework, emphasizing the irreplaceability of each medium in the system	No attention to cognitive adaptation thresholds and usage habit differences of elderly users
Yang et al., 2023	Cognitive Aging Theory	Empirical study	Constructed a multi-level interaction design indicator system for health terminals based on the SRK model	Research scenario limited to health management, not extended to parenting and cross-media publishing

RESEARCH METHODOLOGY

This conceptual study adopts a progressive research process of “theoretical sorting - dimension construction - comparative analysis - framework extraction” (Figure 3). The overall research path is as follows:

Step 1: Systematically retrieve and sort out core literature and industry reports in the fields of age-friendly design, cognitive aging psychology, cross-media publishing and elderly media behaviors, extract key theoretical dimensions, and construct the theoretical analytical framework of this study.

Step 2: Summarize the core characteristics of elderly users from three dimensions: physiological and cognitive constraints, media usage habits, and scenario demands, and clarify the evaluation criteria for comparative analysis.

Step 3: Take the seven principles of Universal Design and the SRK cognitive model as evaluation criteria, conduct multi-dimensional benchmarking analysis on the information

presentation, interaction logic and scenario adaptation features of print media and digital media.

Step 4: Conduct theoretical deduction on the comparative results based on the laws of cognitive aging, extract core influencing factors, and finally construct the conceptual framework of age-friendly cross-media publication design.

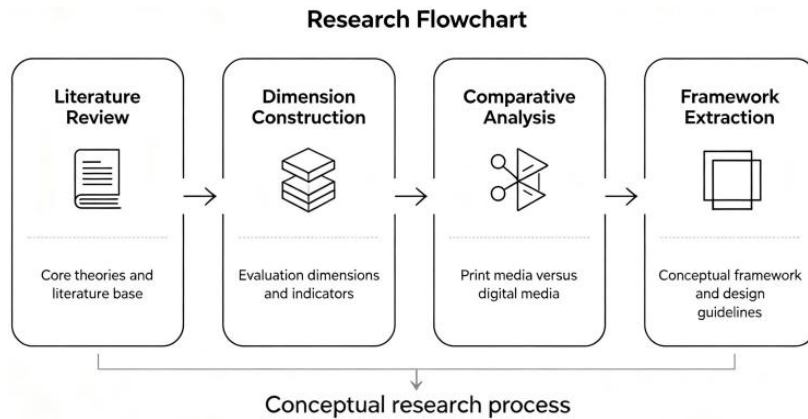


Figure 3 Research Flowchart

Three complementary research methods are adopted to support the above process:

Literature Research: Systematically retrieve and sort domestic and international academic literature, industry reports and policy documents covering age-friendly design, cognitive aging psychology, cross-media publishing and elderly media behaviors, extract core theoretical dimensions and empirical conclusions, and construct the analytical framework and user characteristic database of this research.

Comparative Analysis: Taking the seven Universal Design principles and SRK cognitive model as evaluation criteria, conduct multi-dimensional benchmark comparison on information presentation, interaction logic and scenario adaptation of print media and digital media, summarize respective strengths, limitations and applicable scenarios of the two media forms.

Theoretical Deduction: Based on physiological and psychological laws of cognitive aging, classify media operation tasks by SRK tiers, combine the media preference traits of Chinese seniors, and deduce core influencing factors that determine elderly users' information acquisition efficiency and comprehensive usage experience.

RESEARCH RESULTS

Socio-Cognitive and Media Traits of the Elderly: Foundational Knowledge for Cross-Media Publication Design

Age-friendly cross-media publication design must be rooted in accurate cognition of target users. This study sorts out three core dimensions including physiological cognitive constraints, media usage habits and intergenerational childcare scenario demands to form a complete design knowledge base.

(1) Physiological and Cognitive Constraints of Senior Users

Three layers of physiological and psychological limitations restrict seniors' media interaction experience:

Sensory Perception Layer: Vision degeneration is the most prominent problem, manifested as lens sclerosis leading to presbyopia, lens yellowing weakening recognition of short-wavelength colors, reduced pupil adjustment capacity causing slow light/dark adaptation, and declined visual contrast and search sensitivity. Hearing loss reduces perception of high-frequency and low-volume sounds; cutaneous nerve atrophy lowers tactile sensitivity.

Cognitive Capacity Layer: Working memory capacity shrinks significantly, making it difficult to process multiple information streams simultaneously; information processing speed slows down, extending reaction time for complex operations; selective and divided attention degrade with poor anti-distraction performance; abstract logical reasoning weakens, while crystal memory and life experience remain intact, making experiential content more acceptable.

Emotional Psychological Layer: Most seniors hold anxiety and fear toward unfamiliar digital technologies with strong demand for safety; media operation habits are solidified, and they resist frequent functional iterations and interface adjustments; they value a sense of control and emotional recognition during use, and tend to abandon media once frustration occurs.

(2) Media Usage Traits of Chinese Elderly

Chinese seniors exhibit typical “traditional-based, digital-supplementary” hybrid media ecology features:

Media Structure Preference: Printed books, newspapers and magazines serve as the first choice for systematic knowledge acquisition with high credibility and stable reading habits. Smartphones are primarily used for social connection and fragmented entertainment, with operation paths fixed by long-term muscle memory.

Content Acceptance Tendency: Seniors favor linearly structured, well-organized content, and reject scattered, jump-style information layouts. They prioritize authoritative, practical materials and have low tolerance for dense professional jargon and abstract charts, while case-based visualized content is more accessible.

Interactive Habits: They prefer one- way linear information reception and show extremely low tolerance for multi-layer page jumps and pop-up windows; operation paths are highly fixed, with low willingness to explore new functions and weak capacity to bear trial-and-error costs.

(3) Specialized Demands of Intergenerational Childcare Scenarios

Intergenerational childcare puts forward differentiated cross-media design requirements:

First, diversified usage scenarios bring distinct media demands. Long-term at-home systematic learning fits print media, while emergency parenting problems require instant retrieval supported by digital media.

Second, intergenerational knowledge sharing is a core demand. Cross-media systems need to deliver identical parenting knowledge via different media carriers matching the usage habits of grandparents and young parents to lower family communication barriers caused by media differences.

Comparative Analysis of Age-Adapted Design Traits: Print Media vs. Digital Media

Based on Universal Design and SRK Cognitive Aging Theory, this study compares print and digital media from three core dimensions of information presentation, interaction logic and scenario adaptation.

(1) Information Presentation Dimension Comparison

Information presentation corresponds to the "Simple and Intuitive Use" and "Perceptible Information" principles of Universal Design, directly shaping users' cognitive load and comprehension efficiency.

Table 2 Comparison of Information Presentation Traits: Print Media & Digital Media

Comparison Dimension	Print Media	Digital Media
Visual Performance	Fixed physical reading distance adjustable by users; stable color rendering without screen glare; paper texture provides auxiliary tactile cues; font size fixed and optimized via layout design	Font size, brightness adjustable; prone to screen flicker and glare aggravating visual fatigue; weak identification of short-wavelength colors; single visual channel without tactile feedback
Information Architecture	Linear hierarchical structure with clear table of contents and page numbers, strong spatial memory belonging to skill-based tasks with low cognitive load; no pop-up advertisement interference	Non-linear hyperlink structure causing cognitive disorientation; multi-layer menus require repeated clicks classified as rule/knowledge-based tasks with heavy cognitive consumption; advertisements and push notifications disrupt attention
Content Organization	Suitable for systematic, in-depth knowledge delivery matching linear reading habits; text annotations and attached charts strengthen knowledge retention	Fit fragmented scenario-based knowledge; support multi-sensory audio-visual supplementary materials; yet scattered content hinders the construction of complete knowledge frameworks

Analytical Summary: The linear information structure and stable visual performance of print media are naturally compatible with the cognitive reading habits of elderly users, effectively reducing cognitive consumption during information processing and ensuring the continuity of knowledge acquisition. Although digital media has the advantages of multi-sensory presentation and adjustable font size, its complex information architecture and external interference factors will significantly increase cognitive load. Targeted structural simplification and interference shielding are required to meet age-friendly requirements.

(2) Interaction Logic Dimension Comparison

Interaction logic corresponds to "Flexibility in Use", "Tolerance for Error" and "Low Physical Effort" principles, as well as the SRK Model, determining operation efficiency and psychological experience of the elderly.

Combined with intergenerational childcare scenarios, the three SRK cognitive tiers correspond to the following specific media operations:

Skill-based level: Operations completed by muscle memory without conscious thinking, with the lowest cognitive load. Examples include flipping pages of a printed manual, scanning a large-format QR code with fixed scanning habits, and tapping a permanently fixed back button. Such operations match seniors' long-term usage habits and require almost no learning cost.

Rule-based level: Operations requiring simple rule identification with clear operation hints, with moderate cognitive load. Examples include tapping a play button with clear icon and text labels, swiping left and right to switch video clips, and adjusting font size through a fixed slider. Users only need to follow clear prompts to complete operations without reasoning or decision-making.

Knowledge-based level: Operations requiring active reasoning, multi-step decision-making or exploration of unfamiliar functions, with the highest cognitive load. Examples include searching for target content through multi-level menus, registering and logging into an account, setting personalized parameters, and troubleshooting pop-up windows. Such operations are the main source of seniors' technology anxiety.

Table 3 Comparison of Interaction Logic Traits: Print Media & Digital Media

Comparison Dimension	Print Media	Digital Media
Operation Mode	Page flipping, marking and folding are skill-based physical operations formed through lifelong reading habits requiring zero learning cost	Tap, slide and QR scanning are basic rule-based operations; multi-level setting functions belong to knowledge-based tasks with high learning barriers
Operation Feedback	Direct physical feedback via page turning and bookmark folding with clear spatial positioning; no negative consequences from misoperation	Mainly visual feedback with weak tactile hints; unexpected errors may lead to information loss or interface jump
Learning Threshold	Almost zero technical learning pressure without iterative function updates requiring re-adaptation	Continuous learning required for interface iteration, triggering widespread senior technology anxiety

Analytical Summary: The ultra-high fault tolerance and zero learning cost of printed materials constitute the core reason for seniors' recognition of traditional paper media, which fits the psychological needs of elderly users for sense of control and security. The complex interaction logic of digital media is the primary cause of the elderly digital divide. It is necessary to simplify operation paths and strengthen fault tolerance mechanisms to transform task to rule-based and skill-based ones, so as to lower the usage threshold.

For instance, knowledge-based tasks can be eliminated in their entirety. Non-essential links including account login, advertising pop-ups and multi-level menu navigation are removed to enable "one-click direct access" to digital content upon QR code scanning, so that users can view the content without active decision-making.

Alternatively, rule-based tasks can be downgraded to skill-based tasks. Core function buttons for play, back and font enlargement are uniformly fixed at the bottom of the interface. The consistent fixed layout helps users develop muscle memory over time, gradually transforming operations from rule-identified actions into instinctive clicks.

(3) Scenario Adaptation Dimension Comparison

Scenario adaptation corresponds to "Equitable Use" and "Size and Space for Approach and Use" principles, determining the actual utilization frequency of media products.

Table 4 Comparison of Scenario Adaptation Traits: Print Media & Digital Media

Comparison Dimension	Print Media	Digital Media
Environmental Adaptability	No power or network dependence; clear readability under strong light without equipment failure risks	Require electricity and stable network; poor visibility under sunlight with risks of system crash and update interruption
Hardware Dependence	No extra electronic equipment needed, usable anytime for long or fragmented reading	Reliant on smartphones with pre-operation steps such as unlocking and application opening delaying instant access
Intergenerational Applicability	Grandparents can use independently without auxiliary support; yet content update cycles are long with no real-time data access	Require guidance from younger generations for operation; support real-time content update and remote family sharing

Analytical Summary: Print media features stronger scene universality and independent operability fitting seniors' demand for autonomous learning, and can cover most daily parenting learning scenarios. Digital media has obvious scenario limitations and dependence characteristics, but has unique value in real-time content update and intergenerational interaction, which can serve as a supplementary extension of print media to meet special scenario demands.

Core Influencing Factors Shaping Elderly Information Access and User Experience

Synthesizing the above comparative analysis combined with cognitive aging rules, this study summarizes five decisive factors for age-friendly cross-media design:

Cognitive Load Level: The linearity of information architecture and SRK tier of operations dominate seniors' cognitive resource consumption. Print media's low-load design is more suitable for seniors, while digital interfaces must simplify operation steps to downgrade knowledge-based tasks to rule/skill-based ones.

Sensory Accessibility: Visual contrast, font specification, color matching and multi-sensory auxiliary channels are the basic precondition of media accessibility. Cross-media design can combine print's stable visual performance with digital multi-sensory resources to complement each other.

Operation Fault Tolerance: The severity of misoperation consequences and convenience of rollback directly affect seniors' sense of security. Digital products need to add one-click undo and prominent back buttons to reduce psychological pressure from operational mistakes.

Scenario Adaptability: Matching degree between media format and real-life usage scenarios determines practical utilization frequency. Systematic long-term learning adopts print as carrier, while emergency instant query relies on digital media.

Emotional Identification: Familiar media forms bring a sense of control. Print media forms stable trust for seniors; cross-media design should take printed manuals as the entry point to guide gradual contact with digital auxiliary functions.

Four-Layer Conceptual Framework for Age-Friendly Cross-Media Publication Design

Based on the above research findings, this study constructs a four-layer conceptual framework for age-friendly cross-media publication design in intergenerational childcare scenarios (Figure 4).

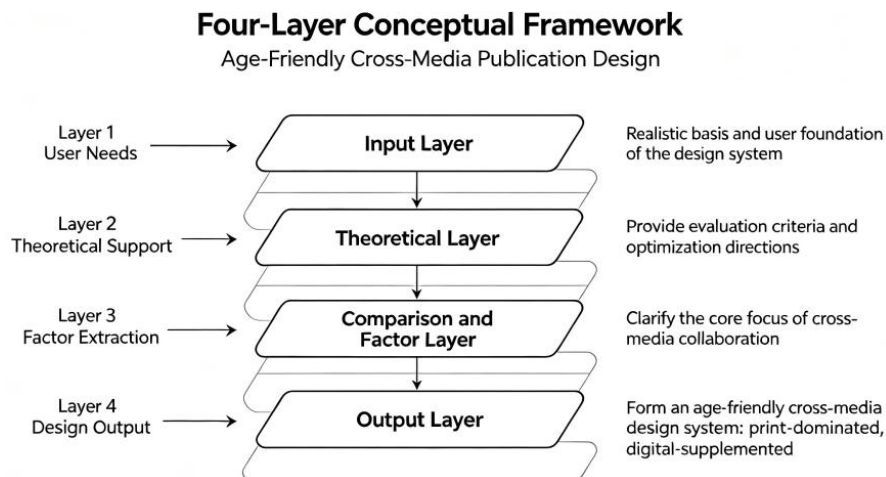


Figure 4 Four-Layer Conceptual Framework

Input Layer: Includes three core elements: physiological and cognitive constraints of elderly users, media usage behavior habits, and intergenerational childcare scenario demands, which serve as the realistic basis and user foundation of the entire design system.

Theoretical Layer: Takes the seven principles of Universal Design and the SRK Cognitive Aging Model as core theoretical support, providing evaluation criteria and optimization directions for media comparison and design optimization.

Comparison & Factor Layer: Through multi-dimensional comparison of age-friendly features of print and digital media, five key influencing factors are extracted, clarifying the core focus of cross-media collaboration.

Output Layer: Forms an age-friendly cross-media design system of “print-dominated, digital-supplemented”. Print media undertakes the core carrier function of systematic parenting knowledge, while digital media undertakes the functions of scenario-based supplementation and intergenerational interaction. The two work together to achieve the design goals of low cognitive load, high inclusiveness and strong emotional identity.

To intuitively present the "print-dominated, digital-supplemented" collaborative strategy, this study designs a prototype schematic of age-friendly cross-media parenting publications (Figure 5) The prototype consists of two parts:

Printed parenting manual: As the core carrier, it adopts large font size, high-contrast color matching and linear hierarchical content structure suitable for the elderly. A large-format high-contrast QR code (no less than $3\text{cm} \times 3\text{cm}$, black-and-white to ensure recognition for presbyopic users) is set beside corresponding knowledge points (e.g., complementary food making, safety care), with clear text prompts such as "Scan to view operation video".

Simplified digital interface: After scanning the QR code, users directly enter the lightweight mini-program interface with no login required and no advertisement pop-ups. The interface only retains three core function buttons: play/pause, go back, and font enlargement, all equipped with large-size icons and matching text labels, and fixed at the bottom of the interface. The content is mainly short operation demonstration videos, matching grandparents' scenario-based fragmented learning needs.



Figure 5 Schematic Diagram of Age-Friendly Cross-Media Publication Prototype

This prototype realizes seamless connection between print media and digital content through a lightweight technical path, controls operation difficulty at the skill-based level, and concretizes the proposed four-layer conceptual framework into an implementable design scheme.

CONCLUSION AND DISCUSSION

Research Conclusions

Chinese seniors live in a hybrid media ecosystem coexisting traditional print media and digital products, with media usage restricted by physiological degeneration, cognitive aging, native

cultural customs and household parenting scenarios. Age-friendly cross-media design cannot blindly pursue full digitalization but must respect seniors' long-established reading and operation habits.

Print media and digital media exhibit complementary age-adapted advantages and defects: print media excels in low cognitive load, high fault tolerance, environmental adaptability and emotional recognition, serving as core carriers of systematic parenting knowledge; digital media is good at multi-sensory demonstration and real-time content update, acting as scenario-based supplementary materials. The two media forms form a hierarchical collaborative relationship rather than substitutes.

Cognitive load level, sensory accessibility, operation fault tolerance, scenario adaptability and emotional identification are five key factors influencing seniors' information acquisition efficiency and comprehensive experience. The core cross-media design logic is to allocate content and interaction tasks based on respective media strengths, building a "print-dominated, digital-supplemented" integrated system to realize synergistic effects.

Research Discussion

The conclusions of this study are consistent with existing relevant research, and also form differentiated expansions in application scenarios and implementation paths. From the perspective of universal design, the study verifies the general applicability of core principles such as equity, fault tolerance and usability in age-friendly design, and extends its application scope from physical products and single interfaces to print-digital integrated cross-media publications. From the perspective of inclusive design, the study adheres to the core stance of covering groups with diverse abilities and eliminating access barriers, and further refines the hierarchical adaptation scheme in the specific scenario of intergenerational childcare. From the perspective of cognitive aging, the study confirms the positive effect of hierarchical cognitive design on reducing cognitive load for older users, and further clarifies the cognitive load distribution logic between print and digital media to realize collaborative optimization of the two media. From the perspective of transmedia storytelling, the study recognizes the information gain brought by multi-media collaboration, adjusts the application logic according to the cognitive and media usage characteristics of the elderly, and proposes an asymmetric "print-dominated, digital-supplemented" collaborative path, which supplements the audience adaptation scope of the original theory.

Theoretically, this study breaks interdisciplinary barriers among age-friendly design, geriatric cognitive psychology and transmedia communication. It systematically applies the SRK cognitive hierarchy and seven Universal Design principles to publication design, improves the complete theoretical analytical framework of media adaptation for the elderly, supplements the theoretical application paths for the segmented intergenerational childcare scenario, and expands the application scope of Cognitive Aging Theory in popular science media.

Practically, this study puts forward the hierarchical collaborative strategy of "print-dominated, digital-supplemented" according to the complementary features of two media. A full set of implementable specifications covering layout rules, simplified digital interaction and scenario matching can directly guide the development of parenting guidebooks and mini-programs. It effectively lowers media barriers for grandparents to acquire scientific parenting knowledge and eases intergenerational conflicts over childcare concepts.

Academically, this study constructs a three-dimensional comparative evaluation system for print and digital media, filling the gap that most existing studies discuss elderly groups generally without targeted analysis on childcare grandparents. It provides standardized analytical references for subsequent empirical and design research on elderly communication and senior publishing.

Core Innovations

This study systematically summarizes five key factors shaping older adults' media information acquisition and usage experience: cognitive load, sensory accessibility, operation fault tolerance, scenario adaptability and emotional identification, which makes up for the deficiency of existing research in analyzing the internal mechanism of media experience for the segmented group of grandparent caregivers. Meanwhile, it innovatively constructs a four-layer conceptual framework for age-friendly cross-media publications, establishes a complete logical chain from users' physiological and cognitive demands to final media design solutions, and provides a structured analytical paradigm for similar cross-media age-friendly research.

Research Limitations and Future Prospects

This study is a conceptual research based on literature review and theoretical deduction, lacking first-hand empirical investigation targeting grandparent caregivers in intergenerational childcare scenarios. Follow-up research will conduct first-hand data collection including in-depth interviews with frontline grandparent caregivers and prototype user testing, to further verify the influence magnitude and weight of the five key influencing factors. Meanwhile, the generalizability and practical effectiveness of the proposed "print-dominated, digital-supplemented" design strategy and the four-layer conceptual framework remain to be further validated in real intergenerational childcare contexts.

To verify the validity of the proposed conceptual framework, follow-up research will conduct empirical validation in three progressive phases:

Qualitative empirical research: Grandparent caregivers aged 60–75 with long-term grandchild care experience in urban China will be recruited for semi-structured in-depth interviews. The study will verify users' actual perception of the five core influencing factors, and adjust factor weights and design priorities in line with users' real pain points.

Prototype usability testing: A physical prototype of age-friendly cross-media parenting publications will be developed based on the four-layer framework, consisting of a printed parenting manual with large-format high-contrast QR codes and a simplified mini-program interface. Grandparent caregivers will be recruited to participate in usability testing, and data including task completion rate, operation duration, cognitive load and user satisfaction will be collected for iterative optimization of the design scheme.

Large-sample quantitative verification: Building on the optimized prototype, valid questionnaires will be distributed to grandparent caregivers across different regions and educational backgrounds, to comprehensively verify the generalizability and effectiveness of the framework among diverse populations and application scenarios.

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