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Report Summary

Augmented reality (AR) is changing how consumers evaluate products. By allowing shoppers to preview furniture in their living rooms or virtually try on items, AR directly shapes purchase decisions and boosts conversion rates. Yet, despite this rapid commercial adoption, marketers lack a reliable way to measure the consumer's subjective psychological experience of AR. Existing metrics are fundamentally flawed: they either focus on specific hardware features—meaning the metric becomes obsolete the moment new technology is released—or they borrow metrics from virtual reality (VR). However, AR is not VR. While VR transports users to a completely simulated world, AR anchors virtual products into a consumer's actual physical space. To understand if an AR campaign is truly working, managers need to measure 'object presence,' the consumer's perception that a virtual product is genuinely co-located and actionable in their real-world environment.

To solve this measurement gap, this research introduces the Augmented Reality Experience Scale (ARES). The researchers developed a concise, technology-agnostic tool that captures the two core dimensions of AR object presence: co-location (does the product look like it physically occupies the user's room?) and possible actions (does the consumer feel they can reach out and interact with it?). The scale was validated in a study of 289 consumers who engaged in an applied, try-before-you-buy AR furniture shopping scenario (using the IKEA app) and a general 3D interaction task.

The results proved that ARES accurately captures the AR experience by successfully distinguishing spatially anchored virtual objects from standard 3D models. More importantly, the research demonstrated that a stronger sense of 'object presence' is positively associated with various drivers of commercial success. When the AR illusion was more convincing, consumers found the tool more useful for decision-making, reported better product

knowledge, and developed a stronger sense of psychological ownership over the item. This translated directly to the bottom line, significantly boosting purchase intentions, consumers' willingness to pay a price premium, and their likelihood of recommending the product to others. However, the data also revealed a critical nuance: while a compelling AR experience drives immediate product-level evaluations, it does not automatically elevate broader brand perceptions.

For marketing leaders and developers, ARES provides a durable, future-proof diagnostic tool to benchmark AR prototypes and campaigns across different devices. The findings highlight two immediate action items for managers. First, when designing AR, prioritize 'spatial anchoring,' ensuring the virtual product perfectly aligns with the physical room's lighting and boundaries. The data shows that this realistic co-location is a major driver of positive consumer behavior. Second, managers must treat AR as a powerful tool for driving pre-purchase confidence and product engagement, rather than a magic bullet for brand building.

Academic Abstract

Augmented reality (AR) is revolutionizing consumer experiences by overlaying digital content onto the physical world, creating the illusion that virtual objects are seamlessly integrated. However, a validated measure of the psychological experience of AR is lacking; existing measures are often technologically-bound or rely on spatial presence metrics borrowed from virtual reality, an approach that rests on a flawed assumption, as AR does not transport users to an artificial environment but anchors virtual objects in their physical world. To address this gap, we build on the presence process model to reconceptualize presence for AR, relocating the relevant psychological judgment from the self, whether one is located in a mediated environment, to the object, whether it is accepted as part of one's physical environment. Building on this reconceptualization, we develop and validate, across two phases, the technology-agnostic augmented reality experience scale (ARES) to measure AR object presence. In Phase 1, we generated an initial item pool capturing co-location, the unique experiential signature of AR, and possible actions, a broader dimension extending across immersive technologies. In Phase 2 ($N = 289$), we refined the item pool and confirmed the scale's two-dimensional structure across a general AR object interaction task and an applied task (try-before-you-buy furniture shopping). The scale demonstrated reliability, construct and discriminant validity, and the expected pattern of associations within a marketing-relevant nomological network, with the notable exception of a null association with brand attitude. We discuss implications for theorizing presence in immersive technologies and for evaluating AR-based marketing experiences.

Measuring What Matters in AR Marketing with the Augmented Reality Experience Scale (ARES)

Augmented reality (AR) is changing how consumers evaluate and interact with brands by overlaying digital content onto the physical world, creating the illusion that virtual and real objects are seamlessly integrated (Rauschnabel et al., 2019). An illusion that enables product visualization, virtual try-on, and contextualized information that can directly shape purchase decisions (Smink et al., 2019, 2022; Van Berlo & Stikos, 2023). Augmented reality-enabled shopping experiences have been linked to higher purchase confidence and stronger conversion outcomes in industry reports (e.g., National Research Group, 2022), underscoring the technology's growing role as a marketing touchpoint. Despite this rapid commercial adoption, no widely accepted, psychometrically validated measure exists to capture consumers' subjective psychological experience of augmented reality (Marto & Gonçalves, 2024).

While recent efforts have attempted to capture AR-related presence (e.g., Huang & Shih, 2026), these measures are often technologically-bound, asking users to evaluate specific hardware capabilities and software rendering (e.g., interface processing speeds or shadow graphics) rather than the internal psychological illusion of presence itself. Such instruments therefore assess how well a particular system performs more than how users experience the AR content. This ultimately limits their practical usefulness: as AR technology evolves, technology-specific items may become outdated and require revision or revalidation, reducing the comparability of scores across devices, campaigns, prototypes, and time.

Beyond these technologically-bound measures, efforts to measure the psychological experience of AR suffer from a persistent conceptual mismatch: AR is often evaluated using metrics borrowed directly from virtual reality (VR) research, an approach that treats the two

media as interchangeable despite fundamentally different underlying psychological mechanisms (Barari et al., 2026; Breves & Greussing, 2021). Virtual reality transports users into a fully immersive, simulated environment, where the central experiential quality is spatial presence, or the sense of being there (Slater, 2009; Van Berlo et al., 2020). Augmented reality, by contrast, leaves users anchored in their actual physical environment and instead layers virtual objects into that space, where the central experiential quality is object presence, or the sense of it being here (Huang & Shih, 2026; Rauschnabel et al., 2022). This distinction becomes clear when comparing browsing for a new sofa in a fully simulated VR showroom to viewing that same sofa placed in one's own living room via AR—a fundamentally different experience despite involving the same virtual object.

These divergent experiential qualities, self-location versus object co-location, are nonetheless conflated when metrics designed for virtual reality, most notably spatial presence and its core dimension of self-location, continue to be applied to AR research despite capturing an experience (self-transportation) that AR, by design, does not produce (e.g., J. Lee et al., 2019; Smink et al., 2020). This conflation obscures the actual mechanism through which augmented reality shapes consumer judgment.

To address this, this study present research develops and validates the augmented reality experience scale (ARES) across two phases. In Phase 1, we generate an initial item pool by drawing on the presence process model (Wirth et al., 2007) and Stevens et al.'s (2002) conceptualization of object presence. In Phase 2, we test, across two sequential tasks, the dimensionality, reliability, construct validity, discriminant validity, and nomological validity of the resulting scale. We first establish the scale's baseline factor structure using a non-commercial AR task, providing a clean test of dimensionality conceptually uncontaminated by commercial framing. We then examine the scale's validity in an applied

AR context (a try-before-you-buy AR furniture task), situating the construct within a broader marketing-relevant nomological network.

Conceptualizing the Augmented Reality Experience

The theoretical grounding for the augmented reality experience scale begins with the presence process model of Wirth et al. (2007). The model proposes that spatial presence emerges through a two-step cognitive process. First, users construct a spatial situation model: a mental representation of the (mediated) environment derived from perceptual cues and prior spatial knowledge (Wirth et al., 2007). Second, they implicitly test the medium-as-primary-egocentric-reference-frame hypothesis—that is, whether 'I am located in this space.' This hypothesis-testing mechanism draws on Bruner and Postman's (1949) theory of perceptual hypotheses, which posits that perceivers actively form and revise expectancy-based hypotheses to resolve ambiguous sensory input. When this hypothesis is accepted, the mediated environment becomes the user's primary frame of reference, giving rise to self-location and perceived possible actions, the two components subsequently operationalized in the spatial presence experience scale (Hartmann et al., 2016).

Reframing Presence Around the Virtual Object

This architecture was developed to explain how a user's experienced location shifts from the physical environment to an artificial one (Wirth et al., 2007). Such a shift is foundational to virtual reality, but it does not adequately characterize augmented reality. In augmented reality, the physical environment remains perceptually available and continues to provide the user's primary spatial frame of reference. The user is not relocated into a mediated environment; rather, mediated content modifies the environment in which the user is already located (Breves & Greussing, 2021).

Augmented reality can modify the physical environment in different ways. Most AR applications introduce virtual content into the user's surroundings (Rauschnabel et al., 2022). Diminished reality, which is also a form of augmented reality, instead obscures, removes, or replaces perceptually available physical content (Lu, Van Berlo, Belleman, et al., 2026; Lu, Van Berlo, Meijers, et al., 2026). The present study focuses on the former and examines the psychological experience of virtual objects introduced into the user's physical environment. Hereafter, we use the term AR exclusively to refer to this form of augmentation.

Within this defined scope, we adapt Wirth et al.'s (2007) two-step process to AR by shifting its focus from the user's location to the virtual object's status. Rather than constructing a mediated environment and evaluating whether it becomes the user's primary spatial frame of reference, users incorporate a virtual object into their existing representation of the physical environment and evaluate whether it can be accepted as present there.

This reframing follows Lee's (2004) object-centered definition of presence as "a psychological state in which virtual objects are experienced as actual objects in either sensory or nonsensory ways" (p. 37). It also builds on Stevens et al.'s (2002) construct of object presence: the subjective experience that a virtual object exists in one's environment despite the cognitive knowledge that it does not. Their work with projection-augmented models demonstrated that such an experience can arise and be measured independently of self-transportation. Object-level presence judgments are therefore psychologically meaningful and conceptually distinct from judgments of self-location.

Integrating the Virtual Object into the Spatial Situation Model

The first stage of the presence process differs between VR and AR because the two media impose different representational demands. In VR, users construct a spatial situation model of a mediated environment that replaces or perceptually dominates their physical

surroundings (Wirth et al., 2007). In AR, by contrast, this model represents a predominantly physical environment augmented by mediated content. We therefore propose that the virtual object is incorporated into the user's existing representation of the physical environment, producing an updated model of the augmented scene rather than a separate mediated environment. This account is consistent with evidence that situation models are dynamically updated as new entities enter an ongoing scenario, rather than reconstructed whenever new information appears (Radvansky & Copeland, 2001).

To achieve this integration, users must reconcile bottom-up perceptual information about the virtual object with top-down expectations concerning how an object at that location should appear and behave (McMains & Kastner, 2011). Relevant information may include whether the object maintains a stable spatial position, changes appropriately with the user's viewing perspective, appears proportionate to its surroundings, and correctly occludes or is occluded by real-world elements (Cooper, 2023). Such cues help determine whether the object can be represented coherently as part of the ongoing physical situation rather than as a detached digital overlay.

Testing the Object-as-Real Hypothesis

The second stage retains the hypothesis-testing function proposed by Wirth et al. (2007), but changes the object of that test. In VR, the user implicitly evaluates whether the mediated environment can serve as the primary egocentric reference frame. In AR, the physical environment already occupies that role. The relevant implicit judgment is instead whether the incorporated virtual object can be accepted as a real or plausible occupant of that environment. We refer to this judgment as the object-as-real hypothesis, drawing on the general expectancy-based hypothesis-testing logic of Bruner & Postman (1949) rather than their specific incongruity paradigm.

Acceptance of the object-as-real hypothesis does not require the user to believe propositionally that the object is physically real. Users may remain fully aware that it is digitally generated (Stevens et al., 2002). Rather, acceptance refers to the object being experienced, at the perceptual and action-oriented level, as sufficiently consistent with the surrounding environment to be treated as though it were physically present. The distinction parallels broader presence research, in which users may cognitively recognize the mediated nature of an experience while nevertheless responding to it as experientially real (Hartmann & Hofer, 2022).

Two Dimensions of AR Object Presence

Once the object-as-real hypothesis is accepted, this acceptance manifests in two distinguishable dimensions of AR object presence: co-location and possible actions. Rather than constituting separate outcomes, these dimensions represent the experiential expression of a single underlying judgment—one spatial, the other action-oriented—through which the accepted object becomes woven into the user's ongoing engagement with their physical environment.

Co-location concerns the perceived spatial status of the virtual object; the experience that it occupies the same physical environment as the user's body (Stevens et al., 2002). It captures the extent to which the object is experienced as being 'here,' within the user's immediate surroundings, rather than as an image viewed through or on a display. Co-location is therefore an egocentric judgment about the relationship between the user's own position and the represented location of the virtual object.

Possible actions concerns the object's perceived action relevance: the extent to which users experience it as something toward which they can direct embodied behavior as they would toward a physically present object. This dimension generalizes across immersive

technologies, as it is also a key component of the spatial presence experience scale (Hartmann et al., 2016) used to measure presence in VR, where it captures the user's perceived capacity to act within a mediated environment. Here, we reorient the construct from the user's location to the object's presence, capturing action relevance directed at a specific virtual entity rather than at the mediated environment as a whole. Consistent with this account, users have been shown to alter their walking trajectories to avoid AR objects that they explicitly know are not physically real (Maidenbaum et al., 2025).

Continuity with the Presence Process Model

The proposed account is consequently homologous to, but not identical with, the presence process model (Wirth et al., 2007). In both models, experiential presence results from an initial spatial representation followed by an implicit judgment concerning the reality status of mediated content. However, each component is transformed in AR. The construction of a new mediated environment becomes the integration of a virtual object into an existing environmental representation; the medium-as-primary-egocentric-reference-frame hypothesis becomes an object-as-real hypothesis; and the resulting experience shifts from the user's presence in a virtual environment to the virtual object's presence in the user's physical environment.

By preserving this higher-order logic while replacing its VR-specific mechanisms, the augmented reality experience scale retains theoretical continuity with the presence literature without importing assumptions that are incompatible with AR. It thereby defines AR object presence from first principles as a construct that is structurally analogous to spatial presence, yet conceptually independent of it, and whose proposed two-dimensional organization can be tested empirically.

Nomological Network of Object Presence: An Applied Context

Having established AR object presence as a psychologically distinct construct, we next test its nomological validity by examining whether it correlates with theoretically relevant antecedents and consumer outcomes in the direction and pattern expected. This validation step is essential for establishing the augmented reality experience scale as a practically useful diagnostic tool: a scale with strong nomological validity gives researchers and practitioners confidence that the scale scores meaningfully track the marketing-relevant outcomes AR investments are ultimately designed to produce, from perceived product diagnosticity to purchase intention and willingness to pay a price premium. Because AR object presence comprises two dimensions, co-location and possible actions, each hypothesis is tested at the level of both dimensions rather than a combined score, allowing us to identify whether the two dimensions carry similar or differing implications for each outcome.

Antecedents of AR Object Presence

Among the technological features that shape AR object presence, perceived vividness, the sensory richness and representational detail of an AR rendering (Steuer, 1992), is of particular interest because it is directly controllable through rendering fidelity, lighting, and level of detail. A more vividly rendered virtual object should be easier for consumers to accept as genuinely co-located in their environment and relevant to potential use; perceived vividness has been found to function as a technological correlate of presence-related experiences in AR contexts (Yim et al., 2017). This relationship is managerially relevant insofar as it identifies vividness as a lever that can be optimized during AR development to strengthen the overall AR experience.

H1: Perceived vividness of the AR experience is positively associated with AR object presence.

Consequences of AR Object Presence

When a virtual product is experienced as occupying the consumer's physical environment and as relevant to embodied action, the shopping encounter more closely resembles a direct product experience, with implications across the customer journey from initial engagement through purchase and post-purchase advocacy.

Shopping Experience Outcomes

The response most directly implied by object presence is perceived proximity, the subjective experience that a product is spatially and psychologically close rather than remote (Argo et al., 2005). This sense of closeness extends beyond mere spatial adjacency: using an AR app has been found to increase consumers' perceived physical closeness to a product, compared to non-AR presentations (Rauschnabel et al., 2024).

A related but more decision-relevant outcome is perceived diagnosticity, the extent to which an experience helps consumers judge how a product would look, fit, or function and reduces purchase-relevant uncertainty. Augmented reality experiences have been found to enhance diagnosticity relative to non-spatial product presentations (Uhm et al., 2022), directly addressing one of AR's core commercial value propositions: closing the information gap that otherwise depresses online conversion and drives returns (Hilken et al., 2017). Within this study, co-location is expected to be positively associated with perceived diagnosticity by situating the product against real environmental references, such as showing whether a sofa fits a specific room, while possible actions may further support it by allowing consumers to imagine interacting with the product before purchase.

Closely tied to both proximity and diagnosticity is enjoyment, the intrinsic pleasure derived from the AR experience itself (Vorderer, 2001). Augmented reality experiences have been found to increase consumer enjoyment relative to non-AR presentations (Sungur et al.,

2024; Zanger et al., 2022), making enjoyment a commercially relevant driver of engagement with branded AR tools (McLean & Wilson, 2019).

H2: AR object presence is positively associated with (a) perceived diagnosticity, (b) perceived proximity, and (c) enjoyment.

Decision-Relevant Cognitive and Self-Related Outcomes

Consumers' understanding of a product's attributes, appearance, or suitability, referred to here as product knowledge, is a practical outcome for marketers seeking to reduce pre-purchase uncertainty without relying on lengthy product descriptions or in-store consultation. Simulated direct experiences have been found to support learning by allowing concrete, contextually grounded inspection (Li et al., 2002), and AR object presence is expected to support product knowledge through this same mechanism.

H3: AR object presence is positively associated with product knowledge.

Another mechanism increasingly leveraged in AR retail is psychological ownership, the subjective feeling that a product is 'mine' prior to purchase (Shu & Peck, 2011). Virtual try-on and at-home placement previews rest on the premise that triggering psychological ownership can increase consumers' comfort and confidence in the purchase decision (Song et al., 2019). Augmented reality use has been found to foster psychological ownership (Yuan et al., 2021), and co-location and possible actions are both expected to be associated to this feeling by placing the product within the consumer's personal space and rendering it usable there

H4: AR object presence is positively associated with psychological ownership.

Product and Brand Evaluations

Experiencing a product as plausibly present allows it to be evaluated in a context resembling actual use; AR and presence-related mechanisms have been found to be associated to more favorable product attitude, the consumer's overall evaluation of the product (Lavoye & Kumar, 2025). This benefit has also been found to extend to brand attitude, however the literature is more mixed. For example, Smink et al. (2020) found no relationship between AR and brand attitude, where other research (Van Berlo & Stikos, 2023; Zanger et al., 2022) did report positive associations between AR-based experiences and brand-level evaluations (Van Berlo & Stikos, 2023; Zanger et al., 2022).

H5: AR object presence is positively associated with (a) product attitude and (b) brand attitude.

Commercial and Behavioral Outcomes

Among the outcomes examined, purchase intention, willingness to pay a price premium, and positive word-of-mouth carry the most direct commercial relevance. A comparable relationship between AR experience and product and brand evaluations has been found for pricing: AR experiences have been associated with higher willingness to pay a price premium relative to comparable alternatives (Poushneh & Vasquez-Parraga, 2017), with direct implications for margin and pricing strategy in AR-enabled retail. A related but distinct outcome is positive electronic word-of-mouth intention, consumers' willingness to recommend or share favorable information about the product or AR experience (Hennig-Thurau et al., 2004); augmented experiences have been found to increase eWOM intentions (Hilken et al., 2017), suggesting that a convincingly present and shareable AR encounter can extend campaign reach organically at comparatively low cost.

H6: AR object presence is positively associated with (a) purchase intention, (b) willingness to pay a price premium, and (c) positive eWOM intention.

Phase 1: Scale Construction and Item Generation

The first phase of this research focused on generating an initial pool of items to capture the domain of AR object presence. Following the recommended procedures for scale development (Boateng et al., 2018), we derived the initial items deductively from our theoretical conceptualization of the AR experience rooted in the presence process model (Wirth et al., 2007) and the object presence literature (e.g., Stevens et al., 2002).

Because our primary goal was to develop a short and convenient-to-apply measure of the AR experience for both practitioners and researchers, we focused on generating a targeted set of items. Since AR presence is fundamentally object-centered rather than self-centered, we adapted the underlying logic of the spatial presence experience scale (Hartmann et al., 2016), a validated and popular scale measuring spatial presence in virtual reality, to reflect the integration of a virtual object into the physical world (rather than the self into a virtual world). This process resulted in an initial pool of 12 items representing the two core dimensions of AR object presence, co-location and possible actions, with the ultimate aim of retaining three to four robust items per dimension for the final scale.

The first dimension, co-location, captures the unique experiential signature of AR: the perception that a virtual object physically occupies space and visually aligns with the user's immediate physical surroundings, consistent with the object-referenced conceptualization outlined above (e.g., K. M. Lee, 2004; Stevens et al., 2002). We generated eight items for this dimension. The second dimension, possible actions, addresses interaction readiness. While the self-location dimension of the validated spatial presence experience scale (Hartmann et al., 2016) is incompatible with AR (because the user does not relocate to a virtual world), and could thus not be integrated as is, the theoretical requirement for interaction readiness remains an important pillar of the presence experience (Wirth et al., 2007). We therefore

retained this dimension but shifted its conceptual target: rather than using the final, validated four-item subscale, which measures interaction potential within a completely virtual environment, we returned to the original theoretical framework (Wirth et al., 2007) and Hartmann et al.'s (2016) initial item pool, which included object-level affordances (e.g., reaching for, touching, and affecting objects). We adapted these concepts to reflect affordances tied to the AR object, resulting in a targeted pool of four items.

In total, 12 items were retained for formal psychometric testing and validation in Phase 2. The full initial item pool is presented in Table 1.

[Please insert Table 1]

Phase 2: Scale Validation

Method

Design, Participants, and Procedure

To test the generalizability and predictive validity of the scale, we set up a two-task study in the laboratory. A total of 305 participants were recruited via the subject pool of a large Western European university and completed the study in exchange for small compensation. The study received ethical approval from the University of [blinded for review]. During the lab session, data were collected for two separate studies, which were counterbalanced to mitigate any potential order bias (Shadish et al., 2002). Ultimately, sixteen participants were excluded from analyses due to technical issues with the AR rendering, resulting in a final sample of 289 (M_{age} = 20.66, SD = 3.00; 84.0% female).

Participants completed two sequential tasks within a single session: an applied (AR shopping) task and a general (AR object) interaction task. In the applied task, all participants engaged in a try-before-you-buy AR furniture shopping scenario using the AR function of the

IKEA app, viewing a virtual chair rendered and anchored within their physical environment. Following exposure, participants completed the initial 12-item pool generated in Phase 1, along with the discriminant and nomological validity measures, including perceived vividness, perceived diagnosticity, perceived proximity, enjoyment, product and brand attitudes, purchase intention, willingness to pay price premium, psychological ownership, product knowledge, and eWOM intentions.

In the general task, participants interacted with a virtual guinea pig from Google's collection of AR-enabled 3D animal models available through Google Search (Chennapragada, 2019). To test the construct validity of the new scale, participants were randomly assigned to one of two conditions for this task: they viewed the animal either rendered and anchored within their physical environment (AR condition; n = 145) or presented as a standalone 3D model without spatial anchoring (3D condition; n = 144). Following this interaction, they completed the augmented reality experience scale items identified in Phase 1.

Although participants completed the applied (furniture shopping) task before the general task, involving the virtual guinea pig, we report the data from the virtual animal test first in the results section. Analyzing the general task first provides the cleanest evaluation of the scale's item reduction and baseline factor structure, (conceptually) uncontaminated by the applied framing, and serves as our experimental construct validity check. We then turn to the data from the applied task to evaluate the scale's discriminant validity and its nomological validity within a full theoretically specified applied AR context.

Measures

Established measures were adapted from prior literature, to test the nomological network and discriminant validity of the scale. All measures in the study were assessed using

a 7-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*), unless otherwise indicated. Table 2 details the sources, example items, descriptive statistics, and reliability coefficients for all variables.

[Please insert Table 2]

Analytical Strategy

All analyses were conducted in R. Confirmatory measurement models were estimated using the *lavaan* package (Rosseel, 2012) with maximum likelihood estimation, and model fit was evaluated using chi-square, CFI, RMSEA (with 90% confidence interval), and SRMR, following conventional benchmarks (CFI ≥ .95, RMSEA ≤ .08, SRMR ≤ .08; Hu & Bentler, 1999). Composite reliability (ω), average variance extracted (AVE), and the heterotrait-monotrait ratio (HTMT) were computed using the *semTools* package (Jorgensen et al., 2026), with composite reliability ≥ .70 and AVE ≥ .50 as benchmarks for adequate reliability and convergent validity. Discriminant validity was evaluated using the heterotrait-monotrait ratio (HTMT), with values below .85 indicating adequate discriminant validity (Henseler et al., 2015), and the Fornell-Larcker criterion, whereby the square root of a construct's average variance extracted should exceed its correlations with other constructs (Fornell & Larcker, 1981). Known-groups comparisons were conducted using Welch's independent-samples *t*-tests (base R stats package), accompanied by Cohen's *d* effect sizes.

To establish the baseline factor structure of the augmented reality experience scale, we estimated a measurement model using SEM on the general task data, testing whether a two-factor structure comprising co-location and object action possibilities provided adequate fit. Item reduction was performed on the AR-only subsample (n = 145) rather than the full sample, because including the 3D control condition at this stage would contaminate the item-reduction process with variance attributable to the experimental manipulation itself, rather

than reflecting the items' intrinsic factor structure. Items were flagged for removal based on large modification indices for correlated residuals, and where two items showed overlapping content, the item retained was determined by which specification produced superior fit and no unresolved correlated residuals in a direct comparison. The resulting structure was then re-estimated on the full sample ($N = 289$) to confirm generalizability beyond the AR-only subsample. We examined the reliability of each subscale using composite reliability (ω) and average variance extracted.

To test construct validity, we conducted independent-samples (Welch) *t*-tests comparing co-location and object action possibilities scores between the AR and 3D model control conditions within the guinea-pig task, accompanied by Cohen's *d* effect sizes. The 3D condition serves as a natural contrast group for testing construct validity because it isolates the presence of spatial anchoring, the defining feature of AR object presence, while holding the object itself constant; a scale that meaningfully captures AR object presence should therefore discriminate between these conditions.

To test discriminant validity between AR object presence and its antecedent, perceived vividness, we estimated a measurement model using SEM on data from the applied task, in which perceived vividness, co-location, and object action possibilities were specified as distinct latent factors. Vividness was selected as the critical discriminant test because it is a closely related antecedent construct in the presence literature (e.g., Steuer, 1992; Yim et al., 2017), capturing general sensory richness rather than the specific spatial and interactive properties targeted by AR object presence; demonstrating separability from vividness is therefore a stronger test than comparing against unrelated constructs. We evaluated discriminant validity using the HTMT ratio and the Fornell-Larcker criterion.

Having established that AR object presence is empirically distinguishable from perceived vividness, we next examined whether the direction of their association, along with associations involving the remaining criterion variables, conformed to theoretical expectations. To test the proposed nomological network, we computed bivariate correlations between the co-location and object action possibilities dimensions of AR object presence and each theoretically specified antecedent and outcome variable, using data from the applied task. AR object presence was examined at the level of its two constituent dimensions rather than as a composite score, consistent with the two-factor structure established in the measurement model. This approach follows recent scale validation research demonstrating nomological validity through correlational associations with theoretically relevant criterion variables, while reserving more rigorous confirmatory procedures specifically for discriminant validity testing between closely related constructs (Hartmann et al., 2026). Consistent with standard practice in nomological validity testing (Boateng et al., 2018), we evaluated whether the direction and significance of these correlations conformed to theoretical expectations.

Results

Dimensionality of Augmented Reality Experience Scale

Item Reduction

Starting from the initial 12-item pool, we iteratively removed items showing high modification indices or theoretically redundant content. Three items were removed on statistical grounds: Co-location item 2, Possible-actions item 3, and Co-location item 6, each flagged by large correlated residuals with conceptually overlapping items (modification indices ranging from 28.3 to 45.4).

A fourth decision concerned two remaining co-location items with overlapping content, co-location item 7 (“the virtual object felt aligned with my physical environment”) and co-location item 8 (“the boundary between the virtual object and my physical environment felt blurred”). We retained co-location item 8 and removed co-location item 7, based on model fit: the resulting four-item co-location factor (co-location items 1, 4, 5, 8) combined with the three-item possible-actions factor (possible-actions items 1, 2, 4) produced excellent fit in the AR-only subsample, $\chi^2(13) = 18.85$, $p = .128$, CFI = .99, RMSEA = .06, 90% CI [<.01, .11], SRMR = .03. This specification substantially outperformed the alternative retaining co-location item 7 instead ($\chi^2(13) = 42.96$, $p < .001$, CFI = .96, RMSEA = .13), which showed a persistent correlated residual between co-location item 7 and a possible-actions item (possible-actions item 1; *MI* = 17.2) that did not resolve across iterations, suggesting shared content between the co-location and possible-actions dimensions. Standardized loadings in the final AR-only model ranged from .62 to .90, and composite reliability was strong for both co-location ($\omega = .89$, AVE = .68) and possible actions ($\omega = .85$, AVE = .67) . The two factors were significantly correlated ($r = .84$, $p < .001$). This four-item co-location specification, retaining co-location item 8, was subsequently confirmed as the final item set for the augmented reality experience scale.

Final Measurement Model

The final measurement model, comprising four co-location items (1, 4, 5, 8) and three possible-actions items (1, 2, 4), showed good fit to the general-task sample ($N = 289$): $\chi^2(13) = 32.78$, $p = .002$, CFI = .99, RMSEA = .07, 90% CI [.04, .11], SRMR = .03. All items loaded significantly and strongly on their intended factors, with standardized loadings ranging from .65 to .92. The two latent factors were significantly and strongly correlated ($r = .80$, $p < .001$), consistent with the theoretical expectation that co-location and possible actions represent related but empirically distinguishable facets of AR object presence. Composite reliability

was excellent for both subscales, co-location (ω = .92, AVE = .75) and possible actions (ω = .85, AVE = .67).

Construct Validity

Welch's *t*-tests comparing the AR and 3D conditions revealed that co-location was substantially higher in the AR condition (M = 3.91) than in the 3D condition (M = 2.68), $t(285.98) = 6.75$, $p < .001$, $d = 0.79$. Possible actions showed a smaller but still significant difference between the AR condition (M = 3.80) and the 3D condition (M = 3.27), $t(286.30) = 2.84$, $p = .005$, $d = 0.33$. These results support the construct validity of the augmented reality experience scale and its capacity to distinguish spatially anchored from non-anchored virtual experiences at the level of both constituent dimensions.

Discriminant Validity

Turning to discriminant validity, the confirmatory measurement model specifying co-location, possible actions, and perceived vividness as distinct latent factors showed acceptable fit, $\chi^2(41) = 102.46$, $p < .001$, CFI = .97, RMSEA = .07, 90% CI [.06, .09], SRMR = .05. As shown in Table 3, discriminant validity between AR object presence and its antecedent, perceived vividness, was clearly supported across all criteria. The square root of the average variance extracted for co-location (√AVE = .76) and possible actions (√AVE = .81) each exceeded their respective correlations with vividness (r = .65 and r = .56), and HTMT ratios for both comparisons fell comfortably below the .85 threshold (co-location/perceived vividness = .68; possible actions/perceived vividness = .62).

[Please insert Table 3 here]

The comparison between co-location and possible actions themselves was more nuanced. The HTMT ratio between the two dimensions (.83) approached, but remained below, the.85 threshold, and √AVE for co-location (.76) was marginally lower than its

correlation with possible actions (.81), representing a technical, borderline violation of the strict Fornell-Larcker criterion for this specific pair. Given that co-location and possible actions are the two theorized subdimensions of the same overarching construct, AR object presence, rather than independent constructs, this pattern is expected and does not undermine the central discriminant validity claim, which concerns the separability of AR object presence from perceived vividness. This finding is nonetheless consistent with the substantively strong correlation between the two dimensions (r = .81) observed throughout our analyses, underscoring that co-location and possible actions, while conceptually and empirically distinguishable, represent closely related facets of a coherent underlying experience.

Nomological Network (H1–H5)

Bivariate correlations between each dimension of AR object presence and the antecedent and outcome variables, using the applied-task data, are shown in Table 4. As shown in Table 4, AR object presence was positively associated with perceived vividness across both dimensions (ps < .001), supporting H1. H2 was likewise supported for perceived proximity, perceived diagnosticity, and enjoyment, with both dimensions significantly and positively correlated with each outcome ($ps \leq .001$). Both dimensions of object presence were also significantly and positively associated with product knowledge (ps < .001), supporting H3, and with psychological ownership (ps < .001), supporting H4. H5 was partially supported: both dimensions were significantly and positively associated with product attitudes (ps < .001), supporting H5a, however neither co-location nor possible actions was significantly associated with brand attitudes (ps = 1.00), so H5b was not supported. Finally, H6 was supported for purchase intention, willingness to pay a price premium, and eWOM intentions, with both dimensions significantly and positively correlated with each outcome (ps < .001).

[Please insert Table 4 here]

Discussion

Consumer AR research has lacked a validated, theoretically grounded measure of the psychological experience of object presence, relying instead on presence scales developed for virtual reality. Building on the presence process model (Hartmann et al., 2016; Wirth et al., 2007) and the object presence literature (e.g., Stevens et al., 2002), we preserved the two-step logic of presence formation while relocating its central judgment from the self to the virtual object. On this basis, we developed and validated the augmented reality experience scale (ARES), a two-dimensional measure of AR object presence comprising co-location and possible actions (see Table 5 for complete set of items). Across two AR contexts, the scale demonstrated a stable factor structure, distinguished spatially anchored AR experiences from non-anchored 3D model presentations, and exhibited theoretically meaningful associations within a broader nomological network of experiential and consumer responses. This research makes four main contributions to the AR, presence, and marketing literatures.

[Please insert Table 5 here]

A Validated, Technology-Agnostic AR Experience Scale

First, this research clarifies why AR experience cannot be adequately captured using virtual-reality-derived measures of spatial presence. Augmented and virtual reality rely on different psychological processes: VR typically replaces or perceptually dominates the physical environment, whereas AR introduces virtual content into an environment that remains perceptually available and continues to provide the user's primary spatial frame of reference (Barari et al., 2026; Breves & Greussing, 2021). Building on the presence process model (Wirth et al., 2007), we therefore retain its underlying logic while relocating the relevant perceptual judgment from the self—whether the self is experienced as located in a

mediated environment—to the object, whose presence instead depends on whether it is accepted as part of the user's physical environment.

The construct-validity findings support this distinction. The scores for both dimensions of object presence were significantly higher in the spatially anchored AR condition than in the non-anchored 3D model condition, despite both conditions presenting the same virtual object. This pattern supports the interpretation that the scale captures the experience of virtual content as co-located and actionable within the user's environment, rather than exposure to vivid or interactive digital content alone. The proposed inversion is also conceptually consistent with the distinction between place illusion and plausibility illusion, originally articulated by Slater (2009) and later incorporated by Skarbez et al. (2017).

Second, by isolating the internal psychological experience of object presence from the hardware and software used to produce it, this research establishes the augmented reality experience scale as a theoretically focused and technology-agnostic measure. Other recent measures combine presence with interface-specific mechanics or evaluations of graphic and rendering quality (e.g., Huang & Shih, 2026). In contrast, the augmented reality experience scale measures whether virtual content is experienced as co-located and relevant to possible embodied action, independent of the technical means through which that experience is generated. Because the scale targets a psychological state rather than a particular interface or rendering approach, it has the potential to remain applicable across devices ranging from mobile screens to immersive headsets and across future developments in AR technology.

Third, the replication of the two-dimensional factor structure across a commercial furniture task and a non-commercial virtual-animal task provides preliminary evidence that AR object presence is not restricted to a particular type of setting. This cross-context stability

is theoretically important because augmented reality is deployed across retail and marketing (e.g., Happonen et al., 2025; Rauschnabel et al., 2019) to education (e.g., Pimentel, 2022), healthcare (e.g., Abels et al., 2021; Sungur et al., 2024), entertainment (e.g., Rauschnabel et al., 2017), and other domains.

Fourth, the study positions AR object presence within a broader nomological network of variables relevant to consumer AR. Object presence was examined in relation to perceived vividness as a theoretically relevant antecedent and to perceived proximity, perceived diagnosticity, enjoyment, product knowledge, psychological ownership, product and brand attitudes, purchase intention, willingness to pay a price premium, and eWOM intentions as experiential and consumer correlates. The resulting pattern of associations is almost entirely in line with prior empirical evidence, supporting the scale's nomological validity and clarifying where object presence is situated within the consumer response to AR experiences.

The one exception concerns brand attitude, where neither dimension of object presence showed a significant association. Although this diverges from our hypothesized nomological network, it is not out of step with the broader AR literature, where effects of AR exposure on brand attitude have been inconsistent across studies (e.g., Smink et al., 2020; Zanger et al., 2022). One possible explanation in the present study is that the focal brand, IKEA, was already well established and familiar to participants. Brand attitudes may therefore have been relatively stable and less susceptible to change following a single AR product encounter, consistent with evidence that AR's influence on brand attitude is significantly weaker for well-known, familiar brands than for unfamiliar ones (Morren et al., 2023). More generally, the findings suggest that object presence may relate more directly to responses concerning the immediate product experience than to broader evaluations of the brand.

Practical and Managerial Implications

For practitioners, the augmented reality experience scale provides a validated diagnostic tool for evaluating the psychological quality of AR-based marketing experiences. Its principal value lies in distinguishing whether virtual content is merely displayed within a consumer's view from whether it is experienced as genuinely situated and actionable within the consumer's environment.

First, the construct-validity findings highlight spatial anchoring as an important design priority. The difference between the AR and non-anchored 3D conditions was larger for co-location ($d = 0.79$) than for possible actions ($d = 0.33$), indicating that co-location was more sensitive to spatial anchoring in the present study. Practitioners should therefore evaluate technical features linked to co-location, such as registration accuracy, occlusion handling, perspective consistency, and environmental lighting (Cooper, 2023), not only as indicators of visual quality, but also in terms of whether they support the psychological experience that the virtual product occupies the consumer's physical space.

Second, the nomological network offers marketers a structured way to evaluate how object presence corresponds with consumer responses, consistent with the purpose of nomological validity testing: demonstrating that the scale relates to theoretically relevant outcomes in the expected direction, rather than establishing causal mechanism. Both co-location and possible actions were positively associated with product attitude, purchase intention, willingness to pay a price premium, and eWOM intentions. Prior experimental research has already established causal effects of AR exposure on several of these outcomes, and the present findings extend this work by showing that these associations hold specifically at the level of object presence's two constituent dimensions, offering marketers a more granular lens on which aspect of the AR experience, spatial anchoring or interactive

affordance, most closely tracks a given consumer response. These findings strengthen the practical case for treating co-location and possible actions as distinct design levers, even though establishing which dimension causally drives which outcome, and to what extent, remains a task for future experimental research.

The absence of an association with brand attitude further cautions against assuming that a convincing AR object experience will automatically produce brand-level benefits. Improving object presence may strengthen the immediate product experience without changing broader brand perceptions. Marketers seeking brand-building effects may therefore need to combine convincing spatial presentation with mechanisms such as brand storytelling (Van Berlo & Stikos, 2023).

Finally, the scale's similar factor structure across applied and general tasks, combined with its technology-agnostic design, provides an initial basis for its use across different AR applications and delivery platforms. Because the augmented reality experience scale measures the psychological experience of co-location and possible actions rather than evaluating a specific interface or rendering approach, practitioners can apply it as a common benchmarking instrument across products, prototypes, and devices—from mobile-based AR to headset-based implementations—as the underlying technology evolves. This flexibility does not eliminate the need to assess the scale's performance in substantially different contexts, devices, and user populations, but it positions the scale as a durable tool that need not be revalidated each time AR hardware or delivery methods change.

Limitations and Directions for Future Research

This research has several limitations and opens several avenues for future research. First, both AR tasks were administered to the same participant sample within a single session. Although this design enabled an efficient and controlled examination of the scale across

contexts, it cannot rule out sample-specific influences on the replicated factor structure. Future research should test the augmented reality experience scale in independent samples and examine measurement invariance across populations, devices, product categories, and application domains.

Second, the nomological network was evaluated through contemporaneous associations, consistent with the purpose of nomological validity testing: establishing that the scale relates to theoretically relevant constructs in the expected direction, rather than identifying causal mechanisms (Boateng et al., 2018). As we discussed in our theoretical framework, prior experimental research has already established causal effects of AR exposure on several of the outcomes examined here. Building on this work, future research could use the two-dimensional structure of the augmented reality experience scale to clarify which specific aspect of the AR experience drives these established effects: whether outcomes are attributable primarily to co-location, to possible actions, or to their joint contribution. Experimental designs that independently manipulate spatial anchoring and interactive affordances, while holding the other constant, would allow researchers to isolate the unique causal contribution of each dimension rather than treating AR object presence as a single undifferentiated construct. Such research would also help clarify how co-location and possible actions each contribute to consumer response, increasing both theoretical understanding of object presence and its practical relevance for AR design.

Finally, beyond these methodological limitations, our findings also raise a broader theoretical question worth pursuing in future work: whether possible actions represents a structurally analogous component across immersive media more generally. Self-location and co-location may capture where the presence illusion is anchored—in the user's location for virtual reality, or the object's location for augmented reality—as medium-specific manifestations of presence rather than a single dimension present in both.

Notably, self-location and co-location have historically received the most theoretical and empirical attention in presence research (Marto & Gonçalves, 2024; Skarbez et al., 2017), and although possible actions was identified as a distinct component of spatial presence in the original process model (Wirth et al., 2007) and later validated as a separable, psychometrically sound dimension (Hartmann et al., 2016), it is often folded into broader presence assessments in virtual reality research rather than treated as a separable component in its own right. This may reflect possible actions' distinct theoretical status: unlike self-location and co-location, it may not be tied to either reference frame in the same way, potentially reflecting a shared action-oriented component of presence regardless of whether the illusion is self- or object-referenced. If confirmed, this would suggest that presence theory could accommodate both medium-specific components (self-location, co-location) and a shared, cross-medium component (possible actions) within a single integrative framework, rather than requiring entirely separate models for each technology.

We offer this interpretation as a theoretical proposition rather than an empirical conclusion, since the present study examined augmented reality alone and did not collect matched virtual reality data. Future research should test whether possible actions has equivalent content and measurement properties across technologies, and could also examine whether acceptance of a primary spatial reference frame precedes object-as-real judgments within that frame, or whether self-referenced and object-referenced presence judgments can form independently. Extended reality (XR) environments, which span the continuum from augmented to virtual reality, provide a particularly useful setting for this work because they may combine a substantially mediated environment with specific virtual entities represented as occupants of that environment (Rauschnabel et al., 2022). Furthermore, future studies could examine whether the relative salience of self-location and object presence changes systematically along the virtuality continuum, and whether possible actions remains

structurally stable as the dominant frame of reference shifts from the physical to the mediated environment. Such research could inform the development of an integrated presence theory that accommodates both medium-specific and shared components, rather than assuming AR and VR are manifestations of a single undifferentiated construct.

Conclusion

By reconceptualizing presence in AR as an object-referenced psychological process, this research introduces and validates the augmented reality experience scale (ARES), enabling researchers and practitioners to evaluate AR experiences on their own conceptual terms rather than through measures developed for virtual reality. The scale provides a foundation for examining how the experienced co-location and action relevance of virtual objects relate to consumer perception, judgment, and behavior, while its cross-context stability offers a starting point for future work extending object presence to other AR applications and, potentially, to a broader theory of presence spanning immersive media.

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Tables

Table 1. *Initial Item Pool and Descriptives for the Augmented Reality Experience Scale (ARES) for Measuring Object Presence*

#	Construct	Item Wording	General Context		Applied Context	
			M	*SD*	*M*	*SD*
1	Co-location	**The AR object felt like it occupied real space in the room around me.**	3.56	1.85	4.01	1.71
2		It seemed as if the AR object was located at a specific place in my physical environment.	3.68	1.92	4.51	1.62
3		I experienced the AR object as being in my space rather than just on my screen.	3.25	1.83	3.34	1.70
4		**The AR object felt present in the same space as my body.**	3.18	1.88	3.06	1.69
5		**The AR object appeared integrated into my environment.**	3.39	1.88	4.15	1.64
6		The AR object looked like it belonged in my environment.	3.16	1.79	3.65	1.67
7		The AR object felt aligned with the real environment.	3.23	1.85	3.71	1.69

8		**The boundary between the AR object and the real environment felt blurred.**	3.07	1.81	3.25	1.63
9	Possible actions	**It felt as if I could reach out and touch the AR object.**	3.67	1.93	3.35	1.75
10		**I felt I could directly interact with the AR object.**	3.79	1.86	3.35	1.73
11		When I moved, I felt like the AR object responded in a natural way.	3.51	1.85	4.17	1.66
12		**It felt as though my actions could meaningfully affect the AR object.**	3.16	1.80	3.42	1.74

Note. All items were rated on a seven-point Likert scale ranging from *strongly disagree* (1) to *strongly agree* (7). Items shown in bold were selected for inclusion in the final scale. $N = 289$.

Table 2. *Construct Measures, Descriptive Statistics, and Reliabilities*

Construct (Source)	Example Item	*M*	*SD*	α
Perceived vividness (Hilken et al., 2017, 2020)	"The experience was vivid."; "The presentation was rich in detail."	4.30	1.31	.87
Perceived diagnosticity (Kempf & Smith, 1998)	"The experience helped me evaluate the product." ; "The experience provided information that is useful for judging the product."	4.96	1.29	.87
Perceived proximity (Argo et al., 2005)	"Close/Far"; "Near/Distant"	3.31	1.28	.87
Enjoyment (based on Vorderer et al., 2004)	"I found the experience enjoyable."; "I had fun."	5.02	1.31	.94
Psychological ownership (Shu & Peck, 2011)	"I feel like this is my chair."; "I feel a very high degree of personal ownership of the chair."	2.13	1.29	.95

Product knowledge (Suh & Chang, 2006)	"I feel very knowledgeable about the product I just examined."; "I feel very confident about my ability to judge the quality of this product."	3.80	1.35	.77
Product attitude (Spears & Singh, 2004)	"Bad/Good"; "Unfavorable/Favorable"	4.87	1.10	.92
Brand attitude (Spears & Singh, 2004)	"Bad/Good"; "Unfavorable/Favorable"	5.64	1.05	.95
Purchase intention (Spears & Singh, 2004)	"I am likely to purchase this chair."; "I intend to purchase this chair."	2.50	1.35	.92
Willingness to pay a price premium (Netemeyer et al., 2004)	"I am willing to pay a higher price for this chair than for other chairs."; "I would be prepared to pay a premium price for this chair."	2.22	1.12	.92
Electronic word-of-mouth (Hennig-Thurau et al., 2004)	"I would recommend this chair online."; "I would share my experience with this chair online."	3.33	1.38	.83

Note. All items were measured on a 7-point scale. Semantic differential items (e.g., product attitude, brand attitude, perceived proximity) were presented with polar adjectives at the endpoints. Reliability values are Cronbach's alpha (α).

Table 3. *Discriminant Validity: Fornell-Larcker Criterion and Heterotrait-Monotrait (HTMT) Ratios*

Concepts	Co-Location	Possible Actions	Perceived Vividness	*M*	*SD*	ω
Co-location	**.76**	.83	.68	3.62	1.37	.85
Possible actions	.81	**.81**	.62	3.37	1.51	.86
Perceived vividness	.65	.56	**.80**	4.30	1.31	.88

Note. Values below the diagonal are inter-construct correlations; diagonal values (bold) are the square root of the average variance extracted (AVE; Fornell & Larcker, 1981); values above the diagonal are heterotrait-monotrait (HTMT) ratios (Henseler et al., 2015). Reliability values are composite reliability (ω).

Table 4. *Overview Table Hypothesis Testing*

Hypothesis	Variable	Dimension of Object Presence		Supported?
		Co-Location	Possible Actions	
H1	Perceived vividness	.59***	.53***	Yes
H2a	Perceived proximity	.25***	.23**	Yes
H2b	Perceived diagnosticity	.39***	.31***	Yes
H2c	Enjoyment	.42***	.40***	Yes
H3	Product knowledge	.39***	.33***	Yes
H4	Psychological ownership	.39***	.43***	Yes
H5a	Product attitude	.40***	.29***	Yes
H5b	Brand attitude	.01	.02	No
H6a	Purchase intention	.30***	.30***	Yes
H6b	Willingness to pay price premium	.36***	.30***	Yes
H6c	Electronic word-of-mouth (eWOM)	.32***	.34***	Yes

Note. This figure shows correlations between the dimensions of object presence and the nomological network variables. Support is based on both dimensions showing a significant relationship in the hypothesized direction. ** $p < .01$, *** $p < .001$.

Table 5. *Final Augmented Reality Experience Scale (ARES) Items for Measuring Object Presence*

Dimension of Object Presence	Item Wording
Co-location	The [AR object] felt like it occupied real space in the room around me.
	The [AR object] felt present in the same space as my body.
	The [AR object] appeared integrated into my environment.
	The boundary between the [AR object] and the real environment felt blurred.
Possible actions	It felt as if I could reach out and touch the [AR object].
	I felt I could directly interact with the [AR object].
	It felt as though my actions could meaningfully affect the [AR object].