VISUAL BIASING EFFECTS: EXPLORING THE IMPACT OF ONLINE PRODUCT VISUALS ON USER BEHAVIOR AND BIASED PROCESSING OF CUSTOMER REVIEWS

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ABSTRACT

The current study investigates the phenomenon of visual biasing effects, exploring how the visual characteristics of a product in digital environments influence consumers' beliefs, attitudes, and information-seeking behaviors. In this research we created a linear progression of visual stimuli by combining package design (plain vs. attractive) and image clarity (low vs. high resolution), ranging from the worst (plain package design with low image resolution) to the best (attractive package design with high image resolution) visual condition. Through three experiments involving 974 participants, we examined how these progressively enhanced product visuals impact dependent variables such as perceived product quality, seller credibility, brand attitudes, and confirmation bias. The results of one-way ANOVAs confirmed that as product visuals become richer, inferential beliefs about product quality and seller credibility, brand attitudes, and selective exposure to customer reviews also increase. Path analyses revealed the mediating processes that underpin these visual biasing effects. The findings demonstrate that the relationship between a product's visual appearance and users' biased processing of customer reviews is mediated by their newly-formed beliefs and brand attitudes about the product. This study highlights that even a single exposure to a product with distinctive visual appeal can induce confirmation biases, manifesting in selective information exposure and biased interpretation of online reviews. These insights are particularly pertinent for practitioners in digital marketing and e-commerce, offering strategies to optimize consumer engagement and information processing in online shopping contexts.

Keywords: Visual biasing effects; Product visual appeals; Inferential beliefs; Brand attitudes; Confirmation biases

1. Introduction

Despite significant progress in understanding confirmation bias, notable gaps remain in the existing body of research. Earlier studies primarily concentrated on how individuals selectively engage with information that aligns with their existing beliefs and attitudes (Eagly et al., 2000; Jonas et al., 2003). This phenomenon is well-documented in scenarios where people's long-standing beliefs and attitudes guide their selective attention to information that supports these beliefs, or they interpret information in a biased manner to confirm them. More recent investigations into pre-decisional distortion, notably by Russo et al. (2008; 2012) and Chaxel et al. (2013; 2018), have broadened our insight, revealing that confirmation bias can affect decision-making even before actual decisions are made. However, these studies predominantly rely on verbal stimuli, such as detailed product information, to exhibit information distortion.

A significant yet underexamined area is the emergence of confirmation bias in response to subtle, peripheral cues, especially those related to product visual appeal. This oversight becomes increasingly pertinent in the context of online shopping, where visual cues are integral. The current study aims to bridge this gap by examining whether confirmation

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bias can influence how consumers process customer reviews in an online setting, specifically in relation to visual cues such as the design quality of a product's packaging and its photographic presentations. In the absence of direct interaction with the product or seller, online consumers often rely on these visual elements to infer product quality and seller credibility. Our research delves into how these visual-based inferences can shape consumer beliefs and contribute to confirmation bias, offering a deeper understanding of how visual cues impact consumer perceptions and information processing in digital commerce.

In the present research, we demonstrate how better product visual appeals, in terms of package design and image clarity, can affect consumers' inferential beliefs about advertised products and attitudes toward advertised brands, and ultimately lead to confirmatory biases when searching for and interpreting information about the products. We refer to this constellation of causes (visual appearance of a product) and effects (on product inferences, attitudes, and confirmatory biases) as visual biasing effects.

We propose and test a new conceptual model of the effects of product visuals on confirmatory biases, mediated by consumers' inferences and attitudes (see Figure 1). We provide experimental evidence that visual-based inferential beliefs and brand attitudes lead to biased search for, and processing of, customer reviews. We use path analysis to reveal the proposed mediating processes underlying the visual biasing effects. This allows better understanding of not only how visuals affect subsequent information search but also to what extent newly developed inferences and attitudes are responsible for the observed condition differences.

There are three studies reported in this paper: Studies 1 and 2 test the primary hypotheses of visual biasing effects (as seen in Figure 1), while Study 3 extends to biased information processing in response to varying product visuals. Study 1 demonstrates how product visuals influence consumers' beliefs and attitudes, leading them to favor reviews that align with their initial perceptions. Study 2 replicates these findings using a different brand and product category, incorporating varied measures to reduce mono-operation bias. To further expand on these results, Study 3 introduces additional dependent variables—information exposure and information distortion—to examine how visual appeal biases consumers' information processing and confirmatory behaviors.

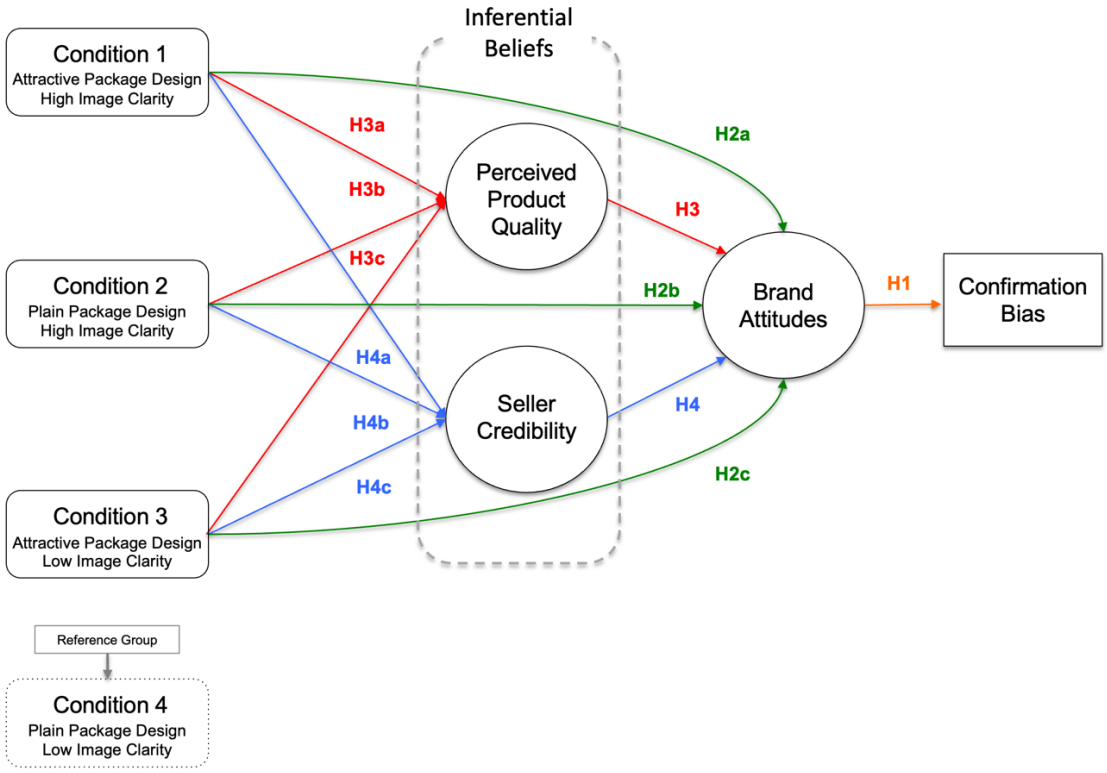

Figure 1: Research Model

2. Conceptual background

2.1. Confirmation bias

People tend to selectively acquire information that supports their pre-existing attitudes, beliefs, or decisions while disregarding contradictory evidence. This phenomenon is known as congenial bias (Eagly et al., 1999) or confirmation bias (Jonas et al., 2001). People process information in a biased manner, at least in part, because they are motivated to avoid cognitive dissonance (Festinger, 1962). For instance, new car owners were more likely to read advertisements for the same car model that they bought than ads for other cars they considered but did not purchase (Ehrlich et al., 1957). People further reinforce their attitudes by interpreting new information in a biased way or by selectively remembering information that aligns with their views (Proctor and Capaldi, 2012).

Much of the research on confirmation biases has focused on well-established, deeply ingrained attitudes and beliefs. For example, studies have involved participants expressing their views on contentious topics such as abortion (Eagly et al., 2000) and mortality (Jonas et al., 2003). Nevertheless, biased processing of information can occur even before a decision is made. For instance, individuals may distort information about two unknown brands to favor their preferred choice, as found by Russo et al. (1998). This distortion persists even when there is little motivation to alleviate cognitive discomfort from decision-making, indicating that individuals favor information aligning with emerging preferences while evaluating products. Building on the findings of Russo and colleagues, our study investigates whether confirmation bias also manifests when consumers encounter a brand for the first time, without any preexisting knowledge or attitudes. However, we examine two types of confirmatory biases: confirmatory information exposure (choosing to view congenial information), and confirmatory information distortion (interpreting neutral information congenially). Further, we examine whether these confirmation biases occur in response to visual information only.

Russo and colleagues demonstrated that biased information seeking occurs prior to decision; however, their research still pertains to attitudes and behaviors driven by verbal messages. Differential attitudinal responses may not be based on issues or messages but may instead be solely induced by visual cues. Consumers may still exhibit confirmation bias even when their preferences are immediately formed in response to an advertised visual stimulus. These considerations are important as vision is the most dominant sense in our sensory system, and we generally give the most importance to visual information when forming impressions (Burgoon et al., 2016). In this research, we demonstrate that people who form positive attitudes toward a brand that they have never seen before will tend to search for and interpret information that confirms their newly formed attitudes.

H1. There is a positive association between brand attitudes and confirmation bias, where individuals with favorable views of a brand are more likely to search for positive reviews.

2.2. Visual appeals

We already know that product visuals elicit a wide range of consumer responses (Bloch, 1995). Numerous studies have demonstrated how the visual appearance of a product influences both cognitive and emotional reactions. For example, package design can shape brand attitudes (Homer and Gauntt, 1992) and create lasting brand impressions (Batra and Homer, 2004). The impact of packaging can be both unexpected (e.g., food in matte packaging is perceived as more natural, tastier, and more purchase-worthy; Marckhgott and Kamleitner, 2019) and predictable (e.g., visually appealing packages hold consumer attention longer and are often preferred over plain packages, even at higher prices; Reimann et al., 2010). Photographic visual cues also affect consumer responses. For example, an eye-tracking study showed that product images on websites attract attention first before product names and price information (Chocarro et al., 2022). Another study revealed that a product depicted with a shadow, compared to the same image without a shadow, is perceived to be heavier and is favored when heaviness is a desirable attribute (e.g., a package of coffee, where heaviness suggests more coffee in the package; Sharma and Romero, 2020).

Throughout the present work, we vary product visual appeals in terms of two variables: package design and image clarity, as these are two of the most prominent product-related visual elements in online shopping environments. In this study, design quality is varied based on whether a product package design is visually attractive or plain. Following prior research on visual aesthetics (Bloch, 1995), package attractiveness or simplicity involves multiple design elements like shape, color, and material, rather than variations in a single attribute. In our studies, the plain package design is minimal, featuring white or off-white backgrounds with basic imagery, while the attractive design is more elaborate, incorporating black backgrounds with stylized imagery (see Appendices 1 and 2). Recent studies highlight how packaging elements can shape consumer perception; for instance, Peng et al. (2023) found that roughness or smoothness in packaging affects perceptions of product healthiness. Similarly, Veflen et al. (2023) demonstrated that specific shape and color cues on cheese packaging—such as round shapes and lighter colors—communicate mildness, while angular shapes and darker colors suggest stronger taste expectations. Building on these findings, we predict that

an attractive package design will foster more favorable evaluations, prompting positive inferences about product attributes and a subsequent positive confirmation bias. This aligns with prior research showing that visually appealing products enhance consumer experiences and help convey meaningful qualities (Bloch, 1995; Hekkert, 2006).

Another factor influencing the visual appeal of a product image is the image's clarity, or resolution. Numerous elements influence image clarity such as color mode (the combinations of color components), contrast, and brightness. Perhaps the most fundamental component of image clarity, though, is image resolution, which refers to the amount of visual information an image can convey (Hunt, 2016). A low-resolution image is difficult to see clearly; a high-resolution image is clear and easy to discern. High quality images facilitate information processing and increase liking, whereas low quality images impede processing and decrease liking (Im et al., 2010). Ryu et al. (2022) found that the image clarity of hotel room photos significantly influenced consumers' inferences about unexperienced service quality. Recent research also indicates that brands' Instagram posts featuring high-clarity images are evaluated more favorably in terms of brand credibility and attitudes, leading to increased social media engagement (Ryu, 2024).

According to the processing fluency theory of aesthetic pleasure, the perceiver's positive processing experience results in increased aesthetic appreciation of a stimulus: the more fluently a stimulus is perceived, the more aesthetic pleasure that stimulus provides. People often prefer visual displays that are easy to process because ease of perception is sometimes mistaken for liking the stimulus (Bornstein and D'Agostino, 1994). The phenomenon of processing fluency is intrinsically affective; high fluency, associated with error-free stimulus processing, tends to produce positive emotions (Winkielman et al., 2003). For example, greater image clarity, such as clearer differentiation of a figure from its background, enhances processing ease and leads to more positive affective responses (Reber et al., 2004). Conversely, factors that hinder perceptual fluency, such as hard-to-read print fonts, can elicit negative reactions (Novemsky et al., 2007). For instance, a disfluency manipulation (e.g., consumable items printed in hard-to-read 10-point gray, italicized, Arial font vs. in the standard 12-point black Times New Roman font) caused purchasable items to be perceived as less valuable (Alter and Oppenheimer, 2008). Building on this concept, low image clarity can lead to a visual slowdown, obstructing both the overall perception of the stimulus and the recognition of individual design features. Consequently, viewers might misinterpret the difficulty in processing caused by low image clarity as a dislike for the stimulus.

We hypothesize linearly increasing positivity in consumer responses such that better product visual appeals will result in more favorable evaluations (inferences and attitudes) which ultimately lead to more positive confirmation biases. In the following experiments, we have four visual conditions that vary in visual quality ranging from worst to best. Given the focus of our study, our primary concern was not the complete independence of each manipulation (package design or image resolution), but rather whether their combined effects created a consistent and systematic pattern in consumer responses.

We expect that a product picture with attractive package design and high image resolution ($C1_{attractivehigh}$) and a product picture with plain package design and low image resolution ($C4_{plainlow}$) would be evaluated most and least favorably, respectively, because they obviously have the best and worst combinations of visual quality. And we anticipate that a product image featuring plain packaging and high image resolution ($C2_{plainhigh}$) will be rated more favorably than one with attractive packaging and low image resolution ($C3_{attractivelow}$). This expectation arises because plain packaging typically receives neutral ratings, while attractive packaging may not fully convey its design appeal if low image clarity interferes with viewers' perception.

According to the Gestalt law, holistic processing occurs by default, allowing individuals to perceive an object as a unified whole before focusing on its individual attributes (Kimchi, 1992). In the context of visual stimuli, a high-resolution image supports this holistic processing by clearly conveying the entire product and its design elements, leading to a more positive consumer perception. Consequently, when image quality is high, as in $C2_{plainhigh}$ (plain design but clear product image), the overall package design is easily recognized, enabling the product's attributes to be accurately perceived. In contrast, low image resolution in $C3_{attractivelow}$ (attractive design but pixelated product image) impairs holistic processing, as poor visual quality disrupts recognition of the product's design and evokes a negative emotional response (i.e., processing fluency; Reber et al., 2004). This impaired recognition can undermine the positive impact of the attractive design, preventing the visual appeal of $C3_{attractivelow}$ from fully conveying its aesthetic value and thus leading to a less favorable consumer reaction compared to $C2_{plainhigh}$. Thus, we expect consumer responses to the experimental conditions to fall into a linear pattern from most to least favorable.

H2a – H2c. Product visuals will positively affect brand attitudes in a linear pattern of increasing favorability in the following order:

Best

H2a: attractive package design with high image clarity has the greatest positive effect on attitudes, followed by

H2b: plain package design with high image clarity, followed by

H2c: attractive package design with low image clarity, followed by
plain package design with low image clarity.
Worst

2.3. Inferential beliefs

The influence of visuals on brand attitudes is often mediated by product attribute beliefs, which are considered to form prior to attitudes. According to expectancy-value theory (Ajzen and Fishbein, 1977), a person's attitude is shaped by both the strength of their beliefs about an object's attributes and their evaluation of those attributes. This theoretical framework assumes that belief formation is a precursor to attitude formation, as beliefs provide the foundational evaluations that shape attitudes. Extensive research supports this view, showing that attitudes are a function of belief strength and evaluation (Middlestadt et al., 1994; Wilkie and Pessemier, 1973; Olson and Maio, 2003). Furthermore, beliefs strongly influence attitudes, with correlations between the two typically ranging from .55 to .80 across various attitude objects (O'Keefe, 1990; Hale et al., 2002). Building on this well-established theory, our study assumes that when consumers are exposed to product images of a new, unfamiliar brand in an online setting, they first form inferential beliefs about product attributes, which then shape their attitude toward the brand.

According to signaling theory, consumers use signals or cues to form impressions and they do so more often when access to product information is limited (Kirmani and Rao, 2000). This is due to information asymmetry such that sellers are fully aware of their product and/or service quality whereas buyers may not know about its true quality prior to actual consumption. Consumers, for instance, often perceive higher advertising costs as signals of greater quality (Kirmani, 1990). Generally, beliefs are assessments of the likelihood that an outcome will occur. Consumers often hold beliefs regarding product attributes and benefits, particularly when they perceive a correlation between them (e.g., expensive products are high quality; Shiv et al., 2005). However, since people seldom have complete product information, they frequently infer the value of missing or undescribed attributes based on the information that is available (Simmons and Lynch, 1991). Such readily available information often pertains to product visual appeals.

Prior research indicates that individuals typically form impressions and make inferences about objects or events quickly and effortlessly. This spontaneous appraisal is frequently influenced by the physical appearance of a stimulus (Pham et al., 2001). For instance, images in advertising can shape consumers' assumptions about unstated product attributes (Smith, 1991). Participants who viewed ads containing diverse images but no text inferred various unmentioned attributes of the featured brands (e.g., an image of a fluffy cat evoked this response, "I would think that that ad for a facial tissue would be soft, nice to touch and feel," Scott and Vargas, 2007, p. 248). Another study has found that the size of the handbag pictures (small vs. large) affects mental intangibility of products and perceived amount of information. Participants perceived smaller handbag pictures to be more mentally intangible than larger pictures. When picture size was small, viewing multiple pictures was perceived as providing more information than viewing one picture (Song and Kim, 2012). Thus, the visual attributes of advertised products can lead consumers to form varying inferences and expectations about those products.

In an online store, consumers often need to infer two critical aspects of product information: the quality of the product and the credibility of the seller (Mavlanova et al., 2012). Due to the absence of direct contact with both the physical product and the seller, online consumers frequently experience uncertainty and struggle to assess the likelihood of the product performing well and the seller being trustworthy (Sun and Wang, 2012). In this research, we examine consumers' inferential beliefs about these attributes, and to what extent such visual-based inferences and attitudes can ultimately lead to confirmation bias.

Perceived product quality. Perceived product quality is a consumer's overall judgment of a product's performance, excellence, or superiority (Zeithaml, 1988). In assessing product quality, consumers typically rely on attributes such as price (Dodds et al., 1991), brand name (Brucks et al., 2000), and brand image (Homer, 2008). In addition to these extrinsic cues, the visual appearance of a product may also be used to evaluate its quality. Several studies have provided evidence for the role of visual cues as an indicator of product quality. For example, perceived product quality mediated the effects of package design on consumers' price expectations (Orth et al., 2010), and the visual appeal of a website (e.g., background color and color tabs) influenced consumers' perceptions of product quality (Wells et al., 2011). Here, we predict a positive effect of product visuals on perceived product quality increasing linearly with visual quality, following H2, above.

H3a – H3c. Product visuals will affect brand attitudes via perceived product quality in which improving visual quality (see H2) results in more favorable inferential beliefs about product quality.

Seller credibility. Seller credibility reflects the belief that a seller is competent and professional and will reliably fulfill the promised transaction terms (Pavlou and Dimoka, 2006). Prior research has focused on extrinsic cues relevant

to online buyer-seller relationships including perceived risk (Grewal et al., 1994), trust in store (Jarvenpaa et al., 1999), and selling effectiveness (Wagner et al., 2003). Several studies have examined the role of visual cues in shaping consumers' assessments of seller credibility. For instance, actual product photographs tend to increase auction bids because they signal that the seller genuinely possesses the item (Van Der Heide et al., 2013). Additionally, the presence of multiple product pictures in internet auctions can signal both product quality and seller credibility (Li et al., 2009); professionally designed Web pages were perceived to be credible (Robins and Holmes, 2008). We propose that consumers will infer greater seller credibility as the visual appearance of a product image improves, and such visual-based inferential beliefs about seller credibility will positively affect brand attitudes.

H4a – H4c. Product visuals will affect brand attitudes via seller credibility in which improving visual quality (see H2) results in more favorable inferential beliefs about seller credibility.

2.4. Outline of visual biasing effects

We propose that consumers' responses to advertised product appearances, varying in package design and image clarity, involve inferring product quality and seller credibility, forming brand attitudes, and favoring reviews that align with these perceptions. We explore these visual biasing effects across three experiments. The current research was carried out following ethical guidelines and was approved by the institutional review board (IRB).

Study 1 demonstrates that product visuals shape consumers' beliefs and attitudes, leading them to seek reviews that match their perceptions, despite consistent product and seller information across all conditions. Study 2 uses visual stimuli from a different brand and product category, employing varied measures to replicate findings and avoid mono-operation bias.

We use different measures because any single operationalization of a construct is likely to underdetermine the construct, and tap irrelevant constructs, thus making inferences about relationships difficult. The use of multiple measures across studies taps different dimensions of the intended construct, and creates a heterogeneity of irrelevancies, strengthening inferences (see Shadish et al., 2002, p. 73). Because Studies 1 and 2 relied on a single measure of confirmation bias, Study 3 was conducted to provide additional evidence for confirmatory information processing with additional dependent variables. In Study 3, we measure consumers' cognitive responses to visual stimuli with two alternative confirmation bias measures: selective exposure and information distortion. We show how better product visual appeals result in biased information processing. More details and formal hypotheses are presented prior to Study 3.

3. Study 1

3.1. Design and stimuli

This study utilized a 2 (design quality: attractive vs. plain package design) x 2 (image clarity: high vs. low image resolution) factorial design. For Study 1, we introduced a fictitious paint brand, Prizm, featuring a novel package design; design quality (attractive vs. plain) was varied while maintaining a consistent brand name and product details (refer to Appendix 1 for details). Image clarity was altered between high and low resolution. The experimental stimuli were developed with input from a professional designer and underwent pretesting to ensure accurate representation of the designated levels of package design and image clarity.

3.2. Pretest of stimuli

We conducted pretests to ensure a linear progression in visual appeal across ad stimuli, arranged as $C4_{plainlow} < C3_{attractivelow} < C2_{plainhigh} < C1_{attractivehigh}$. One hundred twenty-six participants from Amazon Mechanical Turk (MTurk) were recruited for pretesting the manipulations of design and image clarity. Participants were randomly assigned to evaluate one of four experimental stimuli, assessing visual quality. Package design quality was measured using four items on seven-point scales (unappealing/appealing, bad/good design, poorly/well-designed, unstylish/stylish), and image clarity was assessed with three items on seven-point scales (blurry/sharp, low/high resolution, lossy/lossless). Ratings were aggregated into indices for design quality, image clarity, and overall visual quality. Independent samples *t*-tests confirmed effective manipulation of package design quality (M_{plain} = 4.39, SD_{plain} = 1.53, $M_{attractive}$ = 5.29, $SD_{attractive}$ = 1.24, 95% CI [.41, 1.39], $t(124) = 3.61$, $p < .001$) and image clarity (M_{low} = 2.50, SD_{low} = 1.32, M_{high} = 5.58, SD_{high} = 1.16, 95% CI [2.64, 3.52], $t(124) = 13.87$, $p < .001$) were successfully manipulated. More important, a contrast analysis confirmed that there was a significant linear trend in the overall visual quality index from the worst to the best visual ad conditions, $t(122) = 9.81$, $p = .001$, $r_{contrast} = .66$. The results confirmed that four visual stimuli ranged from the worst to the best visual ad conditions, as predicted, providing preliminary support for the linear patterns predicted in H2, H3, and H4.

3.3. Measures and procedure

The manipulation check questions remained consistent with those from the pretest. In an online shopping context, we measured participants' perceptions of product quality, seller credibility, and brand attitudes using seven-point scales adapted from prior research. The dependent measures were presented in a randomized order to minimize any potential order effects. Detailed scale information, including reliability and validity, can be found in Online Appendix A for variable means and standard deviations, and Appendix B for item specifics.

Product quality was assessed through four items related to reliability, quality (Dodds et al., 1991), and performance (Brucks et al., 2000). Seller credibility was evaluated using six items reflecting credibility, expected delivery conditions (Pavlou and Dimoka, 2006), and seller expertise (Ohanian, 1990). Brand attitudes were gauged via five items from Spears and Singh (2004). To measure confirmation bias, participants were asked to select the star rating—from one to seven (negative to positive)—of customer reviews they would prefer to read, with higher ratings indicating a preference for more positive reviews. Trust propensity was also measured as a control variable to account for individual differences in trust towards a product or seller, using four items from Lee and Turban (2001). Participants rated their general tendency to trust using this scale.

We recruited 423 participants from MTurk in the United States, who agreed to participate in the study. None of these Study 1 participants were involved in the pretest. Nine inattentive respondents were excluded from data analysis based on response time to address the issue of careless/insufficient responses (i.e., the total time for completing the study was less than one minute; Curran 2016) so a total of 414 responses were analyzed (46.4 % male; M_{age} = 34.95, SD_{age} = 11.29, range: 18-69).[2] Participants were randomly assigned to one of four ad conditions in which image quality and package design were manipulated, but product and seller information was identical across all conditions: $C1_{goodhigh}$ (N = 106), $C2_{plainlow}$ (N = 105), $C3_{goodlow}$ (N = 103), and $C4_{plainlow}$ (N = 100). Then they were asked to respond to the dependent measures, manipulation check items, and some demographic questions.

3.4. Results

First, the manipulation checks confirmed that participants perceived the level of product visual appeals as intended. Both package design quality (M_{plain} = 3.86, SD_{plain} = 1.70, $M_{attractive}$ = 5.37, $SD_{attractive}$ = 1.41, $t(412) = 9.90$, p = .001) and image clarity (M_{low} = 2.15, SD_{low} = 1.38, M_{high} = 5.70, SD_{high} = 1.04, $t(412) = 27.70$, p = .001) were successfully manipulated. Also, the four visual stimuli linearly ranged from the worst to the best visual ad condition, $t(410) = 20.96$, p = .001, providing additional support for the linear patterns predicted in H2, H3, and H4.

Path analysis was conducted using data from 414 participants. The model demonstrated an acceptable fit: χ^2 (7) = 26.76, p < .001; CFI = .986; TLI = .955; SRMR = .034; RMSEA = .083 with 90% CI [.051, .118]. Standardized path coefficients, estimates, and R^2 values for the model are detailed in Table 1. Only three experimental conditions are reported in Table 1 because three dummy-coded variables were used to represent the total number of visual conditions (i.e., d – 1 dummy-coded variables should be used in path analysis when d represents the number of conditions in the experiment; Russell et al., 1998). $C4_{plainlow}$ served as the reference group in this analysis, meaning that each of the three conditions was compared to $C4_{plainlow}$, the least favorable visual condition. The direct and indirect effects of each visual condition and mediating variables on confirmation bias are detailed on the left side of Table 2.

Selective exposure was significantly influenced by brand attitudes (β = .46, p < .001), accounting for 21.5 % of the variance (R^2 = .22). These results fully support H1. The relationship between experimental conditions and brand attitudes was hypothesized to be mediated by perceived product quality and seller credibility. Brand attitudes were significantly influenced by perceived product quality (β = .49, p < .001) and seller credibility (β = .34, p < .001). Additionally, $C1_{attractivehigh}$ (β = .18, p < .001) and $C2_{plainhigh}$ (β = .08, p = .011) had significant direct effects, whereas $C3_{attractiveplain}$ did not show a significant effect on brand attitudes compared to $C4_{plainlow}$, β = .02 (p > .05). These results support H2a and H2c, but H2b was not supported. Perceived product quality was significantly influenced by all three visual conditions: $C1_{attractivehigh}$ (β = .53, p < .001), $C2_{plainhigh}$ (β = .29, p < .001), and $C3_{attractiveplain}$ (β = .18, p = .001), while controlling for trust propensity (β = .25, p < .001). These predictors explained 26.3% of the variance (R^2 = .26), supporting H3a, H3b, and H3c. Similarly, seller credibility was significantly influenced by $C1_{attractivehigh}$ (β = .51, p < .001) and $C2_{plainhigh}$ (β = .28, p < .001), along with trust propensity (β = .25, p < .001). However, $C3_{attractiveplain}$ showed a marginal effect (β = .10, p = .086). These predictors explained 27.3% of the variance (R^2 = .27). These results support H4a and H4b, but H4c was not supported.

To complement the path analysis and test for a linear pattern in the effect of visual manipulation, we conducted a one-way ANOVA with contrast analysis (see Table 3). The contrast analysis confirmed a significant experimental effect on perceived product quality, $F(3, 410) = 34.46$, p < .001, seller credibility, $F(3, 410) = 36.37$, p < .001, brand attitudes, $F(3, 410) = 49.70$, p < .001, and selective exposure, $F(3, 410) = 4.34$, p = .005. Further analysis revealed a

[2] The determination of the sample size was based on the guidance provided by Kline (2005).

significant linear trend across all four variables. Specifically, as product visuals improved from the worst ($C4_{plainlow}$) to the best ($C1_{attractivehigh}$) condition, participants perceived the product as higher in quality, $t(410) = 10.48$, $p < .001$, $r_{contrast} = .45$, and viewed the seller as more credible, $t(410) = 10.27$, $p < .001$, $r_{contrast} = .45$. This trend was also evident in brand attitudes, with participants forming increasingly favorable evaluations, $t(410) = 11.90$, $p < .001$, $r_{contrast} = .50$. Additionally, selective exposure to customer reviews followed a significant linear pattern, $t(410) = 3.29$, $p = .001$, $r_{contrast} = .17$, indicating that participants increasingly sought information that aligned with their evolving brand attitudes as product visuals improved. Taken together, these results provide strong support for the visual biasing effect, demonstrating that more visually appealing product images lead to systematically more positive consumer perceptions and a greater tendency toward biased information processing.

Table 1: Results of Path Analysis

		Study 1						Study 2						Study 3				
		b	SE	β	Sig.	H Testing	R^2	*b*	SE	β	Sig.	H Testing	R^2	*b*	SE	β	Sig.	H Testing
CB	~ ATT	.520	.051	.463	$p < .001$	H1 supported	.215	.572	.050	.537	$p < .001$	H1 supported	.288	.586	.071	.544	$p < .001$	H1 supported
ATT	~ $C1_{attractivehigh}$	.679	.132	.182	$p < .001$	H2a supported	.757	.126	.120	.032	$p = .293$	H2a failed	.788	1.677	.334	.509	$p < .001$	H2a supported
	~ $C2_{plainhigh}$	.087	.138	.023	$p = .529$	H2b failed		.101	.111	.026	$p = .365$	H2b failed		1.372	.368	.399	$p = .003$	H2b supported
	~ $C3_{attractivelow}$	.311	.123	.083	$p = .011$	H2c supported		.103	.105	.027	$p = .325$	H2c failed		1.199	.402	.315	$p < .001$	H2c supported
	~ PPQ	.566	.065	.492	$p < .001$	H3 supported		.702	.062	.618	$p < .001$	H3 supported		—				
	~ SC	.383	.061	.340	$p < .001$	H4 supported		.367	.068	.298	$p < .001$	H3 supported		—				
PPQ	~ $C1_{attractivehigh}$	1.708	.160	.526	$p < .001$	H3a supported	.263	1.775	.178	.521	$p < .001$	H3a supported	.298	—				
	~ $C2_{plainhigh}$	.929	.183	.285	$p < .001$	H3b supported		.747	.179	.219	$p < .001$	H3b supported		—				
	~ $C3_{attractivelow}$	.583	.182	.178	$p = .001$	H3c supported		.389	.170	.115	$p = .022$	H3c supported		—				
	~ TP	.224	.042	.249	$p < .001$			.295	.041	.314	$p < .001$			—				
SC	~ $C1_{attractivehigh}$	1.677	.172	.507	$p < .001$	H4a supported	.273	1.425	.165	.454	$p < .001$	H4a supported	.295	—				
	~ $C2_{plainhigh}$	.916	.182	.276	$p < .001$	H4b supported		.587	.170	.187	$p = .001$	H4b supported		—				
	~ $C3_{attractivelow}$	.324	.189	.097	$p = .086$	H4c failed		.172	.171	.055	$p = .315$	H4c failed		—				
	~ TP	.230	.044	.252	$p < .001$			.313	.040	.362	$p < .001$			—				
PPQ	~~SC	1.130	.103	.755	$p < .001$			1.054	.087	.745	$p < .001$			—				

Note: PPQ (perceived product quality), SC (seller credibility), ATT (attitudes toward the brand), CB (confirmation bias), TP (trust propensity); H1, H2a, H2b, and H2c for Study 3 reflect the replication of the propositions outlined in H1 and H2, which predict that better visual appeals lead to a more positive bias in customer reviews via brand attitudes. For the specific hypotheses in Study 3, H5a (information exposure) was non-significant, while H5b (information distortion) was significant.

Table 2: Direct and Indirect Effects on Confirmation Bias

					Study 1			Study 2			Study 3		
	Direct Effects					Sig.	Total		Sig.	Total		Sig.	Total
ATT			→ CB	H1	.463	S	.463	.537	S	.463	.544	S	.544
	Indirect Effects												
PPQ		→ ATT	→ CB	H3	.228	S	.228	.332	S	.332	—		
SC		→ ATT	→ CB	H4	.157	S	.157	.160	S	.160	—		
$C1_{attractivehigh}$		→ ATT	→ CB	H2a	.019	S	.112	.017	NS	.149	.509	S	.277
	→ PPQ	→ ATT	→ CB	H3a	.056	S		.093	S		—		
	→ SC	→ ATT	→ CB	H4a	.037	S		.039	S		—		
$C2_{plainhigh}$		→ ATT	→ CB	H2b	.002	NS	.052	.013	NS	.068	.399	S	.217
	→ PPQ	→ ATT	→ CB	H3b	.030	S		.039	S		—		
	→ SC	→ ATT	→ CB	H4b	.020	S		.016	S		—		
$C3_{attractivelow}$		→ ATT	→ CB	H2c	.009	S	.035	.014	NS	.040	.315	S	.171
	→ PPQ	→ ATT	→ CB	H3c	.019	S		.021	S		—		
	→ SC	→ ATT	→ CB	H4c	.007	NS		.005	NS		—		

Note: S (significant), NS (nonsignificant)

Table 3: Results of Contrast Analysis

	Study 1				Study 2					Study 3			
Construct	VC	SE	*t*	$r_{contrast}$	VC	SE	*t*	$r_{contrast}$	Construct	VC	SE	*t*	$r_{contrast}$
Perceived Product Quality	5.634	.538	10.479***	.445	5.641	.597	9.452***	.429	–	–	–	–	–
Seller Credibility	5.794	.564	10.269***	.450	4.648	.562	8.263***	.384	Review Positivity Index	.138	.246	.559	.05
Brand Attitudes	7.223	.607	11.897***	.500	6.043	.692	8.737***	.403	Brand Attitudes	5.203	1.076	4.834***	.52
Confirmation Bias	2.70	.819	3.291**	.165	3.99	.781	5.105***	.249	Confirmation Bias	3.190	1.113	2.862**	.28

Note: The contrast represents lambda weights of (3, 1, -1, -3) assigned to condition 1 to 4; statistics based on robust tests of equality of variances are reported due to significant Levene's test; VC (Value of Contrast); $r_{contrast}$ of 0 to .1 is considered a small effect size, $r_{contrast}$ of .148 to .243 is considered a medium effect size, and $r_{contrast}$ of .287 to .371 is considered a large effect size (Rosnow and Rosenthal, 1996)

Significance level: *** $p < .001$; ** $p < .05$

3.5. Discussion

We explored how visuals influence information processing and the extent to which inferential beliefs and attitudes toward the product mediate these visual biasing effects. Path analysis elucidated the mediating processes that underlie differences in brand attitudes and confirmation bias based on visual conditions. The model demonstrated that, in addition to the direct effects of $C1_{attractivehigh}$ and $C3_{plainlow}$ on brand attitudes, perceived product quality and seller credibility served as mediators between product visuals and brand attitudes, which, in turn, directly influenced confirmation bias. In simpler terms, participants evaluated the visual appearance of a product image with varying package designs and image clarity, formed inferential beliefs about product quality and seller credibility, developed attitudes toward the brand, and selectively engaged with customer reviews that aligned with their preferences. By incorporating contrast analysis, we further validated that variations in product visuals not only shape inferential beliefs and brand attitudes but also drive selective engagement with customer reviews in a linear pattern. The results confirm that more visually appealing product images lead to increasingly positive consumer perceptions and greater biased information processing.

Overall, higher visual appeal led to more favorable inferential beliefs and greater selective exposure to customer reviews. However, H2b and H4c were not supported. First, the direct effect of $C2_{plainhigh}$ on brand attitudes was not significantly greater than that of $C4_{plainlow}$, the worst visual condition. This suggests that when examining the direct impact of product visuals on brand attitudes—beyond the mediation of perceived product quality and seller credibility—the difference between these two conditions does not exert an independent effect. Since $C2_{plainhigh}$ and $C4_{plainlow}$ share the same package design, their only difference lies in image clarity (high vs. low resolution). The results indicate that image quality alone does not significantly impact brand attitudes above and beyond the mediating effects of perceived product quality and seller credibility. In fact, $C2_{plainhigh}$ had significant effects on brand attitudes through both perceived product quality and seller credibility, suggesting that the impact of this visual condition on brand attitudes is fully mediated.

In addition, $C3_{attractivelow}$ did not significantly influence seller credibility compared to $C4_{plainlow}$. These two conditions differ only in package design ($C3_{attractivelow}$ has an attractive package, while $C4_{plainlow}$ has a plain design), but both have low image quality. This suggests that the advantage of an attractive package design is not effectively conveyed when image quality is low. In other words, when the image resolution is poor, consumers may struggle to perceive and appreciate the benefits of an attractive package design, making it ineffective in influencing seller credibility. More importantly, this finding underscores the critical role of image quality in online product presentation. Even if a package design is visually appealing, a low-resolution image can significantly harm seller credibility. Consumers may interpret pixelated or blurry images as a lack of attention to detail on the part of the seller, reducing their trust in the seller's professionalism and reliability. This finding highlights the potential consequences of poor image quality in digital marketplaces, where sellers' credibility is often inferred from product images alone.

Study 1 offers strong support for visual biasing effects; however, these results may be limited to the specific set of visual stimuli and measures used in the first study. To address this limitation, Study 2 was undertaken to provide a close conceptual replication, advancing the findings in at least three ways (Crandall and Sherman, 2016). First, conceptual replications increase confidence in the reliability and validity of the effects. Second, we improve external validity by using different visual stimuli, a different product category, and a different set of respondents to examine whether the effects generalize across different contexts. Third, we hope to improve construct validity by using different measures of the same underlying concepts (Shadish et al., 2002).

4. Study 2

4.1. Method

In Study 2, we introduced a new corn soup brand named Midnight Farmland, employing the same manipulations of product visuals as in Study 1 (refer to Appendix 2). We utilized different measures for the same key constructs and tested the hypotheses established in Study 1. Specifically, we examined whether product visuals influence consumers' inferential beliefs and brand attitudes, subsequently leading them to exhibit confirmatory bias when selecting product reviews.

4.2. Pretest of stimuli

A total of 125 responses were collected from MTurk (all in the United States) to pretest the design and image clarity, employing a between-participants design identical to Study 1. The pretest results verified that the level of package design quality (M_{plain} = 2.88, SD_{plain} = 1.52, $M_{attractive}$ = 4.23, $SD_{attractive}$ = 1.74, $t(123) = 4.65$, $p < .001$) and image clarity (M_{low} = 2.20, SD_{low} = 1.09, M_{high} = 4.94, SD_{high} = 1.24, $t(123) = 13.07$, $p < .001$) were successfully manipulated. A contrast analysis also showed that there was a significant linear trend in the visual quality index from the worst to the best visual condition, $t(121) = 9.67$, $p = .001$, again providing initial support for the linear pattern predicted in H2, H3, and H4.

4.3. Measures and procedure

We recruited 437 research participants, who had not participated in the previous study, from MTurk. Twenty-three inattentive respondents were excluded from data analysis as in Study 1. A total of 414 responses were analyzed for Study 2 (58.7% male; M_{age} = 34.76, SD_{age} = 10.74, range: 19-74; all in the United States). This study replicated the procedures of Study 1, with the addition of measurement scales that varied slightly but were also sourced from established literature. Detailed descriptions and item specifics are available in Online Appendix A for descriptive statistics and Appendix B for item details.

Participants evaluated product quality using four items that represent quality (Low and Lamb, 2000), dependability (Dodds et al., 1991), and superiority (Becker et al., 2011). Seller credibility was assessed through six items reflecting trustworthiness and competence (Ohanian, 1990), and expected delivery condition (Pavlou and Dimoka, 2006). Brand attitudes were measured with five items adapted from previous research (Mitchell and Olson, 2000; Aggarwal, 2004; Walsh et al., 2010; Voss et al., 2003). Information choice was gauged by asking participants to select customer reviews based on the number of stars, ranging from one (unfavorable) to seven (favorable), which indicates their preference for more positive reviews. This approach, different from methods that rely on the attractiveness of information titles for selective exposure (Hart et al., 2009; Fischer, 2011), aims to control for headline attractiveness by using a numeric star rating system, akin to typical online review displays. This method of measuring selective exposure—focusing on the number of stars—provides ecological validity and controls for information attractiveness, essential for examining confirmation bias. As in the initial study, participants' propensity to trust was also measured using the same four-item scale.

4.4. Results

Package design and image clarity were assessed using the same sets of items as in Study 1. Manipulation checks showed that package design quality (M_{plain} = 3.15, SD_{plain} = 1.65, $M_{attractive}$ = 4.53, $SD_{attractive}$ = 1.76, $t(412)$ = 8.22, $p < .001$), image clarity (M_{low} = 2.36, SD_{low} = 1.47, M_{high} = 5.25, SD_{high} = 1.20, $t(412)$ = 21.95, $p < .001$), and a linear trend in visual appeals, $t(410)$ = 17.36, p = .001, were all successfully manipulated. These results provide further support for the linear pattern predicted in H2, H3, and H4.

Path analysis was conducted using data from 414 participants. The model demonstrated an acceptable fit: $\chi^2(7)$ = 32.08, $p < .001$; CFI = .985; TLI = .952; SRMR = .032; RMSEA = .093 with 90% CI [.063, .125]. Selective exposure was significantly influenced by attitudes toward the brand (β = .54, $p < .001$), accounting for 28.8% of the variance (R^2 = .29). These results fully support H1. Brand attitudes were significantly influenced by perceived product quality (β = .62, $p < .001$) and seller credibility (β = .30, $p < .001$). However, $C_{goodhigh}$ (β = .03), $C_{plainhigh}$ (β = .03), and $C_{goodlow}$ (β = .03) did not show significant effects (all ps > .05). These predictors explained 78.8% of the variance in brand attitudes (R^2 = .79). These results failed to support H2a-c. Perceived product quality was significantly influenced by $C_{goodhigh}$ (β = .52, $p < .001$), $C_{plainhigh}$ (β = .22, $p < .001$), $C_{goodlow}$ (β = .12, p = .022), and trust propensity (β = .31, $p < .001$), explaining 29.8% of the variance (R^2 = .30). These results support Hypotheses 3a-c. Similarly, seller credibility was significantly influenced by $C_{goodhigh}$ (β = .45, $p < .001$), $C_{plainhigh}$ (β = .19, p = .001), and trust propensity (β = .36, $p < .001$), while $C_{goodlow}$ did not show a significant effect (β = .06, $p > .05$). These predictors explained 29.5% of the variance in seller credibility (R^2 = .30). These results support H4a and H4b, but H4c was not supported.

As in Study 1, we conducted a one-way ANOVA with contrast analysis (see Table 3). The contrast analysis confirmed a significant experimental effect on perceived product quality, $F(3, 410) = 33.94$, $p < .001$, seller credibility, $F(3, 410) = 26.88$, $p < .001$, brand attitudes, $F(3, 410) = 28.80$, $p < .001$, and selective exposure, $F(3, 410) = 9.96$, $p < .001$. Further analysis revealed a significant linear trend across all four variables. Specifically, as product visuals improved from the worst ($C4_{plainlow}$) to the best ($C1_{attractivehigh}$) condition, participants perceived the product as higher in quality, $t(410) = 9.45$, $p < .001$, $r_{contrast}$ = .43, and viewed the seller as more credible, $t(410) = 8.26$, $p < .001$, $r_{contrast}$ = .38. This trend was also evident in brand attitudes, with participants forming increasingly favorable evaluations, $t(410) = 8.74$, $p < .001$, $r_{contrast}$ = .40. Additionally, selective exposure to customer reviews followed a significant linear pattern, $t(410) = 5.11$, $p < .001$, $r_{contrast}$ = .25, indicating that participants increasingly sought information that aligned with their evolving brand attitudes as product visuals improved. Taken together, these results provide strong support for the visual biasing effect, demonstrating that more visually appealing product images lead to systematically more positive consumer perceptions and a greater tendency toward biased information processing.

Thus, both $C1_{attractivehigh}$ and $C2_{plainhigh}$ had significant indirect effects on confirmation bias through seller credibility and brand attitudes, confirming the robustness of the visual biasing effects across different visual conditions and product categories. This replication strengthens our understanding of how product visuals can shape consumer inferences and preferences, influencing their subsequent information-seeking behaviors.

4.5. Discussion

We replicated the hypotheses tested in Study 1 across a different product category using diverse visual stimuli and measurement approaches, further underscoring the robustness of the observed visual biasing effects. The

appearance of a product influenced participants to formulate inferential beliefs about both the product and the seller, develop brand attitudes, and selectively engage with customer reviews that aligned with their initial perceptions. The results of the contrast analysis fully replicated the findings from Study 1, confirming that as product visuals improved, inferential beliefs, brand attitudes, and selective exposure increased in a systematic linear pattern. However, in Study 2, the direct effects of visual conditions on brand attitudes were not significant. While Study 1 showed significant direct effects for $C1_{attractivehigh}$ and $C3_{attractivelow}$, Study 2 revealed no such direct effects. This contrasts with the strong and consistent indirect effects of visual cues on brand attitudes, which were mediated by inferential beliefs in both studies.

These findings suggest that the influence of product visuals on consumer attitudes is entirely driven by inferential beliefs rather than a direct visual-attitude relationship. In other words, participants did not form brand attitudes based solely on visual appeal. Instead, their brand attitudes emerged through the visual-inference-attitude route, rather than a direct visual-attitude route. This variation highlights the conditional nature of visual influences on consumer attitudes and suggests the need for further research into contextual factors that may shape these effects. One possible reason for the inconsistent results in the direct impact on brand attitudes may be the use of different product categories.

The influence of visual bias on aesthetic products (such as house paint in Study 1) could be driven by emotional responses, while for utilitarian products (like corn soup in Study 2), it might be primarily influenced by cognitive responses due to heightened concerns about food safety. In the case of house paint, product visual appeals may directly shape attitudes, given their relevance to visual experience, particularly color. However, when it comes to soup, consumers might form attitudes by making inferences about product quality and the trustworthiness of the seller, especially considering the potential risks associated with food products. Research on food perception has highlighted that both performance risk (i.e., whether the product lives up to its advertised claims) and physical risk (i.e., the safety of the product for consumption) are crucial factors for consumers (De Jonge et al., 2007). Given the higher perceived risk of food products, consumers may place greater emphasis on quality and the credibility of the seller rather than the visual appeal of the product. This insight also provides a potential explanation for the partial support of hypothesis 4 across both studies.

The lack of a significant difference between $C3_{attractivelow}$ and $C4_{plainlow}$ in terms of the mediating variable, seller credibility, suggests that image clarity played a more decisive role in shaping consumers' inferential beliefs. Specifically, when photographic image clarity was low, the attractiveness of the package design became less influential, indicating that consumers relied more on image resolution as a cue for assessing the seller's credibility rather than the aesthetic appeal of the product packaging itself.

5. Study 3

Our research has explored how the visual presentation of a product influences consumers' preferences for selecting congruent information in customer reviews, and how these effects are mediated by consumer inferences and attitudes. However, the findings from both studies are constrained by their reliance on participants' self-reported intentions to seek congruent information, assessed using a single-item measure for confirmation bias. Biased information processing manifests in three distinct forms: (a) actively seeking information that aligns with pre-existing beliefs, (b) dismissing information that contradicts these beliefs, and (c) interpreting ambiguous information in a way that supports existing preferences (Polman and Russo, 2012). The first two forms pertain to different approaches to information exposure—seeking versus rejecting—while the third form relates to the biased interpretation of information. In Studies 1 and 2, consumers' confirmation bias reflects the first (and, indirectly, the second) type of information exposure: seeking congenial (and avoiding uncongenial) information. To strengthen and expand visual biasing effects, we tested whether product visuals could also cause distorted interpretation of information.

Two new dependent variables were examined in Study 3 (see Appendix 3). First, participants were asked to indicate the number of positive, neutral, and negative customer reviews that they would like to read. As observed in Studies 1 and 2, confirmatory bias in this measure of *information exposure* is demonstrated by participants choosing more positive reviews as the visual quality of the product increases. Second, they were presented with a set of thirteen customer reviews (seven neutral, three positive, three negative) and asked to indicate how favorable or unfavorable to the advertised brand the reviews were. We designed this task following prior research on confirmatory information processing (Chaxel and Han, 2018). Pretesting confirmed that the seven neutral reviews were not statistically different from the midpoint of four on seven-point scales (anchored by favorable/unfavorable; $M_{neutral} = 4.13$, $t(48) = .91$, $p > .05$) whereas three positive ($M_{positive} = 6.32$, $t(48) = 21.29$, $p < .001$) and three negative ($M_{negative} = 2.59$, $t(48) = -6.44$, $p < .001$) were different from the midpoint, in the expected directions. Confirmatory bias on this *information distortion* measure would be indicated by rating neutral reviews more favorably as product visuals become richer. Consistent with Studies 1 and 2, we predict that participants will develop favorable attitudes and engage in biased information

processing as product visuals become richer. In order to minimize respondent fatigue and non-response rate (Johnson et al., 1990) we did not measure inferential beliefs in Study 3.

H5. Better product visuals will positively affect brand attitudes, which lead to more positive a) information exposure and b) information distortion.

5.1. Method

We recruited 200 research participants, who had not participated in either of the previous studies, from MTurk. Fifty four respondents were excluded from data analysis to address the issue of careless/insufficient responses (e.g., the total time for completing the survey was less than one minute; Curran 2016). A total of 146 responses were analyzed; $C1_{attractivehigh}$ ($N = 45$), $C2_{plainhigh}$ ($N = 39$), $C3_{attractivelow}$ ($N = 29$), and $C4_{plainlow}$ ($N = 33$). Respondents' ages ranged from 19 to 68 years old ($M = 36.32$, SD = 11.34; all in the United States). Eighty-two participants were male (56.2%) and 64 participants were female (43.8%). Study 3 used the same stimuli (*Prizm* house paint) and followed a similar procedure as in Study 1. This time, however, they were asked to complete the two dependent measures (selective information exposure and biased information interpretation). An index of information exposure bias was calculated by subtracting the number of chosen negative reviews from the number of positive ones and dividing the result by the total number of reviews (White and Harkins, 1994). This provides a measure with a possible (and an actual) range of -1 to 1 ($M = .34$, SD = .34). This is to explore the amount of positive reviews participants indicated to view relative to negative ones.

5.2. Results

As in Study 1, manipulations worked as intended. There was a significant linear trend in the overall visual quality index from the worst to the best visual ad conditions, $t(142) = 9.11$, $p < .001$. We conducted a one-way ANOVA to see whether the visual manipulation affected consumers' biased information processing (see Table 3). The contrast analysis confirmed a significant experimental effect on brand attitudes, $F(3, 116) = 9.82$, $p < .001$, and information distortion bias, $F(3, 142) = 2.66$, $p = .05$. The results showed that there was a significant linear trend on brand attitudes, $t(61.26) = 4.83$, $p < .001$, and information distortion bias, $t(97.72) = 2.86$, $p = .005$. On the other hand, we found no significant linear trend for information exposure bias, $F(3, 142) = 1.19$, $p > .05$, $r_{contrast} = .05$. Taken together, the results support only H5b, indicating that as the visual appeal of the product picture increased, people form more favorable brand attitudes and interpret a set of neutral customer reviewers more positively.

Path analysis was used to explore the visual biasing effects through brand attitudes. The model demonstrated an acceptable fit: χ^2 (3) = 1.36, $p > .05$; CFI = 1.00; TLI = 1.06; SRMR = .023; RMSEA = .000 with 90% CI = .000 ~ .101. Attitudes toward the brand significantly influenced information distortion bias ($\beta = .54$, $p < .001$), accounting for 31% of the variance ($R^2 = .30$). The results showed that all three visual conditions had positive impacts on brand attitudes compared to $C4_{plainlow}$, with coefficients of $\beta = .51$ ($p < .001$) for $C1_{attractivehigh}$, $\beta = .40$ ($p < .001$) for $C2_{plainhigh}$, and $\beta = .32$ ($p = .003$) for $C3_{attractiveplain}$. Better visual condition positively influenced information distortion bias through brand attitudes, aligning with findings from Studies 1 and 2. Participants formed more positive brand attitudes, and engaged in confirmatory information processing by interpreting neutral customer reviews in favor of the advertised brand as product visuals become richer.

5.3. Discussion

The results confirmed that consumers engaged in biased information processing in response to product visual cues. They interpreted a set of neutral customer reviews more favorably as product visuals became richer. These findings provide additional evidence for biased information interpretation in response to product visuals. On the other hand, product visual appeals did not have significant effects on participants' indication of the actual number of positive, neutral, and negative reviews they would like to read. The lack of a significant effect of our experimental manipulations on information exposure bias could have been caused by any number of factors. Perhaps most likely, the non-significant effect was a result of the probabilistic nature of null hypothesis significance testing. Even with a true effect and power of .80, the likelihood of a non-significant result is substantial (see Lakens and Etz, 2017). Non-significant results in a set of studies testing the same hypothesis are to be expected (Cohen, 1962; Sterling, 1959; Schimmack, 2012) and need not diminish readers' confidence in the truth of the alternate hypothesis (Lakens and Etz, 2017). Another possibility may pertain to the questioning methods. Although both measures in Study 3 were explicit in terms of asking participants to answer to some questions, they may have played different roles in nudging respondents. With respect to the *information exposure* measure, people may have indicated a roughly equal number of positive and negative reviews because doing so makes them look fair and balanced, and requires minimal effort since they do not actually have to read the reviews. The direct questioning method, requiring participants to type in exact numbers, may have disengaged participants from natural responses and made them more inclined to present themselves as rational and objective. On the other hand, with respect to the *information distortion* measure,

participants were presented with a set of information in which they had to indicate their comprehension and interpretation. In line with research on news communication and headline processing (Ecker et al., 2014; Surber and Schroeder, 2007), headlines are typically the first elements encoded, and they possess the ability to activate pre-existing knowledge, thus influencing what information a reader retains and aiding later retrieval of congruent information. In the context of this study, it can be inferred that a visually appealing product image can act as a potent attention-grabbing cue capable of triggering a positive mindset or schema (e.g., suggesting high product quality). This visual bias may cause participants to interpret subsequent information, such as customer review titles, through a more positive lens by directing their attention toward favorable titles while mitigating attention to negative ones.

6. Discussion and theoretical contributions

Confirmatory biases, as noted by Russo et al. (1998), can manifest even without prior predispositions; consumers tend to distort product information in favor of their preferred brand before making decisions. This study expands our understanding of confirmatory biases by illustrating how visual cues in advertising can trigger such biases, with newly developed inferential beliefs and attitudes acting as mediators. Study 1 revealed that enhancing product visual appeal heightened consumers' tendency to seek supportive information in customer reviews. Study 2 replicated these visual biasing effects using different visual stimuli and measurement approaches. Study 3 further demonstrated that as product visual appeal improved, consumers exhibited more positive brand attitudes and engaged in biased information processing.

While the direct impact of visuals on brand attitudes may vary depending on product category or image vividness, all three experiments consistently support the proposed framework for visual-induced confirmatory information processing (visuals → inferential beliefs → attitudes → confirmation bias). Additionally, a linear trend emerged across varying levels of product visuals; as the visual appearance of a product improved, so did inferential beliefs, brand attitudes, and, more importantly, confirmation bias. Together, these studies empirically validate the existence of visual biasing effects, providing a framework for understanding how visual cues influence consumer inferences and attitudes, ultimately leading to confirmation biases in information processing.

Traditionally, research on confirmation biases has focused on topics where individuals possess deeply entrenched attitudes and beliefs. Prior studies have suggested that information distortion can occur even when a decision is tentative (Chaxel et al., 2013; Chaxel and Han, 2018; Russo et al., 1998), yet little research has explored whether confirmation bias can be triggered solely by visual cues. This study sheds new light on the literature by demonstrating that individuals engage in biased information processing immediately upon exposure to a product's visual appearance—even for products they have never encountered before. This marks the first formal exploration of consumers' biased information processing influenced exclusively by a product's visual presentation. These visual biasing effects not only underscore the prevalence of confirmatory information processing in daily life but also extend our understanding by identifying visuals as a significant precursor to confirmation biases.

Prior research on confirmation biases has typically employed information search paradigms, where participants report their attitudes or engage in behaviors on a given issue before selecting additional information to review (Fischer, 2011). In such paradigms, decisions often involve a dichotomous choice between conflicting viewpoints, with information pieces containing either pro-decision or counter-decision content. Consequently, prior studies have demonstrated individuals' preferences for information aligning with their existing attitudes, beliefs, or behaviors. In contrast, our research investigates how newly formed inferential beliefs and brand attitudes can mediate the impact of visuals on confirmation bias. We propose visual biasing effects and present a conceptual framework illustrating how visuals can skew subsequent information processing. Upon exposure to product visuals, consumers develop inferential beliefs and attitudes toward the brand, guiding their selection of supportive customer reviews and influencing their interpretation of neutral reviews in a more favorable light as product visuals improve.

6.1. Managerial contributions

This research holds significance for advertisers and online retailers aiming to shape consumers' attitudes and information-seeking behaviors within digital interfaces. In recent years, companies have recognized the power of positive reviews and encouraged users to generate them (see how review valence is distorted by an increasing number of fake positive reviews; Shih et al., 2023). However, our findings indicate that beyond reviews, the visual representation of product images can significantly influence consumers' attitudes and review processing in online environments. Users exposed to visually appealing product images exhibit a heightened propensity to seek and interpret customer reviews in a manner that reinforces their newly formed positive perceptions. Moreover, the manipulation of product visuals offers valuable insights for brands operating in digital spaces. The juxtaposition of attractive versus plain package designs can be construed as a strategy for brand repositioning, as companies often

endeavor to refresh product packaging while maintaining brand consistency. Such visual enhancements not only facilitate the development of favorable beliefs and attitudes among users but also trigger biased information processing.

In addition, our findings are relevant not only to retailers who control product design but also to those who resell items from manufacturers. Regardless of who determines the packaging, image resolution remains a crucial factor in shaping consumer perceptions. Even with identical package designs, consumers' evaluations of the same product can diverge based on the clarity of its digital imagery, highlighting the importance of high-resolution visuals in an online environment. This is particularly important for brands launching new products in online marketplaces, where direct physical contact is limited.

If a brand neglects package design, a less attractive visual presentation could lead consumers to form less favorable inferential beliefs about product quality and seller credibility. This, in turn, could influence how they seek and interpret customer reviews, leading them to either expose themselves to less favorable reviews or interpret neutral reviews more negatively as a way to validate their initial impressions. While high-quality images are prevalent online, low-resolution visuals continue to be a significant issue.

A global survey by Salsify (Consumer Research 2022) revealed that a large percentage of shoppers in the UK, Germany, France, and the U.S. consider "quality of images and product descriptions" one of the top reasons for choosing where to shop, emphasizing the critical role of image quality in online shopping decisions. Our study demonstrates that even well-designed products can lose their impact when displayed in poor image resolution, leading to biased belief formation and information processing in customer reviews. Additionally, research suggests that high-quality images can enhance consumer affective responses by facilitating smoother cognitive processing (Ryu & Ryu, 2021). Ensuring image quality not only improves the shopping experience but also aligns with ethical standards in e-commerce by fostering transparency and trust, reinforcing the practical and ethical implications of our findings.

6.2. Limitations and directions for future research

The present study is subject to certain limitations. Given our primary focus on visual biasing effects, we opted to utilize fictitious brands. This decision aimed to mitigate potential confounding variables stemming from brand familiarity, thereby enabling stringent control over all visual stimuli and eliminating the influence of other extraneous cues within our experiments. Nonetheless, it is essential to acknowledge that visual effects may be contingent upon various moderating factors. For instance, they could exhibit greater potency when applied to newly encountered brands as opposed to familiar ones and may manifest more prominently in an online shopping context compared to a physical store environment.

Within this study, we explored the impact of product visuals on inferential beliefs, wherein individuals seek indications of product features and make inferences about absent attributes solely based on visual cues. Given that participants had no prior exposure to the fictitious brands and lacked preconceived expectations, they likely relied more heavily on readily available cues such as package design and image clarity. Consequently, in the absence of other extrinsic cues, product visuals are anticipated to exert a more pronounced influence on consumers' inferential beliefs and the formation of brand attitudes. For this reason, the chain of variables included in the path analysis may not have been distinct from each other, and future research should test the discriminant validity of these variables (e.g., by reporting their correlations [Rönkkö and Cho, 2022]). Building on this, future work could also examine how the presence of additional brand-related cues moderates these effects.

Next, although the visual stimuli in our study were experimentally manipulated and contrast analysis demonstrated that higher visual quality corresponded with improvements in the dependent variables, the directional effects presented in the path analysis should be interpreted as correlational rather than causal. Specifically, this study used path analysis to explore the directional effects of visual conditions on perceived product quality, seller credibility, and brand attitudes, but it did not manipulate the mediators directly. As Spencer et al. (2005) suggest, an experimental causal-chain mediation approach, where mediators are manipulated, would provide stronger causal evidence. Future research should consider this approach to better establish that these mediators precede biased information processing in customer reviews.

Furthermore, we acknowledge that our study does not aim to determine how a package design becomes attractive or what level of image resolution ensures clarity. Instead, our focus was on the overall visual effects of product images and how they influence biased information processing. While we manipulated package design and image resolution, we did not examine which specific design elements (e.g., color, material) contribute to attractiveness or whether a visual threshold exists beyond which additional improvements in design or resolution no longer enhance perceptions. Future research could explore these aspects to provide a more detailed understanding of how specific visual attributes shape consumer inferences and decision-making.

Finally, we did not incorporate a moderator or individual difference measures. Prior research has found that consumers differ in their responses to product aesthetics (i.e., centrality of visual product aesthetics; Bloch et al., 2003). Participants' individual differences in sensitivity to visual product appeals may affect their reliance on product

visuals, which could influence the extent to which they engage in confirmation bias. Future research may investigate how cognitive styles, personality traits, or other individual differences shape receptivity to visual biasing effects.

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APPENDIX 1: AD MANIPULATION IN STUDY 1

Imagine that you are looking for house paint and would like to buy some online. You browse an online shopping website and come across the paint brand *Prizm*. The seller uploaded an image of a container of *Prizm* paint. Please take a look and answer the following questions.

(One of the four product pictures below was displayed)

$C1_{attractivehigh}$

$C2_{plainhigh}$

Image Format: JPEG
Image Dimension: 1024 x 768 Pixels
Image Resolution: 72 Pixels/Inch with "Maximum Image Quality" for Compression

$C3_{attractivelow}$

$C4_{plainlow}$

Image Format: JPEG
Image Dimension: 1024 x 768 Pixels
Image Resolution: 72 Pixels/Inch with "Low Image Quality" for Compression
Pixelate Filter: Mosaic
Cell Size: 2 ~7 Square

Additional Information

Item Weight	13 pounds
Size	1 Gal/ 3.785 L
Color	Turquoise
Finish	Matte
Item Package Quantity	1
Product Description	Use on a variety of interior surfaces like wood, metal, ceramic, and canvas
Seller Name	Prizm Paint Inc.
Seller Information	Member since: Jan 23, 2016 Location: United States
Shipping Weights	13 pounds
Domestic Shipping	Currently, item can be shipped only within the U.S. and to APO/FPO addresses.
International Shipping	This item is not eligible for international shipping.

APPENDIX 2: AD MANIPULATION IN STUDY 2

Imagine that you are looking for corn soup and would like to buy some online. You browse an online shopping website and come across the corn soup brand *Midnight Farmland*. The seller uploaded an image of a *Midnight Farmland* corn soup. Please take a look and answer the following questions.

(One of the four product pictures below was displayed)

$C1_{attractivehigh}$ $C2_{plainhigh}$

Image Format: JPEG
Image Dimension: 1024 x 768 Pixels
Image Resolution: 72 Pixels/Inch with "Maximum Image Quality" for Compression

$C3_{attractivelow}$ $C4_{plainlow}$

Image Format: JPEG
Image Dimension: 1024 x 768 Pixels
Image Resolution: 72 Pixels/Inch with "Low Image Quality" for Compression
Pixelate Filter: Mosaic
Cell Size: 2 ~7 Square

Additional Information

Item Weight	1 pounds
Size	14 oz/ 397g
Item Package Quantity	1
Product Description	Excellent choice for a light lunch or as an elegant beginning to dinner
Seller Name	Midnight Farmland Inc.
Seller Information	Member since: Jan 23, 2016 Location: United States
Shipping Weights	1.1 pounds
Domestic Shipping	Currently, item can be shipped only within the U.S. and to APO/FPO addresses.
International Shipping	This item is not eligible for international shipping.

APPENDIX 3: New Measurements in Study 3

Dependent Variable 1 (Information Exposure)
Shoppers can look at as many reviews as they want before they make purchase decisions. Reviews can be generally classified as positive, neutral, and negative. How many of each type of review would you like to see before you buy the paint product *Prizm*? Please indicate the number in the blank.

Positive ( )
Neutral ( )
Negative ( )

Dependent Variable 2 (Information Distortion)
Below you will see a set of online reviews for *Prizm* brand house paint.

Consumer 1: "Works well with some trial and error." (Neu)
Consumer 2: "Ok for a distressed look. Not for a solid finish." (Neu)
Consumer 3: "The paint goes on so smoothly and looks lovely." (Pos)
Consumer 4: "Dries pretty fast but be aware that it gets much lighter once dry." (Neu)
Consumer 5: "The paint leaves some brush strokes." (Neg)
Consumer 6: "It is a nice color but needs several coats for full coverage." (Neu)
Consumer 7: "Clear coat when finished." (Pos)
Consumer 8: "The paint leaves an uneven finish." (Neg)
Consumer 9: "The paint gets thick quickly but can be easily fixed with a few spoons of hot water." (Neu)
Consumer 10: "Alone is not enough. Primer is needed to apply a more even coat." (Neu)
Consumer 11: "It is a bit watery so be sure to check for drips." (Neu)
Consumer 12: "The paint goes on easy and doesn't take long to dry." (Pos)
Consumer 13: "Multiple coats but still doesn't completely cover the base color." (Neg)

Please indicate overall how favorable or unfavorable this online review set is regarding *Prizm* brand paint.

Online Appendix A:

Means and Standard Deviations of Manipulation Checks and Dependent Variables

Construct	Condition	Study 1			Study 2			Study 3		
		N	*M*	SD	*N*	*M*	SD	*N*	*M*	SD
Manipulation Check										
Package Design	$C1_{attractivehigh}$	106	5.96	1.02	104	5.10	1.61	45	5.85	.87
	$C2_{plainhigh}$	105	4.03	1.66	103	3.36	1.72	39	5.40	1.37
	$C3_{attractivelow}$	103	4.77	1.49	106	3.97	1.73	29	5.39	1.22
	$C4_{plainlow}$	100	3.71	1.73	101	2.94	1.57	33	3.96	1.60
	Total	414	4.62	1.74	414	3.85	1.84	146	5.21	1.44
Image Quality	$C1_{attractivehigh}$	106	5.95	.94	104	5.81	.83	45	5.70	.79
	$C2_{plainhigh}$	105	5.44	1.07	103	4.70	1.26	39	5.37	1.10
	$C3_{attractivelow}$	103	2.18	1.39	106	2.37	1.40	29	3.91	2.03
	$C4_{plainlow}$	100	2.11	1.37	101	2.36	1.54	33	2.86	1.71
	Total	414	3.96	2.15	414	3.81	1.97	146	4.61	1.81
Overall Visual Quality	$C1_{attractivehigh}$	106	5.96	.87	104	5.46	1.03	45	5.77	.75
	$C2_{plainhigh}$	105	4.73	1.07	103	4.03	1.18	39	5.38	1.13
	$C3_{attractivelow}$	103	3.47	1.18	106	3.17	1.23	29	4.65	1.40
	$C4_{plainlow}$	100	2.90	1.37	101	2.65	1.38	33	3.41	1.39
	Total	414	4.29	1.64	414	3.83	1.61	146	4.91	1.46
Dependent Variables										
Perceived Product Quality	$C1_{attractivehigh}$	106	5.49	.95	104	4.97	1.26	–	–	–
	$C2_{plainhigh}$	105	4.69	1.35	103	3.91	1.34	–	–	–
	$C3_{attractivelow}$	103	4.28	1.34	106	3.56	1.27	–	–	–
	$C4_{plainlow}$	100	3.75	1.40	101	3.20	1.45	–	–	–
	Total	414	4.56	1.42	414	3.91	1.48	–	–	–
Seller Credibility	$C1_{attractivehigh}$	106	5.34	1.04	104	5.36	.99	–	–	–
	$C2_{plainhigh}$	105	4.56	1.26	103	4.49	1.25	–	–	–
	$C3_{attractivelow}$	103	3.90	1.36	106	4.08	1.20	–	–	–
	$C4_{plainlow}$	100	3.63	1.47	101	3.94	1.51	–	–	–
	Total	414	4.37	1.44	414	4.47	1.36	–	–	–
Brand Attitudes	$C1_{attractivehigh}$	106	5.86	.99	104	5.14	1.45	45	5.62	1.05
	$C2_{plainhigh}$	105	4.52	1.51	103	4.05	1.49	39	5.32	1.39
	$C3_{attractivelow}$	103	4.26	1.39	106	3.66	1.50	29	5.14	1.49
	$C4_{plainlow}$	100	3.54	1.65	101	3.26	1.68	33	3.95	1.72
	Total	414	4.56	1.63	414	4.03	1.68	146	5.07	1.53
Confirmation Bias*	$C1_{attractivehigh}$	106	4.63	1.79	104	4.98	1.70	45	4.89	1.63
	$C2_{plainhigh}$	105	4.34	1.81	103	4.21	1.63	39	4.41	1.63
	$C3_{attractivelow}$	103	3.87	1.67	106	4.03	1.76	29	4.34	1.80
	$C4_{plainlow}$	100	3.89	1.95	101	3.71	1.86	33	3.85	1.40
	Total	414	4.19	1.83	414	4.24	1.79	146	4.42	1.64
Review Positivity Index	$C1_{attractivehigh}$	–	–	–	–	–	–	44	.31	.32
	$C2_{plainhigh}$	–	–	–	–	–	–	39	.43	.34
	$C3_{attractivelow}$	–	–	–	–	–	–	28	.33	.30
	$C4_{plainlow}$	–	–	–	–	–	–	33	.30	.37
	Total	–	–	–	–	–	–	144	.34	.34

Note: Participants did not take part in more than one study; Confirmation bias was measured in terms of selective information exposure in Studies 1 and 2 while measured as biased interpretation in Study 3.

Online Appendix B:

Item Details and Reliability of Measurement Scales

Study 1		Study 2	
Variables	α	Variables	α
Perceived Product Quality (Dodds et al., 1991; Brucks et al., 2000)	.963	*Perceived Product Quality* (Low and Lamb, 2000; Dodds et al., 1991; Becker et al., 2011)	.963
ppq1: The likelihood that the product would be reliable is		ppq1: The likelihood that the product would be of high quality is	
ppq2: The quality of this product should be		ppq2: The likelihood that the product would excellent is	
ppq3: The likelihood that the product works satisfactorily is		ppq3: The likelihood that the product would be dependable is	
ppq4: The likelihood that the product performs well is		ppq4: Compared to other products, the quality of this product would be	
Seller Credibility (Pavlou and Dimoka, 2006; Ohanian, 1990)	.963	*Seller Credibility* (Pavlou and Dimoka, 2006; Ohanian, 1990)	.949
sc1: This seller is likely to be reliable		sc1: This seller is likely to be honest	
sc2: This seller is likely to be credible		sc2: This seller is likely to be trustworthy	
sc3: I believe this seller will deliver to me a product that arrives in good condition		sc3: I believe this seller will deliver to me a product that matches the posted description	
sc4: I believe this seller will deliver to me a product in a timely fashion		sc4: This seller is likely to be competent	
sc5: This seller is likely to be skilled		sc5: This seller is likely to be knowledgeable	
sc6: This seller is likely to be experienced			
Attitudes toward the Brand (Spears and Singh, 2004)	.975	*Attitudes toward the Brand* (Mitchell and Olson, 1981; Aggarwal, 2004)	.976
Please choose the number on each scale that best describes your overall feelings about the brand *Prizm*.		Please choose the number on each scale that best describe your overall feelings about the brand *Midnight Farmland*.	
attb1: unappealing vs. appealing		attb1: dislike vs. like	
attb2: bad vs. good		attb2: negative vs. positive	
attb3: unpleasant vs. pleasant		attb3: undesirable vs. desirable	
attb4: unfavorable vs. favorable		attb4: undelightful vs. delightful	
attb5: unlikable vs. likable		attb5: dissatisfied vs. satisfied	

Note: Items are labeled ppq for perceived product quality, sc for seller credibility, and attb for brand attitudes; α : Cronbach's alpha