

## CONTRIBUTED PAPER

# Behavioral interventions to reduce demand for threatened freshwater turtles as pets

Wuji Zheng<sup>1</sup> | Beilu Duan<sup>1</sup> | Anita Kar Yan Wan<sup>1</sup> | Alexander Clark<sup>2</sup> | Toby Park<sup>2</sup> |  
 Kristina Londakova<sup>2</sup> | Freddy Parker<sup>2</sup> | Xiaoxi Zhang<sup>3</sup> | Lishu Li<sup>3</sup> | Tien Ming Lee<sup>1,4,5</sup> 

<sup>1</sup>School of Life Sciences and State Key Laboratory of Biological Control, Sun Yat-sen University, Guangzhou, China

<sup>2</sup>Behavioural Insights Team, London, UK

<sup>3</sup>China Representative Office, Wildlife Conservation Society, Beijing, China

<sup>4</sup>School of Ecology, Sun Yat-sen University, Shenzhen, China

<sup>5</sup>Oxford Martin School, University of Oxford, Oxford, UK

## Correspondence

Wuji Zheng and Tien Ming Lee, School of Life Sciences and State Key Laboratory of Biological Control, Sun Yat-sen University, Guangzhou 510275, China. Email: zhengwj58@mail2.sysu.edu.cn and lectm@mail.sysu.edu.cn

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## Abstract

Growing demand for freshwater turtles as pets has fueled illegal trade and accelerated wild population declines, underscoring the need for theory-based demand-reduction interventions. We conducted a three-part randomized controlled trial with active turtle keepers ( $n = 1800$ ) in China to test conservation- and legality-framed messages by comparing purchase intention before and after the intervention between treatment and control groups for two globally threatened species: Indochinese box turtle (*Cuora galbinifrons*) and the big-headed turtle (*Platysternon megacephalum*). Drawing on an extended theory of planned behavior (TPB), we modeled frame-specific claim agreement, attitudes, subjective norms, perceived behavioral control, and perceived self-efficacy with structural equation models. Conservation and legality messages significantly reduced purchase intention relative to a no-message control (mean declines of 0.37–0.84 points on a 5-point scale across treatment arms) primarily through indirect psychological pathways. Conservation messages heightened harm-based evaluations and moral concern, whereas legality messages strengthened illegality appraisals and deterrence-related cognitions. Across models, claim agreement was a key proximal antecedent, subjective norms consistently predicted lower self-efficacy, and self-efficacy emerged as the most proximal positive predictor of intention. Perceived behavioral control showed no direct effect. Species-specific differences in pathways, suggestive of reactance in the big-headed turtle conservation model, reflected variation in legal signals and market narratives. Our findings highlight the importance of claim agreement, injunctive norms, and species context in shaping intervention outcomes. Demand-reduction campaigns may be more effective when tailored to species-specific legal and market conditions and when normative cues are paired with feasible alternatives and practical guidance that makes compliance achievable.

## KEYWORDS

demand reduction, effectiveness evaluation, endangered species, exotic pet trade, illegal wildlife trade, randomized controlled trial

## INTRODUCTION

The global wildlife trade, both legal and illegal, poses a significant threat to biodiversity, with many species facing extinction due to such unsustainable exploitation (Nijman, 2010). Among these, the freshwater turtle trade has gained increasing atten-

tion from conservationists, especially in East and Southeast Asia, where turtles are highly prized as food, pets, and traditional medicine (Gong et al., 2009). In China, strong consumer demand for rare and exotic turtles has significantly contributed to illegal trade, resulting in dramatic population declines in the wild (Fong et al., 2021; Li et al., 2020; Stanford et al., 2021).

Wuji Zheng and Beilu Duan contributed equally to this work.

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Despite international regulations and national laws aimed at curbing the illegal trade, enforcement remains challenging due to the clandestine nature of illegal trade and high economic incentives for poachers and traders (Challender & MacMillan, 2014). Consequently, conservation efforts have increasingly focused on reducing consumer demand as a key strategy to mitigate pressure on wild populations (Challender et al., 2015; Zheng et al., 2024).

Recent reviews highlight that many demand-reduction initiatives for illegal wildlife trade (IWT) lack systematic evaluation, theory-driven design, and species-specific tailoring (Greenfield & Verissimo, 2019; MacFarlane et al., 2022). At the same time, an emerging body of empirical work has begun to test message framing and other psychologically informed approaches in wildlife trade contexts, including studies on exotic pets and other wildlife products (Doughty et al., 2021; Moorhouse et al., 2017; Naito et al., 2024; Rizzolo, 2021; TRAFFIC & BIT, 2018). Building on broader work on conservation message framing (Kidd et al., 2019), scholars argue that demand reduction should move from descriptive campaigns to interventions grounded in behavioral science and evaluated through robust experimental methods (Burgess et al., 2018; Verissimo & Wan, 2019). Relative to this growing literature, fewer researchers have jointly compared conservation- and legality-framed messages while explicitly modeling the psychological pathways through which such messages may influence demand for threatened exotic pets across species.

Understanding consumer behavior is critical for designing effective interventions, particularly involving illegal or unsustainable wildlife trade (Burgess et al., 2018; Phelps et al., 2016). The theory of planned behavior (TPB) provides a robust framework for predicting purchasing intentions and behavior, emphasizing the roles of attitudes (e.g., beliefs about ecological harm or legal consequences), subjective norms (i.e., perceived social approval or disapproval), and perceived behavioral control (PBC), which is influenced by external constraints, such as market availability or regulatory clarity (Ajzen, 1991). In the original TPB, PBC captures perceived control over performing a behavior, but it is argued that PBC comprises partially separable controllability and self-efficacy components, which may be analytically distinguished when behaviors depend on both external constraints and internal capability (Ajzen, 2002; Bandura, 1997; Terry & O'Leary, 1995).

In the context of threatened pet turtle purchasing and keeping, we expected this distinction to be substantively relevant. Consumers may perceive external barriers to lawful purchase, such as difficulty finding compliant sellers or verifying whether animals are second generation captive bred, and hold beliefs about their own capability to keep and care for these turtles (e.g., skills, financial resources, time, and attention). We therefore extended the TPB by modeling perceived self-efficacy alongside PBC as a distinct but related construct. PBC primarily reflects perceived external controllability or informational constraints, whereas self-efficacy captures internal capability and competence (i.e., one's belief in being able to perform the behavior successfully despite social or structural barriers) (Bandura, 1997). We hypothesized that subjective norms can indirectly

influence intention by shaping perceived self-efficacy, such that social disapproval or peer pressure may diminish individuals' confidence in acting against group expectations via social persuasion and appraisal mechanisms (Ajzen, 2002; Bandura, 1997; Schwarzer & Renner, 2000). Such an indirect pathway is consistent with social identity and compliance research that shows that group norms and in-group influence alter internal states relevant to control (e.g., efficacy), which in turn shape subsequent intentions (Terry & Hogg, 1996; White et al., 2009).

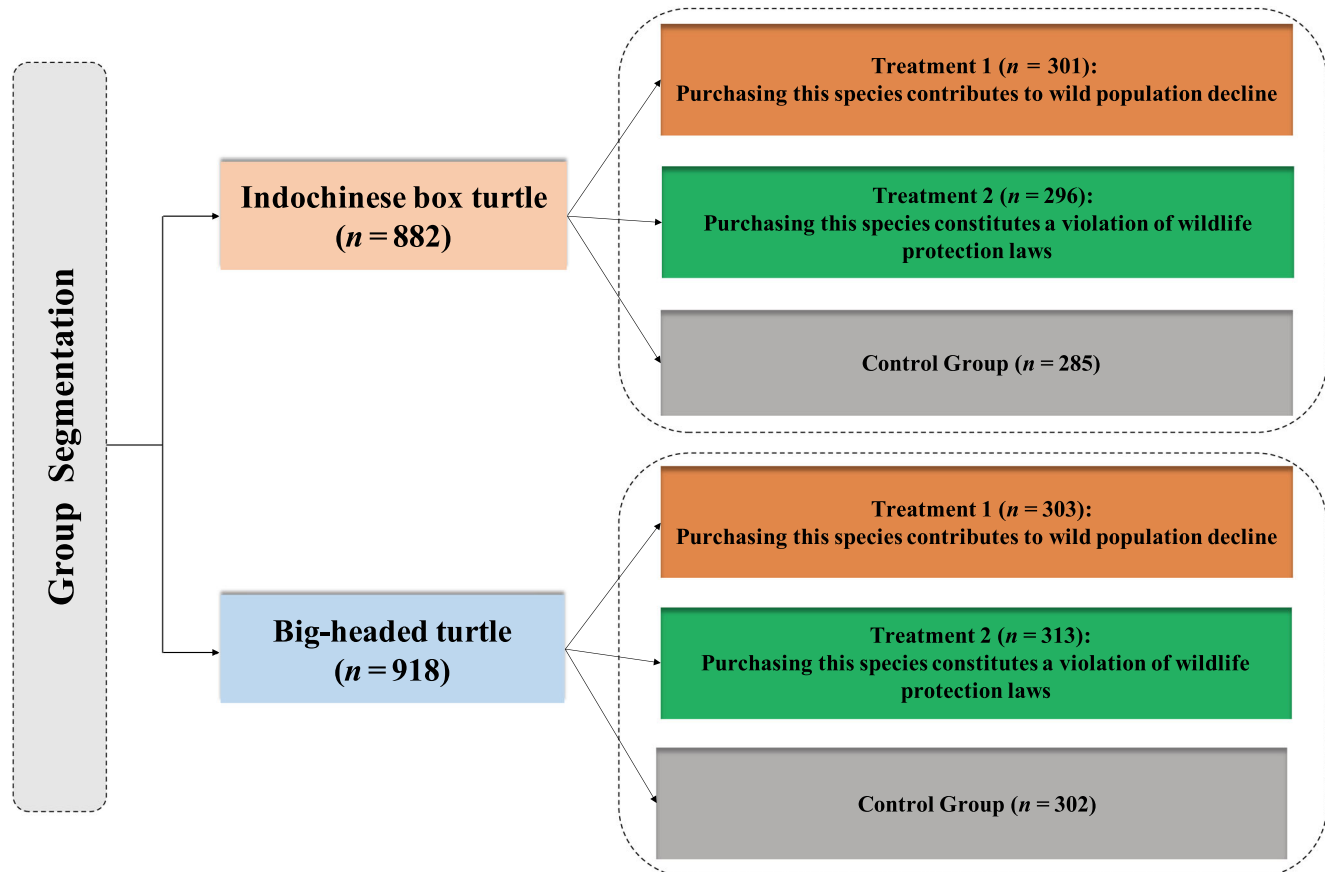
Empirical evidence shows that message framing (i.e., how information is presented) can strongly shape behavioral responses in IWT contexts. Legality-framed messages may activate deterrence and normative pressure through perceived sanctions, whereas conservation-framed messages can elicit empathy and moral responsibility (Kidd et al., 2019; MacFarlane et al., 2022; Verissimo & Wan, 2019). These framing effects align with findings from broader behavioral science suggesting that effective interventions must be contextually grounded and psychologically salient (Thomas-Walters et al., 2020; Wallen & Daut, 2017). We evaluated the effectiveness of two targeted intervention messages, one conservation oriented and the other emphasizing legal risk in reducing consumers' purchase intention for two globally threatened freshwater turtle species: the Indochinese box turtle (*Cuora galbinifrons*) (ICB) and the big-headed turtle (*Platysternon megacephalum*) (BH). Although consumers' behavioral intentions are often shaped by psychological constructs, such as attitudes, subjective norms, PBC, and self-efficacy, agreement with frame-specific claims can serve as a cognitive precursor to these responses (Bamberg & Möser, 2007; Cialdini, 2003). Accordingly, we conceptualized frame-specific claim agreement as an antecedent variable influencing these psychological predictors.

Using a three-part randomized controlled trial (RCT) for each species, we tested how message framing altered purchase intentions among active pet turtle keepers. To elucidate the psychological mechanisms underlying intervention effectiveness, we employed structural equation models (SEMs), extending the TPB to include frame-specific claim agreement (hereafter, claim agreement) and self-efficacy. Moreover, given that prior familiarity with a species may influence the salience and perceived credibility of intervention messages and responses to social or normative pressures (Hong & Sternthal, 2010), we also conducted subgroup analyses to examine whether intervention pathways differed by species familiarity. With these analyses, we sought to provide a theory-driven and empirically grounded evaluation of message framing as a behavioral intervention tool and, thereby, to contribute to the understanding of conservation strategies and inform policymaking aimed at reducing the illegal trade of endangered freshwater pet turtles.

## METHODS

### Study design and target statements

Using an RCT, we evaluated the effectiveness of different intervention messages in reducing purchase intention for ICB



**FIGURE 1** Design of the randomized controlled trials (RCTs) on intention of participants to purchase Indochinese box turtle (ICB) or big-headed turtle (BH) under conservation-oriented messaging (Treatment 1), legal-risk warning messaging (Treatment 2), or no message treatment (control). Measures collected after the intervention included frame-specific claim agreement, attitudes, injunctive norms (perceived social disapproval), perceived behavioral control, and perceived self-efficacy (Appendix S1).

and BH (Figure 1). These species were selected due to their conservation status, their salience among pet turtle keepers and within the pet turtle trade, and differing levels of success in artificial breeding efforts within China (Zheng et al., 2024). To investigate the mechanisms underlying the effectiveness of our intervention messages, we constructed SEMs to examine the relationships between the independent variables derived from extended TPB components, including attitudes, subjective norms (referring to perceived social disapproval), PBC, and perceived self-efficacy, and the dependent variable (postintervention intention). We examined whether conservation-oriented and legal-risk warning messaging independently reduce the intention of consumers to purchase the target turtles and the mechanisms and pathways through which these intervention messages affect consumer purchase intentions.

## Messaging types

The intervention messages were crafted through prior formative research combining quantitative surveys, qualitative

interviews, consumer journey mapping, and focus group discussions to identify target audiences, salient barriers, feasible intervention content, and delivery formats incorporating inputs from pet turtle keepers, freshwater turtle and tortoise experts, and breeders (for detailed methodology, see Zheng et al. [2024]). Two message framings were tested. First, the conservation-oriented message emphasized that artificial breeding techniques remain technically immature and highlighted their negative consequences for wild populations, highlighting that current breeding still relies heavily on wild-caught founders and therefore purchasing contributes to further population decline. This framing aimed to evoke compassion and moral responsibility. Second, the legal-risk warning message, in contrast, explicitly communicated that under the Wildlife Protection Law of the People's Republic of China, first-generation captive-bred individuals (F1) are legally defined as wild and therefore their trade remains prohibited even when it is claimed they are captive bred. This framing focused on regulatory boundaries and potential penalties to activate deterrence and normative pressure.

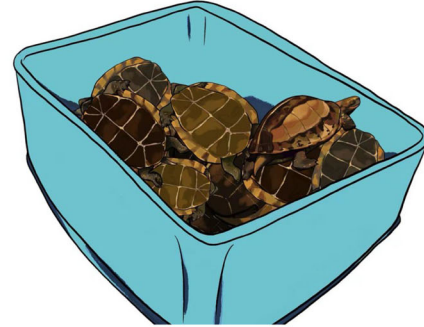
Both messages contained realistic images and were followed by the same set of interactive questions (Figure 2; Appendix S2). For the control group, respondents did not view any

(a)

The Indochinese Box turtles (ICB) market predominantly rely on wild capture.



Mortality rates during capture and transportation exceed 90%!  
(require the extraction of over 100 individuals to sustain just 10 survivors)



**Purchasing ICBs perpetuates unnecessary harm and endangered wild population.**

**We strongly urge consumers to avoid purchasing ICBs as pets.**



Consumers are encouraged to refer to the “List of Aquatic Wild Animals under National Key Protection for Artificial Breeding” to select turtle species with mature and sustainable artificial breeding practices.

(b)

The artificial breeding techniques for the Indochinese Box Turtle (ICB) remain underdeveloped.



Currently available individuals in the market are all first-generation offspring (F1).

According to the Wildlife Protection Act, F1 individuals of ICB are still classified as wild!



**Purchasing ICBs constitutes a violation of wildlife protection laws.**

**We strongly urge consumers to avoid purchasing ICBs as pets.**



Consumers are encouraged to refer to the “List of Aquatic Wild Animals under National Key Protection for Artificial Breeding” to select turtle species with mature and sustainable artificial breeding practices.

**FIGURE 2** Example intervention messages for Indochinese box turtle (*C. galbinifrons*) in a randomized controlled trial testing the efficacy of messages related to purchase intention: (a) conservation-oriented message (emphasis on limited success of artificial breeding and continued reliance on wild-caught founders) and (b) legal-risk warning message (under China’s Wildlife Protection Law, first-generation captive-bred individuals are legally classified as wild and their trade is prohibited, whereas second-generation individuals qualify as captive bred). Both messages were followed by identical interactive questions. Equivalent materials for big-headed turtle and the original Chinese-language versions are in Appendix S2.

intervention messages, but they completed the same interactive questions as the treatment groups. This ensured equivalent engagement across groups and provided a true baseline condition without message exposure. Given that the experimental objective was to compare how different framings (conservation vs. legality) influence behavioral intentions, rather than to test the general effect of message exposure, a no-message control was most appropriate.

## Sampling and data collection

A priori power analysis (G\*Power software 3.1) indicated we should have a minimum of 157 participants per group (power = 0.8,  $\alpha = 0.05$ ). The survey was tested from June to August 2023 and officially conducted from 20 to 30 September 2023. Respondents were recruited from WeChat interest groups comprising more than 2000 turtle keepers. These interest groups represented the primary consumer group most relevant for demand-reduction interventions. Recruiting from these online turtle-keeping communities ensured access to individuals who were directly involved in the target behavior and therefore most likely to be influenced by framing messages. Although most participants were active turtle keepers recruited from hobbyist groups, the experiment focused on their future purchase intentions, reflecting continued demand and potential social influence within hobbyist networks.

Data were collected using the online survey platform Wen Juan Xing (WJX, <https://www.wjx.cn/>). In total, we received 2729 survey submissions. After applying exclusion criteria (i.e., under the age of 18, incomplete responses, failed attention test, exhibited logical inconsistencies), 1800 valid responses were retained for analyses, of which 882 and 918 were assigned to the ICB and BH questionnaires, respectively. Prior ownership of the target species was rare (ICB <10% and BH <5%), aligning with our focus on prospective purchasing among hobbyists rather than current owners. Ownership was not part of the hypothesized mechanism and was not included in primary models. To examine whether intervention pathways differed by species familiarity, participants were further categorized as familiar or unfamiliar with the target species. Species familiarity was operationalized as correctly identifying the species from a photo and accurately reporting more than one ecological trait. Respondents meeting both criteria were coded as *familiar*; otherwise, they were coded as *unfamiliar*. Our research protocol was reviewed by the Wildlife Conservation Society Institutional Review Board (IRB 23–38 RN, 23–52 RN).

## Measures

We measured the extended TPB constructs with 5-point Likert items (1 = *strongly disagree* to 5 = *strongly agree*). Item wordings and scoring are in Appendix S1, and psychometrics (factor loadings, Cronbach's  $\alpha$ , composite reliability, and average variance extracted) are reported in Appendix S3. For SEM analyses, latent constructs were estimated directly from their item indica-

tors rather than from preaveraged composite scores. Descriptive summaries are presented at the item or construct level.

Purchase intention was measured with a single item that indicated willingness to purchase ICB or BH as pets in the future, and it was measured before and after the intervention. Frame-specific claim agreement was measured with frame-specific items. Conservation-claim agreement was measured with three items (conservation models [full wording in Appendix S1]) and captured cognitive endorsement of claims about immature artificial breeding and continued reliance on wild populations (e.g., "I think the artificial breeding technique for ICB or BH is still immature." and "I think the F1 of ICB or BH still rely on wild populations to breed."). Legal-claim agreement was measured with four items (legality models [full wording in Appendix S1]) and captured cognitive endorsement of breeding- and legality-related claims, including the legal status of F1 individuals (e.g., "I think the ICB or BH in the market are all from wild-caught individuals." and "I think the ICB or BH seedlings in the market are all F1 individuals."). We use *agreement* to denote agreement with the substantive claims embedded in each frame, rather than overall approval of the intervention message.

Attitudes were measured as two subdimensions. Harm-based attitude was measured with three items (conservation models [full wording in Appendix S1]); captured cognitive and moral evaluation that purchasing harms wild populations and is inappropriate; and included an affective component stemming from guilt (e.g., "Buying ICB or BH will harm its wild populations." and "I would feel guilty purchasing ICB or BH."). Illegality attitude was measured with three items (legality models [full wording in Appendix S1]) and captured appraisal of illegal transgression and its consequences (e.g., "It makes me feel scared if I purchase ICB or BH as pets." and "Buying ICB or BH as pets will violate the law."). Subjective norms were measured with three items that operationalized injunctive norms, defined here as perceived social disapproval from family members, friends, and respected senior turtle keepers regarding purchasing ICB or BH as pets. PBC was measured with two items that captured perceived external and informational constraints on lawful purchase, including difficulty finding compliant sellers and difficulty verifying whether animals were second generation ("It is difficult to find compliant sellers." and "It is difficult to verify the second-generation offspring."). Perceived self-efficacy was measured with three items that indicated internal confidence in being able to keep and care for ICB or BH, including perceived adequacy of skills, financial resources, time, and attention.

## Data analyses

We used chi-square tests to assess the distribution of demographic variables across six treatment groups and analysis of variance (ANOVA) with Tukey's honestly significant difference (HSD) to test group differences in purchase intention before and after the intervention and differences in target turtle exposure and knowledge. We used Wilcoxon signed-rank tests to compare within-group changes in purchase intention before and after the intervention. All tests were two-tailed with  $\alpha = 0.05$ .

For ICB only, where purchase intention before the intervention differed modestly across parts, we ran an analysis of covariance (ANCOVA) (intention after the intervention  $\sim$  group + intention before the intervention) and reported adjusted contrasts (Tukey), 95% confidence intervals, and partial  $\eta^2$  as a sensitivity check. For BH, no ANCOVA was required because purchase intention before the intervention did not differ across parts.

SEMs were used to test direct (e.g., the effect of the intervention on purchase intention) and indirect effects operating through hypothesized psychological pathways. All SEMs were fitted using item-level indicators to define latent constructs. We treated the 5-point Likert items as approximately continuous and estimated models with robust maximum likelihood (MLR) and full-information maximum likelihood (FIML) for missing data. Robust (Huber–White) standard errors and Yuan–Bentler-scaled  $\chi^2$  statistics are reported. Confirmatory factor analysis (CFA) was conducted to ensure construct validity and reliability (Appendix S3). Discriminant validity between PBC and self-efficacy was assessed by comparing a two-factor solution against a one-factor alternative, testing a constrained model fixing the latent correlation to 1, and estimating the heterotrait–monotrait (HTMT) ratio with 5000 bootstrap confidence intervals (Brown, 2015; Henseler et al., 2014; Kline, 2016). All statistics are reported in Appendix S4. Indirect effects were evaluated using bias-corrected bootstrap confidence intervals (5000 resamples). The SEMs were fitted in R 4.2.0 with the package lavaan (R Core Team, 2022; Rosseel, 2012).

For each species, we fitted two part-specific SEMs (T1 vs. control, T2 vs. control), with the treatment coded 1 and control 0. Main effects were summarized separately by species, whereas SEMs were estimated by species and part because attitude constructs differ by frame (harm focused vs. legality focused) and mechanisms were hypothesized to vary accordingly.

For ICB, education was included as a covariate in SEMs due to a baseline imbalance between the control and legality-focused groups (Appendix S5). We specified an initial theory-informed model including plausible paths from intervention to psychological constructs (frame-specific claim agreement, attitudes, subjective norms, PBC, and self-efficacy), with self-efficacy specified as a mediator from subjective norms to postintervention. Model simplification was then limited to the removal of nonsignificant paths, and final models were selected based on parsimony ( $\Delta\text{AIC} < 2$ ) and theoretical coherence (Appendix S6). Across the four species- and part-specific SEMs (58–68 free parameters,  $df = 92\text{--}152$ ), the case-to-parameter ratio was 8.67–10.43 ( $n = 581\text{--}615$ ), and cases per indicator were 38.7–43.2, meeting common recommendations for model identification and parameter stability.

Multigroup measurement invariance (familiar vs. unfamiliar with the target species) was assessed at configural, metric, and scalar levels with robust Satorra–Bentler  $\chi^2$  difference tests and  $\Delta\text{CFI}$  ( $\leq 0.010$ ) and  $\Delta\text{RMSEA}$  ( $\leq 0.015$ ) decision rules. When supported, structural paths were compared across groups (Appendix S7). As a robustness check for baseline intention, we added intention before the intervention as a covariate, which

predicted intention after the intervention in the two ICB SEMs (Appendix S8).

## RESULTS

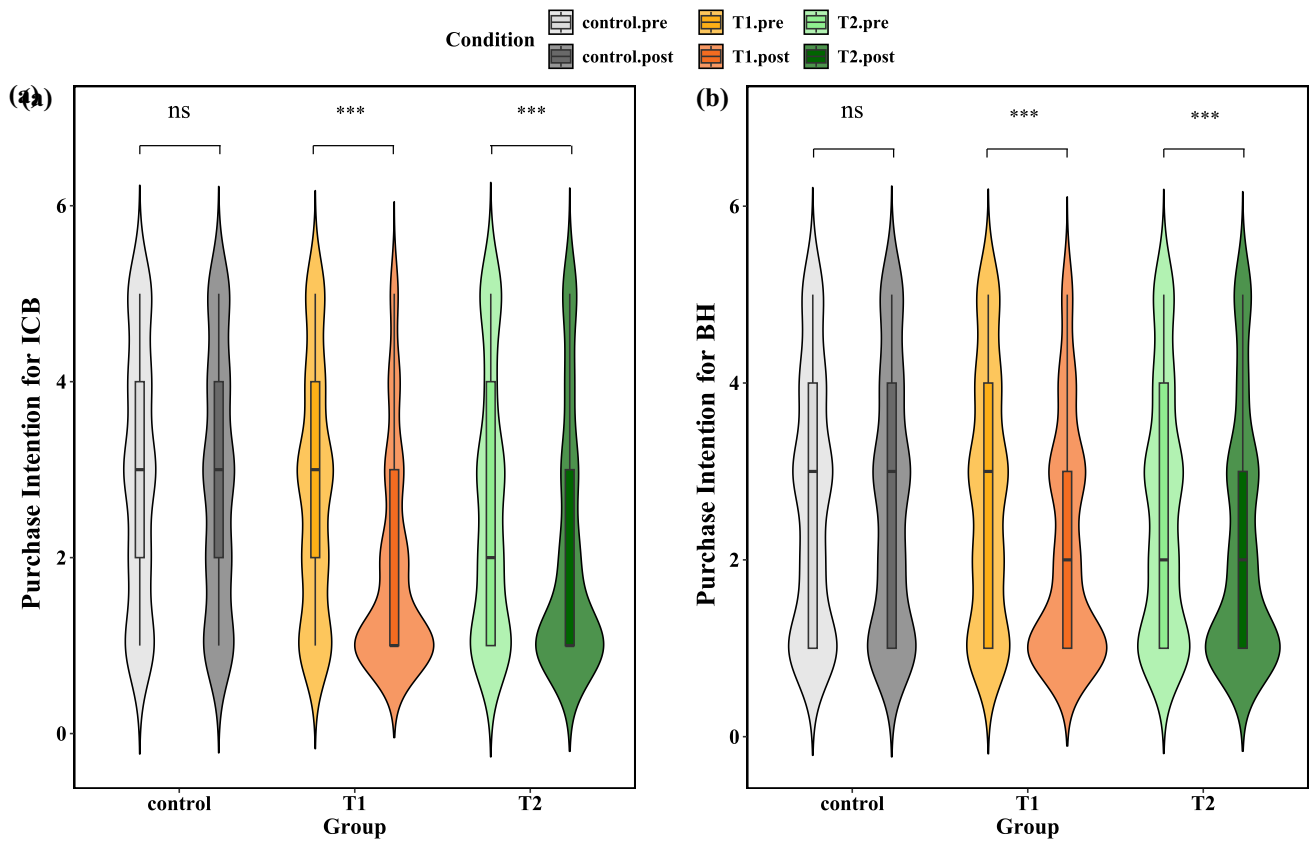
Participant demographics, with the exception of education, were generally balanced across groups (Appendix S5). There were no significant differences among groups in participants' baseline exposure to turtle keeping or their understanding of breeding practices and legality issues (Appendix S9), further supporting the internal validity of the experimental design. Both intervention groups (for both ICB and BH) showed significant declines in purchase intention after the intervention, whereas the control groups did not (Figure 3). Across the four treatment parts, mean intention declined by 0.37–0.84 points on the 5-point scale, with only minimal change in the control groups. Baseline balance checks showed no group difference in purchase intention before the intervention for BH (ANOVA,  $p > 0.30$ ). For ICB, purchase intention before the intervention differed modestly by group (ANOVA,  $p = 0.014$ ). Sensitivity ANCOVA adjusting for purchase intention before the intervention confirmed that both interventions yielded lower adjusted purchase intention after the intervention than the control (Treatment 1 vs. control:  $\beta = -0.824$  [SE 0.080],  $p < 0.001$ ; Treatment 2 vs. control:  $\beta = -0.562$  [0.081],  $p < 0.001$ ) (Appendix S10). Thus, the main conclusion that both messages reduce purchase intention remained unchanged after controlling for baseline intention. Consistent with this pattern, postintervention group differences were significant in both species, with both intervention groups scoring lower than the control group and no difference between two treatment groups (Appendix S11).

In terms of psychological outcomes, participants in the intervention groups reported significantly higher claim agreement, stronger negative attitudes toward purchasing, higher subjective norms (operationalized here as perceived social disapproval), and higher PBC (reflecting greater perceived external and informational constraints). Perceived self-efficacy for successfully keeping and caring for the target turtles was significantly lower in the intervention groups than the control groups (Figure 4; Appendix S12).

Given the observed intervention effects on behavioral intentions and psychological constructs, we employed SEM to examine the pathways through which messages influenced purchase intention. As husbandry practices, legal contexts, and audience norms differ by species, all SEMs were specified and estimated at the species level (Figure 5a–d) (full models including nonsignificant paths are provided in Appendix S13).

Across all four models, total effects of both interventions on purchase intention were significant ( $c = -0.495$  to  $-0.732$ , all  $p < 0.001$ ). In each case, the direct effects ( $c'$ ) were statistically nonsignificant ( $|\beta| < 0.20$ , all  $p > 0.15$ ), whereas indirect effects via psychological pathways were substantial ( $\beta$  indirect:  $-0.424$  to  $-0.924$ , all  $p < 0.001$ ), indicating full or near-full mediation.

Both interventions reduced purchasing intention via overlapping yet distinct psychological mechanisms. Across all four models, exposure to either the conservation- or legality-oriented



**FIGURE 3** Pre- and postintervention purchase intentions for (a) Indochinese box turtle and (b) big-headed turtle for the no-message control, conservation-oriented message (T1), and legal-risk warning message (T2) conditions (light colors, before intervention; dark colors, after intervention; violins, distribution of intention scores; center lines in bars, median; bar ends, interquartile range; whiskers, 1.5× interquartile range; horizontal brackets, within-group pre- and postcomparisons; \*\*\* $p < 0.001$ ; ns, not significant).

message significantly increased claim agreement ( $\beta = 0.449$  to  $0.520$ , all  $p < 0.001$ ). Higher claim agreement, in turn, was associated with stronger frame-consistent attitudes—harm- and guilt-based concern in the conservation models and illegality concern in the legality models. These attitudes were consistently associated with subsequent shifts in subjective norms, PBC, and self-efficacy, forming a robust attitudinal–normative pathway.

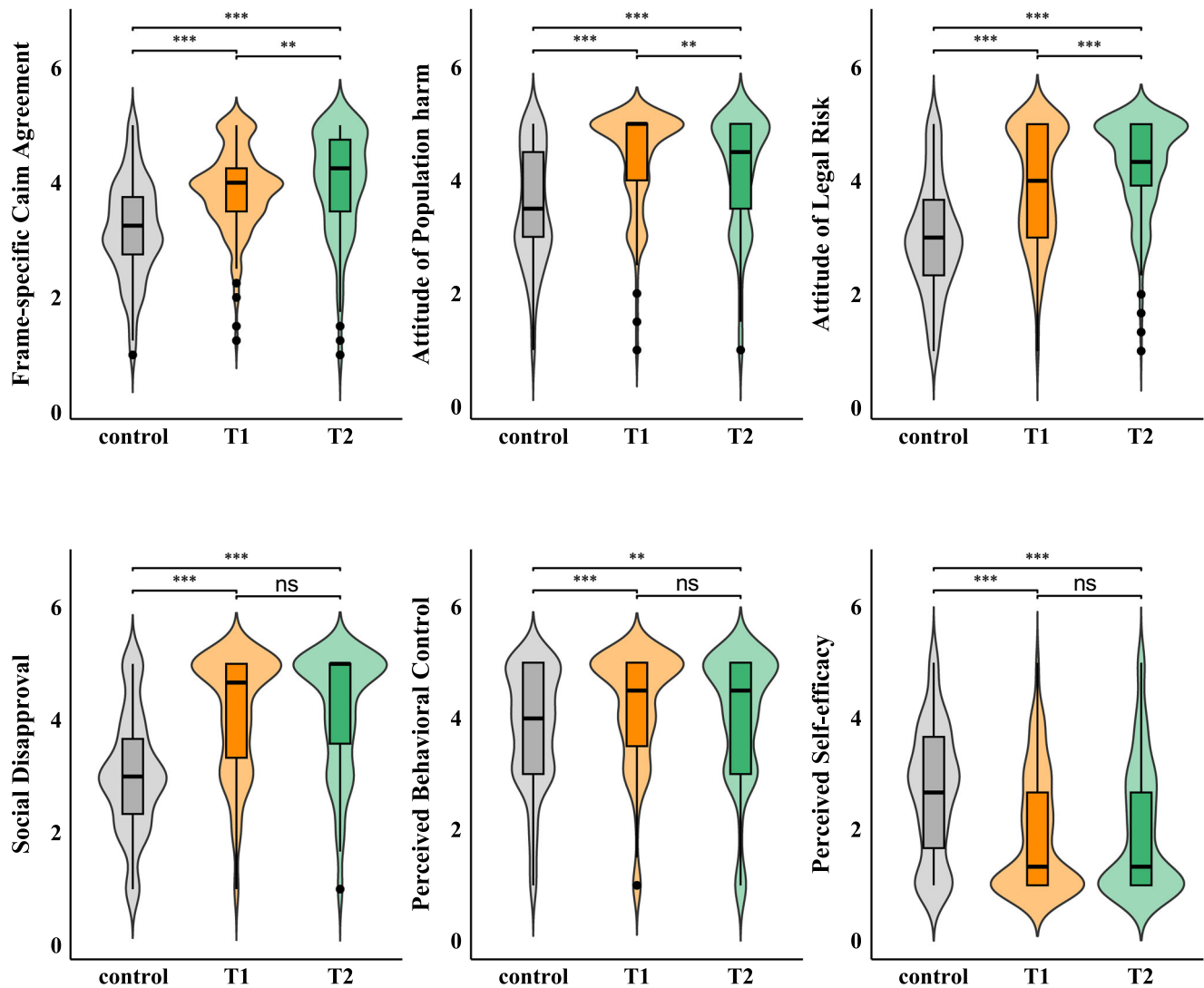
In the ICB conservation model (ICB T1) (Figure 5a), harm-based attitude ( $\beta = -0.175$ ,  $p = 0.053$ ) and subjective norms ( $\beta = -0.239$ ,  $p = 0.005$ ) directly reduced intention. Subjective norms also negatively influenced self-efficacy ( $\beta = -0.617$ ,  $p < 0.001$ ), which subsequently influenced intention ( $\beta = 0.291$ ,  $p < 0.001$ ). In the BH conservation model (BH T1) (Figure 5c), claim agreement unexpectedly reduced perceived social disapproval ( $\beta = -0.353$ ,  $p = 0.005$ ), a counterintuitive negative association. Both harm-based attitude ( $\beta = -0.234$ ,  $p < 0.001$ ) and subjective norms ( $\beta = -0.509$ ,  $p < 0.001$ ) lowered self-efficacy, which substantially predicted intention ( $\beta = 0.428$ ,  $p < 0.001$ ). In addition to this indirect pathway, injunctive norms also directly reduced intention ( $\beta = -0.181$ ,  $p < 0.01$ ).

No significant direct effects from intervention, attitude, or PBC on intention were detected. In the ICB legality model

(ICB T2) (Figure 5b), illegality-focused attitude ( $\beta = -0.234$ ,  $p = 0.004$ ) and subjective norms ( $\beta = -0.218$ ,  $p = 0.010$ ) directly reduced intention. Stronger perceived social disapproval (higher subjective norms) robustly predicted lower self-efficacy ( $\beta = -0.689$ ,  $p < 0.001$ ), which then affected intention ( $\beta = 0.314$ ,  $p < 0.001$ ). In the BH legality model (BH T2) (Figure 5d), illegality concern increased subjective norms ( $\beta = 0.473$ ,  $p < 0.001$ ) and marginally increased PBC ( $\beta = 0.122$ ,  $p = 0.054$ ) but had no significant direct effect on intention. Subjective norms directly reduced intention ( $\beta = -0.236$ ,  $p = 0.001$ ) and indirectly reduced self-efficacy ( $\beta = -0.610$ ,  $p < 0.001$ ), which substantially predicted purchase intention ( $\beta = 0.420$ ,  $p < 0.001$ ).

Across species and frames, PBC and self-efficacy were empirically separable. Two-factor models decisively outperformed one-factor alternatives, constraining the latent correlation to 1 degraded fit in all cases, and HTMT values were well below 0.85 with confidence intervals excluding 1 (Appendix S4). Across all models, PBC showed no significant direct effect, whereas self-efficacy consistently emerged as the most proximal predictor, driven primarily by subjective norms.

For measurement invariance by familiarity, factor loadings were invariant across groups, allowing meaningful comparisons of intervention effects across familiarity groups. Path coeffi-



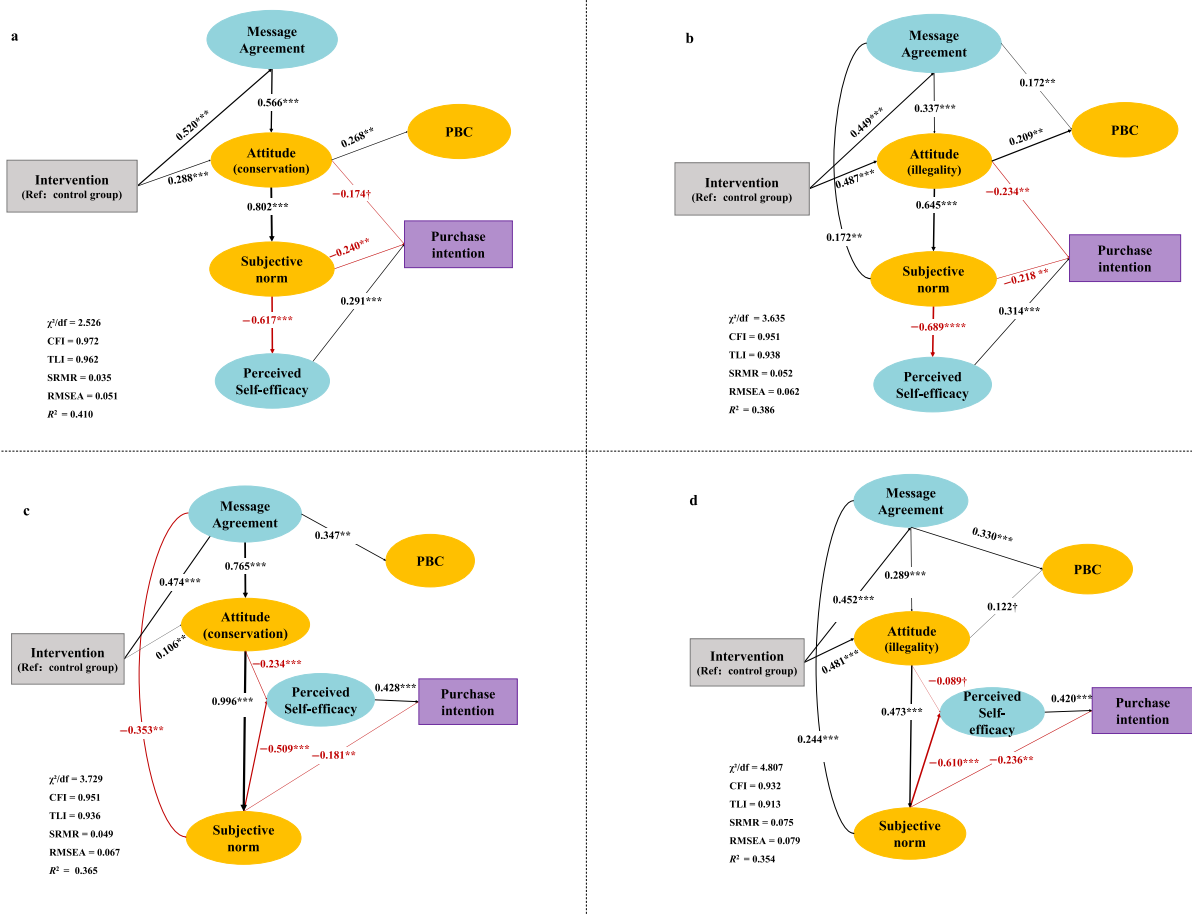
**FIGURE 4** Key outcome variables (frame-specific claim agreement, attitudes toward harm and illegality, perceived behavioral control, social disapproval, perceived self-efficacy of keeping and caring) related to intentions to purchase Indochinese box turtles for the no-message control (gray), conservation message (T1, orange), and legal-risk warning message (T2, green) (violins, distribution of construct scores; center lines in bars, median; bar ends, interquartile range; whiskers, 1.5 $\times$  interquartile range; horizontal brackets, between-group pairwise comparisons based on one-way analysis of variance with Tukey's HSD post hoc tests; \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; ns, not significant). Results for big-headed turtle are in Appendix S12.

clients were largely invariant for ICB T1 and both BH models. Constraining structural paths to equality did not degrade fit for ICB T1 ( $\chi^2 = 27.1$ ,  $df = 19$ ,  $p = 0.10$ ), BH T1 ( $\chi^2 = 12.9$ ,  $df = 14$ ,  $p = 0.54$ ), and BH T2 ( $\chi^2 = 15.8$ ,  $df = 14$ ,  $p = 0.33$ ). In contrast, ICB T2 showed a significant difference between the constrained and free models ( $\chi^2 = 33.3$ ,  $df = 20$ ,  $p = 0.031$ ). Post hoc inspection indicated that the divergence was confined to the path from claim agreement to PBC (PBC  $\sim$  agreement). The path from PBC to postintervention intention was not significant in either familiarity group, and the dominant predictive channels of intention in ICB T2, via subjective norms and self-efficacy, remained unchanged. The results of robustness analyses that had purchase intention before the intervention as a covariate were consistent with the primary models but increased  $R^2$  for intention after

the intervention (ICB T1: 0.599; ICB T2: 0.639) (Appendix S8).

## DISCUSSION

Our results showed that both conservation- and legality-oriented interventions effectively reduced consumers' purchase intention for two threatened freshwater turtles through distinct yet partially overlapping psychological mechanisms. This highlighted the role of message framing in shaping how individuals process behavioral change (Kidd et al., 2019). Across all models, claim agreement served as a crucial starting point and shaped perception of harm-based or illegality attitude, social norm, and self-efficacy. Taken together, the pattern indicated



**FIGURE 5** Structural equation models showing the psychological pathways through which conservation- and legality-oriented messages influenced purchase intention for Indochinese box turtle (ICB) and big-headed turtle (BH): (a) conservation-oriented message on ICB, (b) legal-risk warning message on ICB, (c) conservation-oriented message on BH, (d) legal-risk warning message on BH (numbers next to arrows, standardized path coefficients; solid arrows, statistically supported paths; not shown, nonsignificant estimated paths; black arrows, positive effects; red arrows, negative effects; \*\*\* $p < 0.001$ ; \*\* $p < 0.01$ ; \* $p < 0.05$ ; † $p < 0.10$ ; model fit indices: CFI, comparative fit index; TLI, Tucker–Lewis index; SRMR, standardized root mean square residual; RMSEA, root mean square error of approximation). Full models are in Appendix S13. Education was controlled as a covariate in the ICB models. Path significance was assessed using bias-corrected bootstrapping (5000 resamples).

that treatment effects were transmitted primarily through indirect psychological pathways (i.e., full or near-full mediation), with claim agreement acted as a proximal cognitive antecedent of subsequent appraisals and control beliefs (MacFarlane et al., 2022; Thomas-Walters et al., 2020).

### Differential impact of message framing

Although both frames reduced purchase intention, their effects operated through partially distinct psychological routes. The conservation frame was more closely associated with harm-based and moral evaluation, whereas the legality frame more strongly activated illegality appraisals and deterrence-related cognition. This distinction is consistent with previous work showing that conservation-oriented messages often operate by heightening perceived harm and moral concern, whereas

legality-oriented messages are more likely to work through perceived sanctions, legitimacy, and social accountability (Antonetti & Maklan, 2014; Cialdini & Goldstein, 2004; Gibbs, 1968; Moorhouse et al., 2017; Naito et al., 2024; Posner, 1997). In our models, the two frames therefore reached similar directional outcomes while remaining mechanistically nonequivalent, operating through different combinations of attitudes, subjective norms, and self-efficacy.

Across all models, self-efficacy emerged as the most proximal predictor of intention, and subjective norms were consistently linked to lower self-efficacy. This suggests that the interventions did not reduce intention simply by changing what participants thought about the messages; rather, they changed them by altering whether purchasing remained socially supportable and personally actionable. This interpretation is in line with broader behavior-change research showing that attitudes and awareness often have limited effects unless they are translated into stronger

normative expectations and changed efficacy beliefs (Ajzen, 1991; Bamberg & Möser, 2007; Bandura, 1978; Michie et al., 2011; Sheeran, 2002; Webb & Sheeran, 2006). In this sense, agreement with frame-specific claims was necessary but not sufficient. Information appeared to matter most when it was internalized in ways that increased perceived social disapproval and undermined confidence in carrying out the behavior. By contrast, PBC did not directly predict postintervention intention in any model. Although species familiarity moderated the path from claim agreement to PBC in the ICB legality model, this moderation did not carry through to intention because PBC itself was not a significant predictor of intention. Taken together, these findings reinforce the distinction between external control constraints and internal efficacy beliefs, and suggest that cognition-level shifts in perceived control are unlikely to alter motivation unless they are translated into stronger efficacy- or norm-related consequences (Ajzen, 2002; Bandura, 1997).

### Species-specific differences in intervention effectiveness

Notable species-specific divergences emerged in how participants responded to the same message, likely reflecting differences in market situation, perceived legality, and consumer narratives surrounding the focal species. For BH, claim agreement was unexpectedly associated with lower subjective norms (Figure 5c), a pattern consistent with a potential reactance effect (Brehm & Brehm, 1981) or cognitive dissonance (Festinger, 1957, 1962), where accepting the harm-related content conflicted with prevailing community norms or perceived legitimacy of keeping BH turtles as pets. One plausible interpretation of this is that some respondents accepted the conservation-related claims at a cognitive level but did not translate this into stronger perceptions of social disapproval because those claims sat uneasily with preexisting beliefs about the acceptability of keeping BH turtles. This may stem from the sociolegal ambiguity surrounding BH turtles. Despite their threatened status, they are often smuggled and laundered as captive-bred individuals and may circulate in trade with signals of apparent legality, which can weaken the moral clarity of the purchase decision (Nijman & Shepherd, 2014; TRAFFIC, 2008). Moreover, limited public awareness and weak conservation narratives for BH turtles may further dilute perceived social or moral urgency, reducing susceptibility to normative pressure (Zheng et al., 2024). More broadly, this pattern suggests that new interventions may be interpreted through longer-standing market narratives and hobbyist understandings of what counts as legitimate, responsible, or legally acceptable ownership. Where such narratives are already entrenched, messages that challenge them may be reinterpreted, discounted, or resisted rather than simply internalized as intended.

By contrast, ICB turtles displayed a clearer mediation structure, consistent with lower commercial breeding success and clearer conservation concern in China (Li, 2018). Participants more readily internalized the message content, allowing both

frames to work through similar psychological mechanisms (Figure 5a,b). Across the two ICB models, attitude retained a direct negative association with intention (robust under the legality frame; marginal under the conservation frame), whereas for BH, the influence of attitude on intention was indirect, operating through stronger subjective norms and reduced self-efficacy. In both species, subjective norms were negatively associated with self-efficacy and—importantly—also exhibited a direct negative association with intention in the conservation models.

Taken together, these patterns suggest that species context conditions whether evaluative judgments translate directly into intention or require normative and efficacy-related mediation, reinforcing the need for audience- and species-tailored intervention design. This interpretation is consistent with broader concerns that legality signals and wildlife-farming narratives can increase perceived acceptability and blur the conservation implications of purchase, rather than simply reducing pressure on wild populations (Rizzolo, 2021). These findings also suggest that intervention design should not rely too heavily on inherited assumptions about audience beliefs or on framing strategies carried over from earlier communication efforts without retesting them in the current market context. In markets where consumer preferences, legitimacy cues, and trade narratives evolve over time, formative work to identify the beliefs currently shaping responses is an important step before designing or adapting interventions.

### Implications for conservation policy and practice

Our study provides actionable insights into the psychological and social levers driving wildlife consumption. In line with established social norms scholarship, interventions that make the community standard salient (e.g., when well-respected keepers disapprove of buying threatened turtles, most peers choose not to purchase) can shift perceived approval and thereby suppress intention (Cialdini, 2003). Given that subjective norms in our models consistently reduced self-efficacy, such norm cues should be paired with efficacy supports that make compliance feel feasible. This is also consistent with recent work on exotic pet trade messaging suggesting that interventions are more likely to shift private intentions and broader engagement when messages are tailored to audience segments and linked to people's perceived ability to act (Naito et al., 2024; Tankard & Paluck, 2016; Tyler, 2006).

Across models, claim agreement remained critical, reinforcing the need for designing messages that are both accurate and personally relevant. Coproducing messages with stakeholders, such as hobbyists, veterinarians, or community influencers, may maximize claim agreement and contextual credibility (Zheng et al., 2024), consistent with IWT behavior-change guidance that emphasizes theory-informed design, audience research, and pretesting (Greenfield & Veríssimo, 2019; MacFarlane et al., 2022; Thomas-Walters et al., 2020; Veríssimo & Wan, 2019). For legality framing, clarity on regulatory definitions

and enforcement expectations (e.g., the F1 and F2 distinction in China) strengthen deterrence-related cognitions when paired with norm cues, thereby helping to harmonize external deterrence with internal responsibility, capability, and identity (Winders, 2018).

Species context also matters. The effectiveness of a given frame is contingent on species-specific conditions, including conservation salience (i.e., threat visibility and limits to captive breeding); clarity and enforcement of legal signals (e.g., F1 and F2 distinctions); prevailing market narratives (e.g., claims of captive bred, availability, pricing); and community norms or familiarity within hobbyist networks. Accordingly, demand-reduction messaging should be designed specifically for a species rather than assumed to transfer across taxa. This is particularly important where claims of captive breeding or legal supply may increase consumer acceptance without necessarily reducing conservation risk, a concern also highlighted in broader work on legalization and wildlife farming (Rizzolo, 2021).

We recommend formative audience and market research (mapping conservation salience, legal clarity, market narratives, and audience norms) followed by coproduction with stakeholders and pretesting of frame variants with target segments, consistent with guidance for behaviorally informed IWT interventions (Greenfield & Veríssimo, 2019; 't Sas-Rolfes et al., 2019; Thomas-Walters et al., 2020; Veríssimo & Wan, 2019). This preparatory work may be undertaken by conservation organizations in collaboration with researchers, communication specialists, and local implementation partners and may range from rapid assessment and message pretesting to more in-depth audience and narrative research, depending on the focal species, the complexity of the market, and the existing evidence base. In our case, the interventions we evaluated were informed by prior consumer-insight work, including audience identification, consumer journey mapping, and message development (Zheng et al., 2024). In contexts where legal signals or market narratives are especially ambiguous, as in the BH case, more extensive formative work may be needed before message design or adaptation.

Finally, tailored messaging is not a substitute for regulation. Conservation-framed narratives can build moral concern and strengthen norms that ultimately lower self-efficacy to purchase, whereas legality-framed messages provide clear prohibitions and credible sanctions. Coordinated strategies that integrate legal clarity, salient subjective norms, and efficacy supports are most likely to deliver sustained reductions in demand and to generalize across species or markets (Bamberg & Möser, 2007; 't Sas-Rolfes et al., 2019).

## Limitations and future directions

Our study has several limitations. First, although participants were matched across groups, they were primarily recruited from WeChat turtle-keeping communities, which, by design, prioritizes internal validity for the core consumer segment but limits

generalizability beyond hobbyist networks. Future work should test the transportability of these mechanisms in noncommunity samples (e.g., general-population panels, pet-market audiences) and, where feasible, with behavioral proxies (e.g., click-throughs, purchase deferrals) to address the well-documented intention-behavior gap and to clarify the boundary conditions of external validity (Sheeran, 2002; Webb & Sheeran, 2006).

Second, reliance on self-reported data introduces potential biases, such as social desirability effects (Grimm, 2010). Anonymous online surveys likely reduced reputational concerns and improved response honesty (Ibbett et al., 2021). Future studies could complement self-report with sensitive-question designs (e.g., unmatched count) and the behavioral proxies noted above to triangulate the psychological pathways (Nuno & St John, 2015). Although we applied standard data-quality checks for online survey research, including completeness screening, attention checks, and logical consistency checks, we cannot fully exclude the possibility of more sophisticated automated or AI-assisted responses. This is an increasingly important limitation for unsupervised online surveys, given recent evidence that LLM-based agents may evade conventional screening procedures (Westwood, 2025).

Third, we assessed PBC with two reflective indicators that captured external and informational constraints. As is typical for two-item scales, internal consistency was modest and content coverage necessarily narrow (Ajzen, 2002; Brown, 2015; Kline, 2016). Although our two-factor CFAs and HTMT statistics supported discriminant validity between PBC and self-efficacy, the limited breadth of this measure constrains interpretation of the null PBC results. In particular, the nonsignificant PBC-intention paths should be interpreted as evidence regarding the specific constraints measured here, rather than as evidence that perceived control is broadly irrelevant to threatened pet turtle purchasing. Future research should broaden PBC content to cover opportunities and obstacles (availability, affordability, source channels) and dependence on third parties (seller documentation, certificate authenticity) and have a richer item set. This would help determine whether a wider range of control-related beliefs contributes to intention and whether some barriers require structural or regulatory responses in addition to message-based interventions.

Finally, although the interventions clearly influenced short-term intention, longitudinal follow-ups and real-world replications are needed to assess durability and practical impact when participants face actual purchase opportunities.

Psychologically tailored messages can reduce intention to purchase threatened freshwater turtles by activating specific attitudinal-normative-efficacy pathways. By comparing conservation and legality frames across two species and unpacking the mediating roles of frame-specific claim agreement, subjective norms, and self-efficacy, we showed that different message frames can achieve comparable reductions via nonequivalent mechanisms. Our findings highlight the need for species-specific, theory-informed, and evaluated interventions that integrate legal clarity, salient norms, and efficacy measures to curb IWT and promote responsible pet ownership.

## AUTHOR CONTRIBUTIONS

Wuji Zheng, Beilu Duan, Anita Kar Yan Wan, Alexander Clark, Toby Park, Kristina Londakova, Freddy Parker, Xiaoxi Zhang, Lishu Li, and Tien Ming Lee designed the research. Wuji Zheng and Anita Kar Yan Wan designed the initial experiment. Wuji Zheng and Beilu Duan designed the final experiment and survey questions. Wuji Zheng led the collection of data, analyzed data, and wrote the initial draft. All coauthors revised the paper.

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## ORCID

Tien Ming Lee  <https://orcid.org/0000-0003-2698-9358>

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## SUPPORTING INFORMATION

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