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Multimodal anti fraud education improves cognitive emotional and behavioral engagement in older adults

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This study examines the differential effectiveness of video-based versus text-based anti-fraud educational interventions in improving cognitive comprehension, emotional engagement, and behavioral intentions among older adults. Using a stratified sample of 220 older adults aged 60 and above, the findings reveal that video-based materials significantly outperform text-based interventions in enhancing cognitive comprehension, emotional engagement, and behavioral intentions related to fraud prevention. Conversely, text-based materials offer more structured and detailed informational guidance, effectively heightening older adults' awareness of financial vulnerabilities, although generating comparatively lower emotional engagement. By introducing and validating a multimodal approach that strategically integrates video and text, this research addresses a critical gap in current anti-fraud education strategies tailored to older adults' diverse cognitive and emotional needs. The results carry substantial implications for policymakers and educators aiming to enhance older adults' resilience to financial fraud, particularly amidst increasingly sophisticated threats such as artificial intelligence-enhanced scams.

Keywords Anti-Fraud education, Cognitive comprehension, Emotional engagement, Financial vulnerability, Video and text

Older adults face a rising risk of financial exploitation, frequently falling prey to sophisticated fraud schemes such as investment scams, consumer fraud, imposter scams, and identity theft[1,2]. Despite these severe risks, older victims are often hesitant to report such incidents, resulting in disproportionately high financial losses[3]. Accumulating evidence consistently underscores older adults' susceptibility to deceptive schemes, exacerbated by age-related cognitive decline, social isolation, and over-reliance on trust-based relationships[4,5]. These vulnerabilities necessitate urgent investigation into psychological, emotional, and cognitive factors that shape older adults' capacity to identify, comprehend, and resist fraud attempts[4,6].

Socioemotional Selectivity Theory[7] provides a critical theoretical framework for understanding older adults' unique susceptibility to fraud, suggesting that aging individuals prioritize emotionally meaningful experiences over purely informational content[8]. Further supported by the Positivity Effect, older adults typically focus on positive information and subconsciously neglect negative cues[9]. Consequently, anti-fraud educational materials designed for older adults must effectively leverage emotional resonance, providing a sense of security and emotional comfort that facilitates deeper message retention and behavioral change.

Alongside emotional factors, cognitive constraints significantly influence older adults' information-processing capabilities. Cognitive aging is typically characterized by declines in memory capacity, attentional control, and information-processing speed[10]. According to Cognitive Load Theory[11], the effectiveness of educational materials decreases markedly when cognitive demands surpass an individual's available cognitive resources, particularly during complex or unfamiliar tasks[12–14]. Multimedia learning research has consistently demonstrated that dynamic visual and auditory stimuli—characteristic of video-based educational formats—can substantially reduce cognitive load, enhancing comprehension, retention, and recall of critical information[15,16]. Moreover, research emphasizes the importance of accommodating older adults' cognitive limitations through

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thoughtfully tailored instructional designs, thereby ensuring educational content remains both accessible and engaging[17,18].

In parallel, emotional engagement introduces another layer of complexity critical to older adults' learning processes. Socioemotional Selectivity Theory posits that older adults prioritize emotionally meaningful content due to their increased awareness of limited lifetime horizons[7,8]. Empirical evidence indicates that educational videos enriched with non-verbal emotional cues, such as gestures and facial expressions, significantly enhance older adults' emotional resonance and memory retention[19–21]. Emotional resonance effectively facilitates deeper cognitive processing, enhancing attention, recall, and application of learned materials, making it particularly valuable for fraud prevention education[22–24].

While video-based formats excel at capturing emotional engagement and reducing cognitive load, text-based educational materials also have distinct pedagogical advantages. Text formats offer structured, detailed, step-by-step instructions particularly suited for older adults with higher cognitive abilities or preferences for systematic learning[25]. Empirical evidence shows older adults often favor text materials due to their alignment with familiar, cognitively systematic learning styles[26]. Additionally, text-based formats present practical advantages, including low production costs, easy distribution, and high accessibility, thus remaining a vital component of comprehensive anti-fraud strategies[27].

Given the complementary strengths of these two formats, a multimodal educational approach integrating video and text may provide optimal learning outcomes, simultaneously maximizing cognitive comprehension, emotional engagement, and practical behavioral intentions. To date, limited research has explicitly tested such an integrated approach within anti-fraud educational programs specifically tailored to older adults' cognitive and emotional profiles.

Grounded theoretically in Cognitive Load Theory[11], Socioemotional Selectivity Theory[7], and Multimedia Learning Theory[17], the present study systematically compares the effectiveness of video-based and text-based anti-fraud interventions among older adults. The study evaluates three critical dimensions—cognitive comprehension, emotional engagement, and behavioral intention—and examines the mediating psychological mechanisms through which intervention format influences these outcomes. Additionally, this research assesses how different intervention formats shape older adults' perceptions of financial vulnerability.

Specifically, this study proposes and tests the following hypotheses:

H1: Compared to text-based materials, video-based anti-fraud interventions will yield significantly higher overall acceptance of anti-fraud information among older adults.

H1a: Video-based materials will enhance cognitive comprehension significantly more than text-based materials.

H1b: Video-based materials will elicit significantly greater emotional engagement than text-based materials.

H1c: Video-based materials will result in stronger behavioral intentions to implement anti-fraud strategies.

H2: Compared to text-based anti-fraud materials, video-based interventions will reduce the overall perceived financial vulnerability among older adults.

H2a: Video-based materials will lead to higher perceived financial insecurity compared to text-based materials.

H2b: Video-based materials will reduce perceived psychological vulnerability compared to text-based materials.

H2c: Video-based materials will reduce perceived relational insecurity compared to text-based materials.

H3: Intervention format (video vs. text) will exert a direct effect on behavioral intentions.

H4: Cognitive comprehension will mediate the relationship between intervention format and behavioral intentions.

H5: Emotional engagement will mediate the relationship between intervention format and behavioral intentions.

Method

Participant

We conducted an a priori power analysis using G*Power[28] to determine the minimum required sample size. Assuming a medium effect size (Cohen's $f^2 = 0.15$), a significance level of 0.05, and a desired statistical power of 0.80, the estimated minimum sample size for a between-group design was 128 participants. To ensure adequate statistical power and broader generalizability, we recruited a total of 220 participants, exceeding the minimum requirement.

Participants were elderly individuals aged 60 and above, in accordance with the definition provided by the Law on the Protection of the Rights and Interests of the Elderly. The final sample consisted of 220 participants (Mage = 69.9 years, $SD = 5.4$), with 51.8% identifying as female. A stratified site-based sampling strategy was used to ensure demographic diversity across age, gender, education, and geographic region. Recruitment took place across three types of venues: urban community centers, senior universities, and township-based elderly clubs, thereby enhancing the representativeness of the sample.

Age was categorized into three intervals: 60–64 years (29.5%), 65–69 years (38.6%), and 70–75 years (31.8%). Educational attainment was distributed as follows: 39.5% primary school, 42.3% middle school, and 18.2% high school or above. Monthly income levels were grouped into low (35.5%), medium (43.6%), and high (20.9%) categories based on self-reported household income.

Participants were randomly assigned to one of two experimental conditions: (1) the video group ($n = 110$), and (2) the text group ($n = 110$). This between-subjects design builds upon prior research supporting the effectiveness of multimodal interventions in aging populations[29,30]. Ethical approval was obtained from the institutional review board (Approval No. 202405201116), and all procedures complied with the Declaration of Helsinki and national ethical guidelines for research involving human subjects.

Instruments

Two validated instruments were employed to measure the dependent variables.

The Elderly Fraud Prevention Information Acceptance Questionnaire is an 11-item measure specifically developed for this study to evaluate older adults' acceptance of anti-fraud educational materials. It comprises three core dimensions: cognition (4 items), emotional response (3 items), and behavioral intention (4 items). Items were systematically generated based on prior research on persuasive communication strategies and fraud risk awareness among older populations[31]. These items were subsequently refined through expert consultation and pilot testing with older adults to ensure content relevance, clarity, and cultural appropriateness. Responses were provided on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with higher scores reflecting greater acceptance of fraud prevention information. Psychometric evaluation confirmed the scale's reliability and validity. Internal consistency was good, with a Cronbach's α of 0.82 and item-total correlations ranging from 0.25 to 0.52. Confirmatory factor analysis (CFA) supported the hypothesized three-factor structure, indicating a satisfactory model fit: $\chi^2(41) = 72.4$, CFI = 0.94, TLI = 0.92, RMSEA = 0.058, SRMR = 0.045. All factor loadings were statistically significant ($p < .001$) and exceeded 0.60, confirming robust structural validity. These findings suggest that the questionnaire is appropriate for evaluating acceptance of educational interventions in early stages of fraud prevention.

The Financial Exploitation Vulnerability Scale[5] is a 17-item instrument designed to assess older adults' perceived vulnerability to financial exploitation, spanning three critical dimensions: financial insecurity (Items 1–8), psychological vulnerability (Items 9–13), and relationship insecurity (Items 14–17). Sample items include "Who manages your money day to day?" (financial insecurity), "How often do you talk with or visit others on a regular basis?" (psychological vulnerability), and "Did anyone ever tell you that someone else you know wants to take your money?" (relationship insecurity). Responses were recorded on a 3-point Likert scale (1 = strongly disagree to 3 = strongly agree), with higher scores indicating greater perceived vulnerability. To maintain consistency in scoring direction, items 1–8 were reverse-coded prior to analysis. The instrument exhibits robust psychometric properties. In the current study, internal consistency was strong (Cronbach's $\alpha = 0.80$), with moderate to strong inter-item correlations. Item analysis revealed no substantial improvements in reliability upon the removal of any individual item, confirming good scale cohesion. Confirmatory factor analysis (CFA) validated the proposed three-factor structure, yielding a strong model fit: $\chi^2(98) = 149.3$, CFI = 0.95, TLI = 0.93, RMSEA = 0.049, SRMR = 0.041. All standardized factor loadings exceeded 0.65 and were statistically significant ($p < .001$), demonstrating solid structural validity.

Materials

The experimental materials were designed to provide consistent anti-fraud knowledge, leveraging principles of multimedia learning[17] and socioemotional selectivity theory[7]. To enhance engagement and accessibility, the materials were developed in two formats:

Video group Professionally produced videos featuring real actors and voiceovers, enhanced with subtitles for accessibility. The videos were designed to include dynamic gestures and facial expressions, aligned with findings that nonverbal cues enhance emotional engagement[21].

Text group Comic-style booklets combining illustrations with concise text. The materials incorporated humor and vivid imagery, which have been shown to reduce cognitive load and improve retention among older adults[15].

Both formats underwent rigorous validation, including expert reviews (involving psychologists and financial advisors) and pilot testing with 20 older adults. Future studies could explore integrating AI-generated elements (e.g., synthetic voiceovers, virtual avatars) to further enhance scalability and accessibility.

Procedure

The study adopted a between-subjects experimental design to compare the effectiveness of video- and text-based educational materials in promoting fraud prevention among older adults. Participants were randomly assigned to one of two experimental groups: (1) the video group (2) the text group. The procedure consisted of four phases:

Baseline data collection

At the outset of the study, participants completed a demographic questionnaire assessing baseline characteristics, including age, gender, education level, living arrangement, and media exposure frequency. These variables were selected based on previous research demonstrating their influence on learning performance and susceptibility to financial fraud[5]. The collected data were used to identify baseline group differences and to control for potential confounding variables in subsequent statistical analyses.

Learning phase

Participants were exposed to the assigned experimental materials. The video group watched a 30-minute professionally produced video featuring real actors and voiceovers, with subtitles provided for accessibility. The text group read a 30-minute comic-style booklet combining illustrations with concise textual explanations. The materials were presented in randomized order within each group to minimize order effects. Additionally, participants were instructed to avoid distractions and were monitored to ensure compliance with the experimental protocol.

Measurement phase
Following the learning phase, participants completed two validated questionnaires:

Elderly Fraud Prevention Information Acceptance Questionnaire: This measured participants' cognitive comprehension, emotional engagement, and behavioral intention.

Financial Exploitation Vulnerability Scale: This assessed participants' financial vulnerability across three dimensions: financial insecurity, psychological vulnerability, and relationship insecurity.

The questionnaires were administered in paper form and completed under the supervision of a trained researcher, who provided clarification if needed.

Debriefing and resources provision
At the end of the session, participants were debriefed about the study's objectives and methodology. They were provided with practical anti-fraud advice, including tips for identifying scams and steps to report fraudulent activities. Participants also received a curated list of resources for financial education and assistance, ensuring the study adhered to ethical guidelines for human research.

Statistical analysis
Statistical analyses were conducted using R with the lm function for linear regression modeling. The data analysis comprised four stages:

Descriptive statistics
Descriptive statistics, including means, standard deviations, and ranges, were calculated for the total scores and subscales of both questionnaires. This provided a comprehensive overview of participants' responses across the video and text groups.

Inferential statistics
To examine the impact of intervention format on anti-fraud information acceptance, multiple linear regression analyses were conducted to assess group differences in both the total scores and subdimensions of the Elderly Fraud Prevention Information Acceptance Questionnaire and the Financial Exploitation Vulnerability Scale. Effect sizes were interpreted using standardized beta coefficients, which indicate the relative contribution of each predictor. Model fit was evaluated based on adjusted R^2 values, reflecting the proportion of variance explained by the model. In addition, demographic variables such as age, education level, and media exposure were included as covariates to control for potential confounding effects.

Mediation analysis
To investigate the underlying mechanisms through which intervention format influences behavioral intention, a parallel mediation analysis was conducted using R. Cognition and emotion were specified as parallel mediators. The analysis estimated both the average direct effect (ADE) of intervention format on behavioral intention and the average causal mediation effects (ACME) via the two mediators. This approach enables a rigorous examination of the distinct cognitive and emotional pathways through which the intervention may shape behavioral outcomes.

Reliability testing
Internal consistency for both questionnaires was verified using Cronbach's α, with thresholds of 0.7 indicating acceptable reliability and 0.8 or higher considered good reliability[32]. In this study, Cronbach's α for the Elderly Fraud Prevention Information Acceptance Questionnaire was 0.82, and for the Financial Exploitation Vulnerability Scale, it was 0.80.

Results
Demographic characteristics
The demographic characteristics of participants were generally comparable across the two experimental conditions, indicating balanced baseline distributions. The text group had a slightly higher mean age ($M = 70.2$, $SD = 5.5$) than the video group ($M = 69.6$, $SD = 5.3$). In terms of media exposure frequency, the video group reported moderately higher levels ($M = 3.45$, $SD = 1.30$) compared to the text group ($M = 2.75$, $SD = 1.46$). Living arrangements were also similar, with approximately 47% of participants living alone and 53% living with a spouse or partner.

Inferential analyses revealed that several demographic variables were significantly associated with the acceptance of anti-fraud information. Specifically, older participants exhibited lower acceptance ($p < .001$): those aged 60–64 demonstrated significantly higher acceptance than participants aged 65 and above, with the lowest scores observed in those aged 70 and older. Education level was also a significant factor ($p < .001$), with participants holding a high school degree or above reporting the highest levels of acceptance. Media exposure frequency was positively correlated with acceptance ($p < .001$), indicating that greater exposure was associated with better comprehension and receptiveness to anti-fraud materials.

By contrast, gender ($p > .05$), living arrangement ($p > .05$), and household income ($p > .05$) were not significantly related to acceptance outcomes. Together, these findings suggest that age, education, and media exposure were the primary demographic correlates of anti-fraud information effectiveness in the present sample.

Anti-fraud content effectiveness scale (Q1)
To evaluate the impact of intervention format (video vs. text), participant age, education level, and media exposure on anti-fraud information acceptance, multiple linear regression analyses were conducted for the total

score and its three subdimensions—cognitive comprehension, emotional engagement, and behavioral intention (see Fig. 1).

Overall effectiveness Participants exposed to the video intervention reported significantly higher total acceptance scores than those in the text group ($B = 6.95$, $SE = 0.55$, $p < .001$), providing strong empirical support for Hypothesis 1. Greater media exposure was also associated with higher overall acceptance ($B = 0.82$, $SE = 0.20$, $p < .001$). Neither age nor education level significantly predicted total acceptance. The model explained approximately 42% of the variance (Adjusted $R^2 = 0.42$).

Cognition Participants in the video group demonstrated significantly greater cognitive comprehension than those in the text group ($B = 2.59$, $SE = 0.27$, $p < .001$), supporting Hypothesis 1a. Media exposure was positively associated with comprehension scores ($B = 0.39$, $SE = 0.10$, $p < .001$). No significant effects were observed for age or education. The model accounted for 31% of the variance (Adjusted $R^2 = 0.31$).

Emotional response Video-based materials elicited significantly higher emotional engagement than text-based materials ($B = 1.59$, $SE = 0.23$, $p < .001$), aligning with Hypothesis 1b. Age showed a marginal negative association with emotional response ($B = -0.27$, $SE = 0.16$, $p = .085$), suggesting a possible decline in emotional engagement with increasing age. Education and media exposure did not significantly predict emotional engagement. The model explained 18% of the variance (Adjusted $R^2 = 0.18$).

Behavioral intentions Participants in the video group reported significantly stronger behavioral intentions than those in the text group ($B = 2.77$, $SE = 0.28$, $p < .001$), providing robust support for Hypothesis 1c. Higher media exposure was also associated with increased behavioral intention ($B = 0.33$, $SE = 0.10$, $p = .001$). Age and education were not significant predictors. The model explained 31% of the variance (Adjusted $R^2 = 0.31$).

These findings indicate that video-based educational materials were significantly more effective than text-based materials in enhancing cognitive comprehension, emotional engagement, and behavioral intention related to anti-fraud education. Media exposure positively influenced cognitive comprehension and behavioral intentions, highlighting its facilitative role in enhancing receptivity to anti-fraud information. Age was marginally linked to lower emotional engagement, while education showed no significant associations across the outcome dimensions.

Financial exploitation vulnerability scale (Q2)

Further regression analyses were conducted to evaluate the effects of intervention type, age, education, and media exposure on participants' perceived financial vulnerability. Higher scores on this scale reflect greater perceived vulnerability (see Fig. 2).

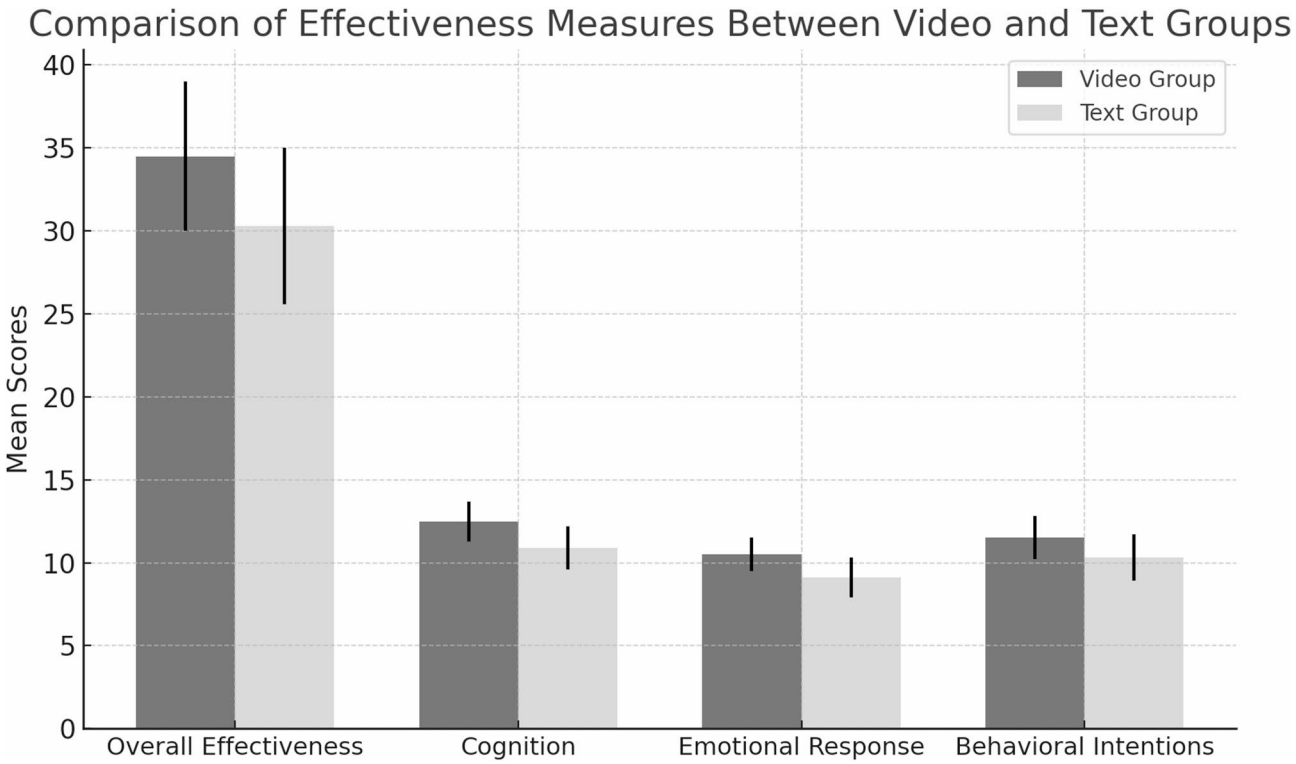

Fig. 1. Comparison of Effectiveness Measures Between Video and Text Groups.

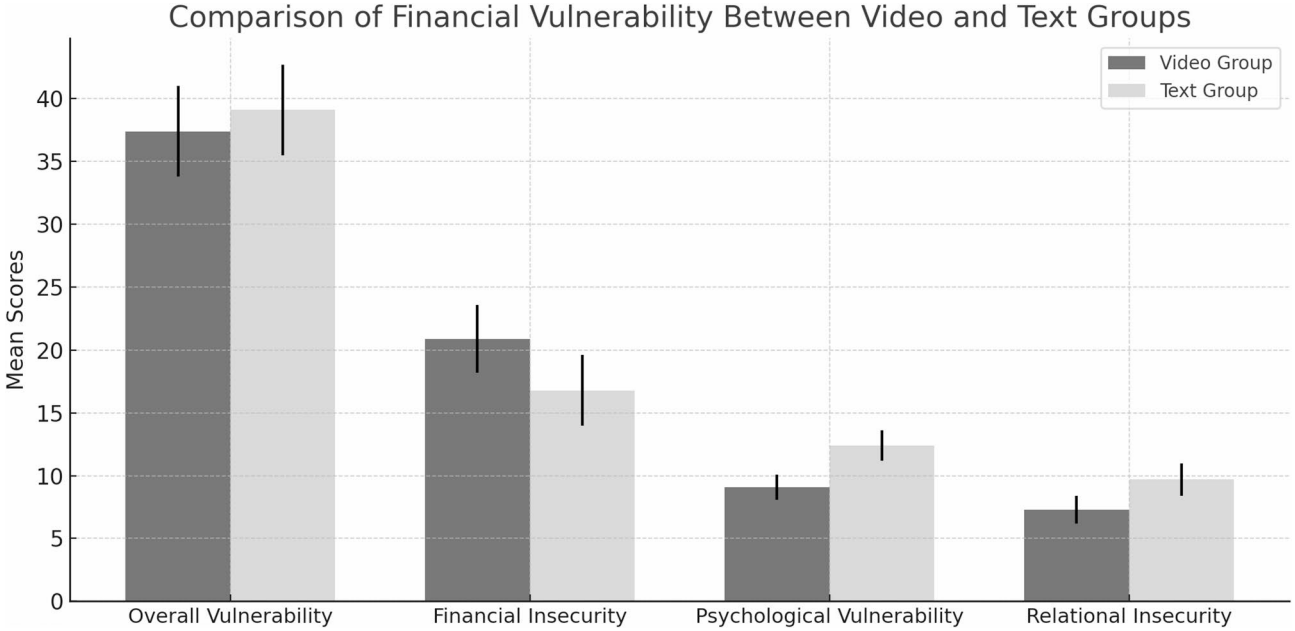

Fig. 2. Comparison of Financial Vulnerability Measures Between Video and Text Groups.

Overall effectiveness The video condition reported significantly lower overall vulnerability compared to those in the text condition ($B = -1.65$, $SE = 0.51$, $p = .001$). Our results align closely with the theoretical premise of H2 and validate its predictions. Increased media exposure was significantly associated with lower vulnerability scores ($B = -0.75$, $SE = 0.18$, $p < .001$). Education showed a marginally significant negative association with vulnerability scores ($B = -0.59$, $SE = 0.35$, $p = .09$), whereas age was not significantly related. The adjusted R^2 was 0.13.

Financial insecurity participants in the video group scored significantly higher on financial insecurity than the text group ($B = 4.04$, $SE = 0.39$, $p < .001$), indicating greater perceived insecurity. The evidence obtained from the current analysis support the validity of H2a. Increased media exposure was associated with lower financial insecurity scores ($B = -0.85$, $SE = 0.14$, $p < .001$). Higher education was negatively related to financial insecurity scores ($B = -0.68$, $SE = 0.26$, $p = .011$). Age was not a significant predictor. The model explained approximately 37% of the variance (Adjusted $R^2 = 0.37$).

Psychological vulnerability Participants exposed to video materials reported significantly lower psychological vulnerability compared to the text group ($B = -3.31$, $SE = 0.20$, $p < .001$). This result upholds the expectations stated in H2b. Age, education, and media exposure were not significantly associated with psychological vulnerability scores. This model accounted for approximately 57% of the variance (Adjusted $R^2 = 0.57$).

Relationship insecurity The video group also reported significantly lower relational insecurity than the text group ($B = -2.39$, $SE = 0.18$, $p < .001$). The observed pattern is consistent with the predictions of H2c. Age, education, and media exposure were not significant predictors of relational insecurity scores. Approximately 44% of the variance was explained by the model (Adjusted $R^2 = 0.44$).

Overall, the video-based intervention proved significantly more effective than the text-based counterpart in enhancing the acceptance of anti-fraud information. Participants exposed to video materials demonstrated higher levels of cognitive comprehension, emotional engagement, and behavioral intention. This consistent pattern suggests that audiovisual content may facilitate deeper information processing and stronger motivational activation, likely due to its vivid, emotionally engaging format. Additionally, media exposure frequency emerged as a stable positive predictor of both comprehension and behavioral outcomes, indicating that individuals with greater routine exposure to media are more receptive to anti-fraud messages. In contrast, neither age nor education level significantly influenced acceptance outcomes, suggesting that video-based interventions may exert broadly effective influence across diverse demographic groups.

In terms of subjective vulnerability, participants in the video group reported significantly lower overall perceived financial exploitation risk, including dimensions of psychological vulnerability and relational insecurity. This supports the theoretical expectation that video materials can reduce risk salience and promote a sense of protection. An exception was observed in the domain of financial insecurity, wherein participants in the text condition reported significantly lower scores, indicating a greater sense of perceived financial security. This pattern suggests that the structured and detailed nature of text-based materials may facilitate enhanced cognitive control over financial risk, thereby attenuating subjective feelings of insecurity.

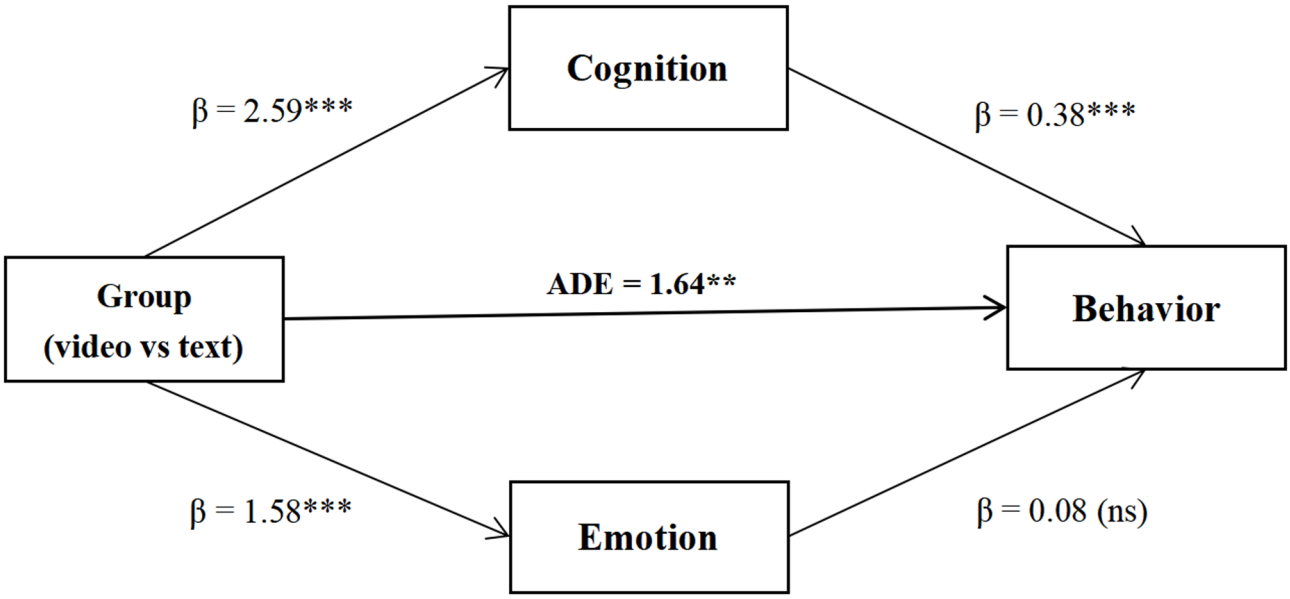

Fig. 3. Parallel Mediation Model.

Across models, media exposure consistently served as a protective factor—higher levels of exposure were associated with reduced perceived financial vulnerability and enhanced information acceptance. Education was negatively associated with financial insecurity, suggesting that higher educated individuals may be more attuned to potential financial risks, possibly due to heightened awareness or cognitive monitoring. Other demographic variables, including age, gender, and living arrangement, were not significant predictors across any outcome dimensions. This indicates that personal experience with media and information processing styles may play a more central role than static demographic attributes in shaping responses to anti-fraud interventions among older adults.

Mediation analysis

To examine the underlying mechanisms through which intervention format influenced behavioral intention, a parallel mediation analysis was conducted, including cognitive comprehension and emotional engagement as simultaneous mediators. The analysis revealed a significant total effect of intervention format (video vs. text) on behavioral intention (*Total Effect* = 2.64, 95% CI [1.97, 3.28], $p < .001$), indicating that participants exposed to video-based materials reported significantly higher behavioral intention scores than those in the text condition.

The indirect effect through cognitive comprehension was statistically significant (*ACME* = 1.00, 95% CI [0.53, 1.45], $p < .001$), suggesting that improved cognitive comprehension partially mediated the effect of intervention format on behavioral intention. This mediating pathway accounted for approximately 38% of the total effect, providing empirical support for Hypothesis 4 (H4). By contrast, the indirect effect via emotional engagement was not statistically significant (*ACME* = 0.13, 95% CI [− 0.13, 0.40], $p = .38$), indicating that enhanced emotional response did not play a meaningful role in explaining differences in behavioral intention. Thus, Hypothesis 5 (H5) was not supported.

The direct effect of intervention format on behavioral intention remained significant after controlling for both mediators (*ADE* = 1.64, 95% CI [0.80, 2.51], $p < .01$), supporting Hypothesis 3 (H3). These findings indicate that the video-based intervention promoted stronger behavioral intention primarily through its enhancement of cognitive comprehension, while emotional engagement exerted a negligible effect in this process. This pattern underscores the centrality of cognitive pathways over affective ones in mediating the impact of educational format on anti-fraud behavioral outcomes among older adults (see Fig. 3).

Discussion

Key findings and theoretical contributions

The results clearly demonstrate the critical roles of media exposure and education in shaping older adults' responses to anti-fraud interventions. Previous research has established that age, media exposure, and education significantly shape older adults' vulnerability to fraud[33,34]. This study extends these findings by further elucidating how these demographic and experiential factors influence older adults' acceptance of anti-fraud information and their perceptions of financial vulnerability. Specifically, media exposure emerged as a robust protective factor, positively correlating with cognitive comprehension and behavioral intention. This suggests that frequent engagement with informational media enhances older adults' ability to process anti-fraud messages and motivates preventive behaviors. Such a result is congruent with Multimedia Learning Theory[17], emphasizing the role of multi-channel information in facilitating schema activation and effective knowledge transfer. Moreover, increased media exposure significantly predicted reduced overall financial vulnerability and perceived financial

insecurity, highlighting its critical role in promoting subjective financial security. These findings underline the moderating effect of information engagement in shaping older adults' risk perception and reinforce the strategic value of media as a scalable preventive mechanism.

Educational attainment significantly predicted the acceptance of anti-fraud information, with participants holding a high school degree or above reporting higher acceptance levels. Additionally, educational attainment was negatively associated with perceived financial insecurity, suggesting that higher-educated individuals may experience greater cognitive control and thus feel more financially secure. Such nuanced findings are consistent with previous research[35], suggesting that education improves the precision of risk perception rather than uniformly enhancing openness to intervention content.

Interestingly, age did not emerge as a consistently significant predictor in most measured outcomes, yet it exhibited a marginal negative association with emotional engagement. This finding aligns with Socioemotional Selectivity Theory[7], suggesting that older adults tend to regulate emotional investments, prioritizing emotional stability over emotional intensity. Importantly, chronological age alone did not significantly affect perceived financial vulnerability, highlighting that subjective risk appraisal among older adults may be shaped more substantially by experiential and cognitive factors, such as media exposure and cognitive resources, rather than mere age.

Beyond demographic influences, this study advances our understanding of the interplay among emotion, cognition, and behavior within anti-fraud education. Specifically, video-based interventions significantly increased emotional engagement and cognitive comprehension, pointing to complex underlying psychological mechanisms. Video interventions benefit from rich sensory stimuli and have been shown to evoke deeper emotional reactions compared to text-based approaches[29]. This aligns again with Socioemotional Selectivity Theory[7,8], which posits an age-related attentional shift toward emotionally meaningful content due to heightened awareness of time limitations. Videos address these emotional needs directly, making educational experiences engaging and memorable. Furthermore, non-verbal cues in videos (gestures, facial expressions) effectively guide attention and mitigate cognitive load, crucially benefiting older adults who may struggle with processing complex information. This dynamic illustrates the practical applicability of dual-channel multimedia learning model[17].

Conversely, text-based materials complement videos by facilitating structured, analytical cognitive processing. Text formats provide detailed, systematic guidance conducive to deep cognitive engagement, especially beneficial for cognitively capable individuals[36]. The structured nature of text aligns with older adults' preferences for systematic analysis, particularly when encountering complex or unfamiliar information[6]. Thus, an integration of video's emotional immediacy with text's structured clarity appears essential to effectively address the diverse cognitive needs within older adult populations. Nevertheless, this complementary relationship presumes equitable digital access and literacy among older adults. Recent studies[37,38] highlight significant structural barriers—limited technology access, low digital literacy, and cultural diversity—hindering older adults' adoption and effective use of digital educational resources[39,40]. Addressing these constraints is thus critical to ensure multimodal educational interventions are both pedagogically effective and equitably accessible.

This research highlights a robust pattern across multiple domains: video interventions not only enhanced cognitive, emotional, and behavioral outcomes, but also reduced perceived psychological and relational vulnerability. These contrasting effects, however, are not mutually exclusive but rather synergistic. The emotional resonance and intuitive clarity from videos initiate learning, overcoming psychological defensiveness and sparking initial behavior change. Text materials then consolidate the initial cognitive activation through structured knowledge and reflective analysis, reinforcing cognitive schemas for risk recognition and response. Together, video and text form a cognitive-affective feedback loop: the initial emotional and cognitive activation from videos primes individuals to engage more thoroughly with detailed text content, while textual analysis may help reinforce the structural understanding of video messages, particularly among cognitively capable individuals. This integration raises fundamental considerations about learning itself. Learning transcends factual memorization; it involves creating meaningful associations and motivating change. Incorporating emotional and cognitive dimensions into anti-fraud educational interventions thus reflects the inherent complexity of human learning processes, particularly significant for older adults who confront distinct cognitive challenges but remain deeply responsive to emotionally meaningful stimuli[17,41].

Practical implications

The implications of these findings extend directly to anti-fraud educational program design. A multimodal approach integrating video and text materials provides a comprehensive solution for meeting older adults' diverse educational needs. Video materials simplify complex concepts and effectively foster emotional engagement, particularly critical for emerging fraud threats involving advanced technologies, such as artificial intelligence[42]. Text materials, by contrast, offer structured, actionable strategies, particularly benefiting older adults with higher cognitive capabilities[43]. Combining these formats reduces cognitive load, optimizes learning outcomes, and more effectively accommodates diverse older adult populations.

Further, recent research emphasizes enhancing older adults' digital and financial literacy via personalized education tailored to individual cognitive and emotional profiles[44], community support[45], and technology-assisted tools[46]. However, increased financial literacy may paradoxically heighten fraud exposure risks[47], underscoring the need for balanced, multimodal educational approaches. Integrating these multimodal strategies into community outreach programs and digital platforms (e.g., online tutorials, mobile applications) can significantly extend their accessibility and effectiveness. Adaptive learning systems that tailor anti-fraud content to individual learners represent promising future applications, ensuring older adults effectively internalize and practically apply anti-fraud strategies.

Importantly, emotional engagement emerges as a crucial motivator for behavioral change, addressing not just cognitive but also emotional consequences of fraud victimization[48,49]. Consequently, anti-fraud educational programs should strategically integrate video and text formats through clearly structured steps—combining emotional triggers from videos with analytical and reflective elements from texts—to optimize older adults' readiness to act upon anti-fraud knowledge.

Limitations and future research directions

This study, while contributing valuable insights, contains several limitations. First, although introducing the Cognitive-Affective Synergy Model, it did not empirically validate sequential modality effects. Future research should experimentally examine how sequencing "video-first, text-following" interventions influence learning outcomes and behavioral persistence[50]. Second, sampling predominantly from urban community centers restricts generalizability. Future studies must recruit diverse socioeconomic and digital literacy populations and examine independent predictive effects of demographic variables. Third, lacking baseline measurements restricts assessment of intervention-driven changes[51], highlighting the importance of pre-test/post-test designs in future research. Fourth, evaluating only immediate post-intervention outcomes neglects long-term efficacy. Longitudinal research designs with follow-ups at three or six months can elucidate sustained cognitive and behavioral effects[52,53]. Finally, emerging technologies (virtual reality, gamification) represent exciting avenues for future studies to enhance older adult fraud education[42,54], provided these technologies are thoughtfully customized to older adults' cognitive capacities.

Conclusion

This study confirms multimedia-based interventions effectively enhance anti-fraud education for older adults. Integrating video's emotional engagement with text's structured guidance optimizes learning outcomes, accommodating diverse cognitive and emotional needs. Future anti-fraud interventions should systematically incorporate both formats, emphasizing tailored educational experiences to maximize practical effectiveness.

Ethics statement

This study was reviewed and approved by the Ethics Committee of the School of Journalism and Communication, Ningxia University (Approval No. 202405201116). All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee and the 2013 revision of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their involvement in the study. Participation was voluntary, and participants were informed of their right to withdraw at any time without penalty. No deception or potentially harmful procedures were involved. All intervention materials (videos and texts) were developed by the research team and reviewed by academic experts to ensure ethical appropriateness and relevance for the elderly population.

Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request. Due to ethical restrictions involving participant confidentiality, the raw data are not publicly available."

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References

1. Nguyen, A. L. et al. Perceived types, causes, and consequences of financial exploitation: narratives from older adults. *J. Gerontol. B Psychol. Sci. Soc. Sci.* **76**, 996–1004 (2021).
2. Kemp, S. Erades pérez, N. Consumer fraud against older adults in digital society: examining victimization and its impact. *Int. J. Environ. Res. Public. Health*. **20**, 5404 (2023).
3. DeLiema, M. & Witt, P. Risk factors and impact of financial fraud on older adults and disadvantaged communities. *Innov. Aging*. **6**, 407 (2022).
4. Ebner, N. C., Pehlivanoglu, D. & Shoenfelt, A. Financial fraud and deception in aging. *Adv. Geriatr. Med. Res.* **5**, e230007 (2023).
5. Lichtenberg, P. A., Campbell, R., Hall, L. & Gross, E. Z. Context matters: financial, psychological, and relationship insecurity around personal finance is associated with financial exploitation. *Gerontologist* **60**, 1040–1049 (2020).
6. Acosta, T., Zambrano-Miranda, J. & Luján-Mora, S. Techniques for the publication of accessible multimedia content on the web. *IEEE Access.* **8**, 55300–55315 (2020).
7. Carstensen, L. L., Isaacowitz, D. M. & Charles, S. T. Taking time seriously: a theory of socioemotional selectivity. *Am. Psychol.* **54**, 165–181 (1999).
8. Carstensen, L. L. & Hershfield, H. E. Beyond stereotypes: using socioemotional selectivity theory to improve messaging to older adults. *Curr. Dir. Psychol. Sci.* **30**, 1–8 (2021).
9. Petro, N. M., Basyouni, R. & Neta, M. Positivity effect in aging: evidence for the primacy of positive responses to emotional ambiguity. *Neurobiol. Aging*. **106**, 232–240 (2021).
10. Sommers, M. S. & Dessenberger, S. The effects of aging on processing speed, inhibitory control, executive function, and working memory: an integrated account of age-cognition relations across the adult lifespan. In *Comprehensive Clinical Psychology*. 2nd edn, 40–51 (2022).
11. Sweller, J. Cognitive load theory: implications for educational design. *Cogn. Sci.* **12**, 257–285 (1988).
12. Paas, F. & Van Merrienboer, J. J. G. Cognitive-load theory: methods to manage working memory load in the learning of complex tasks. *Curr. Dir. Psychol. Sci.* **29**, 394–398 (2020).
13. Schnotz, W. & Kürschner, C. A reconsideration of cognitive load theory. *Educ. Psychol. Rev.* **19**, 469–508 (2007).
14. Sweller, J. Cognitive load theory and individual differences. *Learn. Individ Differ.* **110**, 102423 (2024).
15. Arguel, A. & Jamet, E. Using video and static pictures to improve learning of procedural contents. *J. Educ. Psychol.* **101**, 693–702. https://doi.org/10.1037/a0014703 (2009).

16. Noetel, M. et al. Multimedia design for learning: an overview of reviews with meta-meta-analysis. *Rev. Educ. Res.* **92**, 413–454 (2022).
17. Mayer, R. E. *Multimedia Learning Theory: Integrating Auditory and Visual Information* (Cambridge University Press, 2009).
18. Sharit, J. & Czaja, S. J. Overcoming older adult barriers to learning through an Understanding of perspectives on human information processing. *J. Appl. Gerontol.* **39**, 233–241 (2020).
19. Abo Foul, Y., Eitan, R., Mortillaro, M. & Aviezer, H. Perceiving dynamic emotions expressed simultaneously in the face and body minimizes perceptual differences between young and older adults. *J. Gerontol. B Psychol. Sci. Soc. Sci.* **77**, 84–93 (2022).
20. Ford, J. H., Daley, R. T. & Kensinger, E. A. The benefits of socioemotional learning strategies and video formats for older digital immigrants learning a novel smartphone application. *Front. Aging.* **5**, 1416139 (2024).
21. Zebrowitz, L. A. & Montepare, J. M. Social psychological face perception: why appearance matters. *Soc. Pers. Psychol. Compass.* **2**, 1497–1517 (2008).
22. Ouwehand, K., Van Gog, T. & Paas, F. Effects of gestures on older adults' learning from video-based models. *Appl. Cogn. Psychol.* **29**, 115–128 (2015).
23. Rühlemann, C. How is emotional resonance achieved in storytellings of sadness/distress? *Front. Psychol.* **13**, 952119 (2022).
24. Schrock, D., Holden, D. & Reid, L. Creating emotional resonance: interpersonal emotion work and motivational framing in a transgender community. *Soc. Probl.* **51**, 61–81 (2004).
25. Singh, A. et al. Deep learning-based predictions of older adults' adherence to cognitive training to support training efficacy. *Front. Psychol.* **13**, 980778 (2022).
26. Goodman, C. & Lambert, K. Scoping review of the preferences of older adults for patient education materials. *Patient Educ. Couns.* **108**, 107591 (2023).
27. Ferraz, L. T. et al. Design considerations for the migration from paper to screen-based media in current health education for older adults: a scoping review. *BMJ Open.* **14**, e078647 (2024).
28. Faul, F., Erdfelder, E., Lang, A. G. & Buchner, A. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav. Res. Methods*. **39**, 175–191 (2007).
29. Walthouwer, M. J. L., Oenema, A., Lechner, L. & de Vries, H. Use and effectiveness of a video- and text-driven web-based computer-tailored intervention: randomized controlled trial. *J. Med. Internet Res.* **17**, e222 (2015).
30. Soetens, K. C., Vandelanotte, C., de Vries, H. & Mummery, K. W. Using online computer tailoring to promote physical activity: a randomized trial of text, video, and combined intervention delivery modes. *J. Health Commun.* **19**, 1377–1392 (2014).
31. Lusardi, A. & Mitchell, O. S. The economic importance of financial literacy: theory and evidence. *J. Econ. Lit.* **52**, 5–44 (2014).
32. Nunnally, J. C. An overview of psychological measurement. In *Clinical Diagnosis of Mental Disorders: A Handbook* 97–146 (Springer, 1978).
33. Mao, X. & Liu, Y. Relationship between socioeconomic conditions and financial fraud victimization among older adults in china: do financial literacy and financial attitudes matter? *Res. Aging*. **45**, 503–516 (2023).
34. Li, Y., Cao, Y., Wu, Y. & Mi, H. Risk factors for financial fraud among older chinese: an analysis based on CHARLS data. *Innov. Aging*. **8** (Suppl. 1), 429 (2024).
35. Heuckmann, B. & Krueger, F. Approaching the risk perception gap: effects of a subject matter knowledge-based intervention in a health context. *J. Biol. Educ.* **57**, 1006–1021 (2023).
36. Burke, J., Kieffer, C., Mottola, G. & Perez-Arce, F. Can educational interventions reduce susceptibility to financial fraud? *J. Econ. Behav. Organ.* **198**, 250–266 (2022).
37. Gallistl, V., Rohner, R., Seifert, A. & Wanka, A. Configuring the older non-user: between research, policy and practice of digital exclusion. *Soc. Incl.* **8**, 233–243 (2020).
38. Gomez-Hernandez, M., Adrian, S. W., Ferre, X. & Villalba-Mora, E. Implicit, explicit, and structural barriers and facilitators for information and communication technology access in older adults. *Front. Psychol.* **13**, 874025 (2022).
39. Wang, X. & Luan, W. Research progress on digital health literacy of older adults: a scoping review. *Front. Public. Health*. **10**, 906089 (2022).
40. Jun, W. A study on the current status and improvement of the digital divide among older people in Korea. *Int. J. Environ. Res. Public Health* **17**, 3917 (2020).
41. Mayer, R. E. The past, present, and future of the cognitive theory of multimedia learning. *Educ. Psychol. Rev.* **36**, 8 (2024).
42. Herrera, L. D., Van Sickle, L. & Podhradsky, A. Bridging the protection gap: innovative approaches to shield older adults from AI-enhanced scams. Preprint at https://arxiv.org/abs/2409.18249 (2024).
43. Albayram, Y., Liu, J. & Cangonj, S. Comparing the effectiveness of text-based and video-based delivery in motivating users to adopt a password manager. In *Proc. Eur. Symp. Usable Secur*. 89–104 (2021).
44. Schirmer, M., Dalko, K., Stoevesandt, D., Paulicke, D. & Jahn, P. Educational concepts of digital competence development for older adults—a scoping review. *Int. J. Environ. Res. Public. Health*. **20**, 6269 (2023).
45. Henning-Smith, C. Strategies for promoting successful aging and well-being. *J. Appl. Gerontol.* **39**, 231–232 (2020).
46. Dong, Q., Liu, T., Liu, R., Yang, H. & Liu, C. Effectiveness of digital health literacy interventions in older adults: single-arm meta-analysis. *J. Med. Internet Res.* **25**, e48166 (2023).
47. Yu, S. J., Kuo, C. T. & Tseng, Y. C. Association of financial literacy and risk preference with fraud exposure and victimization among middle-aged and older adults in China. *J. Appl. Gerontol.* **42**, 89–98 (2022).
48. Button, M., Lewis, C. & Tapley, J. Not a victimless crime: the impact of fraud on individual victims and their families. *Secur. J.* **27**, 36–54 (2014).
49. Deliema, M., Deevy, M., Lusardi, A. & Mitchell, O. S. Financial fraud among older americans: evidence and implications. *J. Gerontol. B Psychol. Sci. Soc. Sci.* **75**, 861–868 (2020).
50. Nguyen, M. H. et al. Tailoring the mode of information presentation: effects on younger and older adults' attention and recall of online information. *Hum. Commun. Res.* **43**, 102–126 (2017).
51. Skvarc, D. R. & Fuller-Tyszkiewicz, M. Calculating repeated-measures meta-analytic effects for continuous outcomes: a tutorial on pretest–posttest-controlled designs. *Adv. Methods Pract. Psychol. Sci.* **7**, 25152459231217238 (2024).
52. Christensen, K., Doblhammer, G., Rau, R. & Vaupel, J. W. Ageing populations: the challenges ahead. *Lancet* **374**, 1196–1208 (2009).
53. McQuail, J. A. et al. Cognitive reserve in model systems for mechanistic discovery: the importance of longitudinal studies. *Front. Aging Neurosci.* **12**, 607685 (2021).
54. Zhao, S., Kang, C., Cheng, J. & Yu, K. A design approach of education for the seniors supported by digital technology. *In Envisioning the Future of Education Through Design* 365–383 (Springer, Singapore, 2024).

Author contributions

Yan-Bang Zhou* conceived the study, designed the experiment, and led the manuscript writing. Ya-Ru Bu contributed to data analysis, statistical interpretation, and critical manuscript revisions. Hong-Jin Zhao assisted with manuscript drafting and was responsible for data collection and participant coordination. Qing Bao* provided overall project supervision, and contributed to the conceptual framework and manuscript refinement. All authors reviewed and approved the final version of the manuscript.

Declarations

Competing interests
The authors declare no competing interests.

Conflict of interest
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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