More Than Aesthetic: Visual Boundaries and Perceived Variety

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Abstract

Many online retailers use seemingly innocuous visual boundaries when presenting choice sets to consumers. In contrast to previously studied aspects of information presentation, visual boundaries do not alter underlying information structure. The authors argue that, beyond their aesthetic role, visual boundaries can systematically increase or decrease perceived choice variety but the impact of visual boundaries on variety perceptions depends on consumer cognitive load. Study 1 finds that, by-attribute (vs. alternative) boundaries increase (decrease) perceived variety under high but not low cognitive load. Study 2 further demonstrates that retailer intent moderates the interaction between visual boundaries and cognitive load such that, when cognitive load is high, effects of visual boundaries on perceived variety are strengthened when consumers believe that retailers use boundaries to aid consumer navigation but reversed when they believe retailers use boundaries to persuade consumers to make purchases. Finally, Study 3 rules out attribute order and number of attribute levels as alternative accounts for the effect and enhances generalizability through a different manipulation of cognitive load. This work advances understanding of how simple environmental cues affect consumer behavior, with implications for retail strategy.

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Keywords: Visual boundaries; Cognitive load; Perceived variety; Assistive intent; Persuasive intent

Introduction

Online retailers often present products in product-attribute matrices in which visual boundaries, such as lines or color blocks, separate attributes or alternatives (and sometimes both; see Appendix A). For example, of the top 100 shopping web sites in the United States as ranked by traffic (Alexa 2017), 62 compare different product options in a product-attribute matrix. Of those 62, 94% (n=58) use visual boundaries between alternatives, attributes, or both alternatives and attributes. The proportion of sites that use boundaries to visually separate both product alternatives and attributes is significantly lower than the proportion that use boundaries to either separate alternatives (7% vs. 45%, z=4.93, p<.05) or attributes (7% vs. 42%, z=4.61, p<.05). The proportion of sites using visual boundaries between product alternatives is not significantly different from those using visual boundaries between product attributes (45% vs. 42%, z=.36, NS). These results suggest that, among top online retailers that present information in product matrices: (1) visual boundaries separating alternatives or attributes are used by the vast majority; (2) there is a tendency to visually separate alternatives or attributes but not both; and (3) there is little consensus among retailers for using visual boundaries to separate alternatives versus attributes. Given the widespread use of visual boundaries, yet limited consensus on their use, the current research examines whether, how, and under what conditions, visual boundaries impact consumer behavior.

Although a small but growing body of research examines the influence of environmental cues on consumer behavior, most focuses on the aesthetic role of these cues. For example, retail store layout can serve as aesthetic communication (Bitner 1992) and affect store image (Baker, Grewal, and Parasuraman 1994); the aesthetic appeal of online environments affects consumer satisfaction and arousal (Wang, Minor, and Wei 2011); and interstitial space between products affects aesthetic perceptions (Sevilla and Townsend 2016). Similarly, academic research and practitioner articles on visual boundaries has focused on their aesthetic properties (Hartmann, Jan, and Angeli 2008). In contrast, we argue that, beyond their aesthetic appeal, visual
boundaries can guide the way consumers evaluate product information, influencing perceptions of choice variety.

Drawing on research on context effects (Bargh 1982; Meyers-Levy and Tybout 1997; Schwarz 1994) and adaptive decision making (Payne, Bettman, and Johnson 1993), we propose that visual boundaries can provide guidance to consumers about how product information should be processed. In contrast to prior research on information organization (Jarvenpaa 1989), choice architecture (Lamberton and Diehl 2013), and display orientation (Deng et al. 2016), we argue these effects occur even in the absence of changes to underlying information structure. However, because they are contextual rather than structural (Kahn and Wansink 2004), we propose that effects of visual boundaries on perceived variety should be stronger under cognitive load. In addition, building on previous research on retailer intent (Campbell and Kirmani 2000; Gupta, Yadav, and Varadarajan 2009; Forehand and Grier 2003), we posit that consumer beliefs about why retailers use visual boundaries can further moderate visual boundary effects such that the effects of visual boundaries and cognitive load on perceived variety are strengthened when consumers believe retailers use visual boundaries for assistive reasons but weakened (or reversed) when consumers believe visual boundaries are used for persuasive and manipulative reasons.

We examine these ideas in a series of laboratory experiments. We focus on commonly used visual boundaries in online environments—color blocks separating attributes and alternatives—and test our predictions across a variety of product categories. Study 1 finds that, under cognitive load, visual boundaries separating product attributes significantly increase perceived variety while visual boundaries separating product alternatives significantly decrease perceived variety. Study 2 investigates the moderating role of retailer intent and shows that, when cognitive load is high, visual boundary effects on perceived variety are strengthened when consumers believe that retailers use boundaries to aid consumer navigation but reversed when they believe retailers use visual boundaries for persuasive intent. Study 3 rules out attribute order and number of attribute levels as alternative explanations for the interactive effects of visual boundaries and cognitive load on perceived variety and replicates the results using a more externally valid cognitive load manipulation.

By identifying when, how, and why seemingly innocuous visual boundaries affect perceived variety—without changing the underlying structure of information—we add to research examining how structural aspects such as information organization (Jarvenpaa 1989; Kahn and Wansink 2004), choice architecture (Lamberton and Diehl 2013), and orientation (Deng et al. 2016) affect decision making. By showing contingent effects of visual boundaries in choice environments, our work adds to prior research on how consumers use contextual cues in choice (Huh, Vosgerau, and Morewedge 2014; White, Dahl, and Ritchie 2016). In addition, by investigating the moderating role of retailer intent, this research helps identify a boundary condition for visual boundary effects and advances understanding of how the interplay between retailer intent and visual design can affect consumer perceptions.

This research also offers a bridge between research on visual representation (Lurie and Mason 2007; Townsend and Kahn 2013) and research on context effects (e.g., Bargh 1982; Meyers-Levy and Tybout 1997). In particular, we provide evidence that, when consumers are under cognitive load, they are more inclined to rely on visual boundaries to evaluate product choice sets with implications for perceived variety. Our research also adds to prior work focusing on the aesthetic use of visual design elements in decision environments (Baker, Grewal, and Parasuraman 1994; Bitner 1992; Wang, Minor, and Wei 2011) and offers a new vista for studying the connections among simple environmental cues and consumer behavior. We show that, beyond their aesthetics, visual boundaries systematically affect how consumers evaluate product information, influencing subsequent behavior.

### Theoretical Background

#### Visual Boundaries and Consumer Behavior

Visual designers use a wide variety of design elements, including lines, shapes, color palette, texture, typography, and form, to communicate form and function (White 2011). Design principles, such as unity, gestalt, space, hierarchy, contrast, closure, and similarity, impact user perceptions and experiences (Wagemans et al. 2012). Although visual boundaries have long been of interest in vision (Clarke and Miklossy 1990), perception (Cohen and Grossberg 1984), psychology (Bass 1997), and more recently marketing (Cutright 2012), relatively little is known about how visual boundaries affect consumer behavior, especially in an era of almost limitless choice.

In the offline world, physical boundaries are used by designers for both aesthetic and navigation purposes. For example, linear structures such as concrete barriers or rail bridges, create structure, unity, and harmonious proportion (Bullard 2006) in addition to guiding movement. The “zig-zag path” design of the Ikea store encourages consumers to browse as many products as possible (Lubin 2014). Physical boundaries, such as walls or borders, set off a place from the spaces surrounding it and establish the range within which place-specific rules and conventions govern behavior (Jacob and Guo 2013). Given the role of physical boundaries in offline settings, might visual boundaries in online environments also guide consumer behavior?

#### Visual Boundaries, Cognitive Load, and Perceived Variety

A large literature shows that changing the way choice sets are structured has dramatic effects on perceived variety. For example, organizing product information by attributes rather than benefits reduces the perceived similarity of choice options (Lamberton and Diehl 2013). Altering assortment structure affects perceived variety and consumption (Kahn and Wansink 2004). Displaying alternatives horizontally versus vertically affects perceived product assortment (Deng et al. 2016). Importantly, all of these examples involve substantive changes in the way information is structured that affect the cognitive effort required to engage in different information evaluation pro-
cesses (Payne, Bettman, and Johnson 1993). This raises the question: Can simple visual boundaries separating product alternatives or attributes—that do not change underlying information structure—affect perceived variety? If so, how, when, and why?

Previous research on context effects suggests that people tend to rely on task relevant information, such as cues, stimuli, or representations, to direct their attention, especially under cognitive load (Bargh 1982; Meyers-Levy and Tybout 1997; Schwarz 1994). In particular, when a task is more demanding, people lack the resources required to ignore contextual influences and rely on contextual cues as guides. Relatedly, a large body of decision-making research shows that consumers adaptively change their decision strategies in response to changes in cognitive resources (Gigerenzer and Selten 2002; Payne, Bettman, and Johnson 1993). For example, when cognitive load is high, consumers tend to use heuristics since they require fewer cognitive resources (Kahneman and Frederick 2004; Payne, Bettman, and Johnson 1988), while when cognitive load is low, they tend to use more systematic decision strategies in order to maximize gains (Roch et al. 2000). This suggests that, to the extent visual boundaries are regarded as task relevant aids, they should affect decision processes; more so under cognitive load. In sum, because visual boundaries—as simple and basic design elements (White 2011)—provide a sense of where things belong or are contained (Cutright 2012; Hamilton, Hong, and Chernev 2007; Myrseth and Fishbach 2009), and define rules for behavior (Merriam-Webster 2016), they provide task relevant information that consumers can easily rely on, especially under cognitive load. In particular, under high cognitive load, visual boundaries are more likely to serve as task-relevant cues for how product information should be processed. This, in turn, should affect consumer behavior in predictable ways.

If consumers adhere to them, visual boundaries should change the way in which product information is processed. Specifically, consumers who follow visual boundaries separating attributes should engage in greater by-attribute information processing and inter-category comparisons. That is, consumers who adhere to boundaries separating attributes should tend to make attribute-by-attribute comparisons across product options and evaluate products on each attribute sequentially (Mantel and Kardes 1999; Payne, Bettman, and Johnson 1993). For example, consumers engaged in by-attribute processing might evaluate different restaurants by location, then by price, then by service.1

By changing the way information is processed, visual boundaries should affect perceived variety. For example, assessing product options separately on each attribute makes options appear more heterogeneous and distinct (Mogilner, Rudnick, and Iyengar 2008). This suggests that visual boundaries separating attributes should foster a contrastive mindset, in which consumers focus on how choice options are distinguished from one another on each attribute, enhancing perceived differences among available products and increasing perceived variety. In contrast, visual boundaries separating alternatives should encourage greater by-alternative information processing and intra-category comparisons. That is, consumers who adhere to visual boundaries separating alternatives should be more likely to evaluate each product option on all attributes simultaneously (Bettman et al. 1993). This suggests that visual boundaries separating alternatives should foster an assimilative mindset, in which consumers focus on integrating information forming an overall assessment for each option, reducing perceived differences among products and lowering perceived variety.

However, consistent with the context effects literature, because visual boundaries involve contextual rather than structural changes to information presentation (e.g., Deng et al. 2016; Jarvenpaa 1989; Kahn and Wansink 2004; Lamberton and Diehl 2013), these differences in information processing, and resultant effects on perceived variety, should depend on cognitive load. This is because, under high cognitive load, consumers tend to rely on contextual aids (Bargh 1982; Baumeister 2002; Usta and Häubl 2011), engage in automatic processing (Bargh and Chartrand 1999; Just and Carpenter 1992), and use heuristics (Shah and Oppenheimer 2008). This means that consumers under high cognitive load, who have fewer cognitive resources to allocate to effortful and compensatory information processing (Bettman, Luce, and Payne 1998), should be more likely to process information in a way that is consistent with visual boundaries. However, consumers under low cognitive load; who have abundant cognitive resources, can evaluate information in a more effortful way (Cacioppo et al. 1996), and are less open to external influence (Baumeister 2002); should be less likely to conform their information processing to visual boundaries. In other words, we expect that the effects of visual boundaries on perceived variety will be more prominent under high cognitive load. More formally:

**H1.** Cognitive load moderates the impact of visual boundaries on perceived variety such that when cognitive load is high, the effect of by-attribute (by-alternative) boundaries on increasing (decreasing) perceived variety is stronger than when cognitive load is low.

### Study 1: Visual Boundaries, Cognitive Load, and Perceived Variety

The purpose of Study 1 is to examine whether the impact of visual boundaries on perceived variety depends on cognitive load. In particular, we examine whether, relative to a control condition in which no visual boundaries are present, visual boundaries separating attributes increase perceived variety while visual boundaries separating alternatives decrease perceived variety and if these effects are more prominent under cognitive load.

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1 Supporting this processing argument, a separate study using a Mouselab-like interface (Bettman et al. 1993) showed that, relative to the absence of visual boundaries, visual boundaries separating attributes led to greater information acquisition by attribute while visual boundaries separating alternatives led to greater information acquisition by alternative (see Web Appendix in Supplementary material).
Method

Design and procedure

Three hundred and eleven undergraduates (mean age = 21; 49% female) completed this study in a behavioral lab. Participants were randomly assigned to one condition in a 2 (cognitive load: low vs. high) x 3 (visual boundaries: separating alternatives vs. separating attributes vs. no visual boundaries) between-subjects design.

Following prior research (McFerran et al. 2010), cognitive load was manipulated first by asking participants to memorize either a ten (high cognitive load) or two (low cognitive load) digit number which they would be asked to later recall. (JavaScript was used to ensure that participants were unable to copy and paste the code.) Next, participants took part in an ostensibly unrelated study, in which they were told that Sound Tech, Inc., a large online headphone retailer, was interested in consumers’ headphone evaluations. Participants were instructed to imagine they were visiting the company’s online shop and to take their time to peruse a headphone table. The shape of the table was square and consisted of ten headphone types and ten headphone attributes. This underlying information was identically presented in all conditions. Visual boundaries were manipulated through light and dark grey color blocks separating headphone types or headphone attributes in the boundary-present conditions; and were absent in the control condition (see Appendix B).

Dependent measures

After perusing the headphone table, participants were asked to evaluate the variety of available headphones. Following prior research (Mogilner, Rudnick, and Iyengar 2008), we measured perceived variety by averaging participants’ responses to three 7-point scales (Cronbach’s alpha = .76): “How much choice do you feel you were offered in terms of the headphone selection?” (1 = no choice at all; 7 = a lot of choice), “How much variety do you think there was in the table?” (1 = very little variety; 7 = a lot of variety), and “How similar do you think all of the head- phones in the table were to each other?” (1 = not at all similar; 7 = extremely similar; reverse coded; Cronbach’s alpha = .76). Next, the cognitive load manipulation was assessed by averaging two 7-point Likert scales (1 = strongly disagree, 7 = strongly agree; r = .76): “I found it challenging to read the scenario while trying to remember the number” and “Remembering the number was easy” (adapted from McFerran et al. 2010).

Results

Manipulation check

Results confirmed that participants in the high cognitive load condition felt the task was harder compared to those in the low cognitive load condition ($M_{high-load} = 4.65$ vs. $M_{low-load} = 2.32$; $F(1, 309) = 231.02, p < .001$).

Perceived variety

Providing support for H1, ANOVA results showed a significant interaction between visual boundaries and cognitive load on perceived variety ($F(2, 305) = 8.28, p < .001$; see Fig. 1). Planned contrasts revealed that, under high cognitive load, relative to the control condition ($M = 4.82$), by-attribute boundaries increased perceived variety ($M = 5.57$; $F(1, 305) = 11.71, p < .01$) while by-alternative boundaries decreased perceived variety ($M = 3.97$; $F(1, 305) = 14.52, p < .001$). However, under low cognitive load, participants did not perceive significant differences in variety regardless of whether visual boundaries separated attributes ($M = 4.55$), alternatives ($M = 4.22$), or were absent ($M = 4.43$; $F's < 2.20, p's > .13$).

The main effect of visual boundaries on perceived variety was also significant ($F(2, 305) = 19.25, p < .001$). Planned comparisons showed, relative to the control condition, participants perceived more variety in the by-attributes condition ($M_{control} = 4.62$ vs. $M_{attribute} = 5.06$; $F(1, 305) = 8.71, p < .01$) but less variety in the by-alternatives condition ($M_{control} = 4.62$ vs. $M_{alternative} = 4.09$; $F(1, 305) = 11.16, p < .001$). Perceived variety was also greater under high ($M = 4.79$) versus low cognitive load ($M = 4.40$; $F(1, 305) = 9.12, p < .01$).

Discussion

Study 1 provides support for the hypothesized effect of visual boundaries and cognitive load on perceived variety. Supporting the proposal that visual boundaries are more likely to affect consumer perceptions under cognitive load, results show that, relative to the control condition, visually separating attributes (alternatives) increases (decreases) perceived variety but only under cognitive load. Given these results, we conducted Study 2 to: (1) explore a moderator of visual boundary effects and (2) rule out alternative explanations based on information orientation and processing fluency.
Study 2: The Moderating Role of Retailer Intent

Study 1 shows that visual boundaries have a significant impact on perceived variety but this effect is contingent on cognitive load. The goal of Study 2 is to investigate a potential boundary condition for visual boundary effects. Because visual boundaries are regarded as contextual aids and guides, we posit that consumer beliefs about why retailers use visual boundaries can further strengthen or weaken the effects of visual boundaries and cognitive load on perceived variety. In particular, building on prior research that consumers often ascribe assistive or persuasive intent to marketers (Robertson and Rossiter 1974), we propose that the interactive effects of visual boundaries and cognitive load on perceived variety should be stronger under assistive intent but weaker under persuasive intent.

Assistive intent refers to marketer actions or information that consumers believe are provided to help consumers (Gupta, Yadav, and Varadarajan 2009) while persuasive intent refers to actions by which marketers are viewed as trying to sell something (Forehand and Grier 2003). Assistive intent is more likely to be ascribed when marketers provide task-facilitative tools or interactive aids that are aligned with consumer interests or can help them easily fulfill a specific task (Gupta, Yadav, and Varadarajan 2009). When marketer actions are perceived as assistive, consumers tend to comply with requests for action (Gupta, Yadav, and Varadarajan 2009). However, when persuasive intent is inferred, consumers are more likely to activate persuasion knowledge and develop coping strategies (Campbell and Kirmani 2000). In particular, overt marketing tactics, such as rebate restrictions (Hardesty, Bearden, and Carlson 2007), pushy sales tactics (DeCarlo 2005), or blatant advertising (Darke and Ritchie 2007), are regarded as serving ulterior motives that make them untrustworthy, manipulative, deceptive, and more likely to be resisted or strayed away from (Campbell and Kirmani 2000; Meyers-Levy and Zhu 2007).

Drawing on these ideas we predict that, when consumers believe retailers use visual boundaries for assistive reasons—for example, to help consumers navigate a shopping website—those under high cognitive load will be more inclined to rely on the guidance of visual boundaries when processing product information; strengthening the effects of visual boundaries and cognitive load on perceived variety. Whereas, when consumers believe retailers use visual boundaries for persuasive reasons—for example, to persuade consumers to buy—those under high cognitive load may be less likely to follow and may even resist the guidance of visual boundaries when processing product information; weakening (and potentially reversing) the effects of visual boundaries and cognitive load on perceived variety. Formally, we hypothesize that:

**H2.** Consumer perceptions of retailer intent moderate the interaction between visual boundaries and cognitive load on perceived variety such that:

(a) When retailer intent is perceived as assistive, the effects of by-attribute (by-alternative) boundaries on increasing (decreasing) perceived variety under high cognitive load are stronger;
(b) When retailer intent is perceived as persuasive, the effects of by-attribute (by-alternative) boundaries on increasing (decreasing) perceived variety under high cognitive load are weaker.

In addition to testing H2, Study 2 is designed to rule out two alternative explanations for Study 1’s results. First, one might argue that our effects are driven by the orientation of the alternative versus attribute information rather than whether visual boundaries divide alternatives or attributes. Accordingly, in Study 2 we manipulate information orientation (i.e., whether product options are presented in rows vs. columns) as a between-subjects factor. Further, given recent research suggesting that visual presentation affects processing fluency that, in turn, affects perceived variety (Deng et al. 2016), we measure perceived processing fluency.

**Method**

Nine-hundred MTurk participants (mean age = 34; 66% female) completed this study. Participants were randomly assigned to one condition in a 3 (retailer intent: assistive vs. persuasive vs. control) × 2 (cognitive load: low vs. high) × 3 (visual boundaries: separating alternatives vs. separating attributes vs. no visual boundaries) × 2 (information orientation: alternatives in rows and attributes in columns vs. alternatives in columns and attributes in rows) between-subjects design. Participants in the assistive (persuasive) intent condition were instructed to take their time to read an essay that claimed that the intent of web designers when using color palettes is to help consumers navigate a website (persuade consumers to buy products that the seller wants them to buy). Those in the control condition read a neutral essay of similar length (see Appendix C). Cognitive load was manipulated as in Study 1.

Next, participants were instructed to complete a seemingly unrelated task in which they were provided with a table of seven types of chocolate truffles defined by seven attributes (chocolate, flavor, calories, sugar, caffeine, gluten-free, and place of origin). As an alternative manipulation of visual boundaries, in Study 2, we used a different set of color blocks (light blue and grey) to separate the chocolate truffle options or attributes in the visual-boundary conditions. In the control condition, there were no visual boundaries. As in Study 1, the shape of the chocolate truffle table was square.

Perceived variety (Cronbach’s alpha = .80) was measured as in Study 1. As an alternative account for the observed effects, processing fluency was assessed by averaging responses to two 7-point scales ($r = .74$): “How easy was it to evaluate the information shown in the chocolate truffle table?” (1 = not at all easy, 7 = very easy) and “How comfortable did you feel when you

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3 Across all dependent measures, main and interaction effects of information orientation were non-significant and results were collapsed across orientation conditions, leading to approximately 50 participants per experimental cell.
evaluated the information shown in the chocolate truffle table” (1 = not at all comfortable, 7 = very comfortable; Deng et al. 2016).

Finally, to assess the retailer intent manipulations, participants indicated the extent to which the design of the chocolate truffle table reflected an attempt to make the website: (1) easy to navigate and (2) persuasive, on two 7-point scales (1 = not at all, 7 = very much so). The success of the cognitive load manipulation was measured as in Study 1 (r = .73).

Results

Manipulation checks

ANOVA results confirmed the successful manipulation of the perception of assistive (F(2, 897) = 67.90, p < .001) versus persuasive intent (F(2, 897) = 42.55, p < .001). Participants in the assistive intent condition (M = 5.31) were more likely to believe the design of the chocolate truffle table reflected an attempt to help consumers navigate the website, compared to those in the control (M = 4.85; F(1, 897) = 17.08, p < .001) or persuasive intent conditions (M = 4.01; F(1, 897) = 132.56, p < .001). Similarly, participants in the persuasive intent condition (M = 4.77) were more likely to believe the design of the chocolate truffle table reflected an attempt to make the website persuasive relative to those in the control (M = 4.13; F(1, 897) = 23.87, p < .001) or assistive intent conditions (M = 3.56; F(1, 897) = 85.03, p < .001). In addition, as in Study 1, participants in the high cognitive load condition felt the task was harder (Mhigh-load = 4.54 vs. Mlow-load = 1.98; F(1, 898) = 560.44, p < .001).

Perceived variety

ANOVA results revealed main effects of cognitive load (F(1, 882) = 7.83, p < .01) and visual boundaries (F(2, 882) = 25.86, p < .001), and interaction effects of retailer intent × cognitive load (F(2, 882) = 3.32, p < .05), cognitive load × visual boundaries (F(2, 882) = 2.41, p = .09), and retailer intent × visual boundaries (F(4, 882) = 24.14, p < .001). In support of H2, there was a significant retailer intent × cognitive load × visual boundaries interaction (F(4, 882) = 7.76, p < .05; see Fig. 2). To interpret this three-way interaction, we conducted separate analyses of the no intent, assistive, and persuasive intent conditions.

First, in the no intent condition, where consumers did not hold specific beliefs about retailer intent, replicating Study 1 results, there was a significant cognitive load × visual boundaries interaction (F(2, 882) = 13.56, p < .001). Planned contrasts revealed that, under high cognitive load, relative to the no visual boundaries condition (M = 4.80), by-attribute boundaries increased perceived variety (M = 5.40; F(1, 882) = 5.74,

\[ p < .05 \]

while by-alternative boundaries decreased perceived variety (M = 4.21; F(1, 882) = 6.56, p < .05). However, under low cognitive load, differences in perceived variety were not significant (Mattribute = 4.51 vs. Malternative = 4.33 vs. Mcontrol = 4.30; F’s < 1).

Second, in the assistive intent condition, where consumers believed retailers use visual boundaries to assist navigation, there was also a significant interaction of cognitive load and visual boundaries on perceived variety (F(2, 882) = 22.95, p < .001).

Fig. 2. Study 2: retailer intent, visual boundaries, cognitive load, and perceived variety.
Results showed that, under high cognitive load, compared to the no visual boundaries condition ($M = 4.67$), by-attribute boundaries increased perceived variety ($M = 6.01; F(1, 882) = 36.71, p < .001$) while by-alternative boundaries decreased perceived variety ($M = 3.62; F(1, 882) = 20.48, p < .001$). Under low cognitive load, relative to the no visual boundaries condition ($M = 4.46$), perceived variety was also greater ($M = 5.10; F(1, 882) = 7.81, p < .01$) when visual boundaries separated attributes but lower when visual boundaries separated alternatives ($M = 3.95; F(1, 882) = 5.69, p < .05$). In support of H2a, additional planned comparisons showed that in the assistive intent condition, relative to in the no intent condition, the effect of by-attribute boundaries on increasing perceived variety ($M_{\text{assistive intent}} = 6.01$ vs. $M_{\text{no intent}} = 5.40; F(1, 882) = 115.03, p < .001$), and the effect of by-alternative boundaries on decreasing perceived variety under cognitive load ($M_{\text{assistive intent}} = 3.62$ vs. $M_{\text{no intent}} = 4.21; F(1, 882) = 36.71, p < .001$), were stronger. These results suggest that, when consumers believe retailers use visual boundaries to assist navigation, visual boundary effects are strengthened such that boundaries separating attributes (alternatives) increase (decrease) perceived variety under cognitive load to a greater extent than when consumers do not hold specific beliefs about retailer intent.

Third, in the persuasive intent condition where consumers believed retailers use visual boundaries to persuade, the interaction of cognitive load × visual boundaries was also significant ($F(2, 882) = 18.02, p < .001$). Interestingly, and in contrast to the no intent and assistive intent conditions, results showed that, when cognitive load was high, compared to the no visual boundaries condition ($M = 4.65$), by-attribute boundaries decreased perceived variety ($M_{\text{attribute}} = 4.09; F(1, 882) = 6.23, p < .05$) while by-alternative boundaries increased perceived variety ($M_{\text{alternative}} = 5.08; F(1, 882) = 4.38, p < .05$). Under low cognitive load, differences in perceived variety were not significant ($M_{\text{attribute}} = 4.72$ vs. $M_{\text{alternative}} = 4.65$ vs. $M_{\text{control}} = 4.58; F's < 1$). In support of H2b, additional planned comparisons showed that in the assistive intent condition, relative to in the no intent condition, the effect of by-attribute boundaries on increasing perceived variety ($M_{\text{persuasive intent}} = 4.09$ vs. $M_{\text{no intent}} = 5.40; F(1, 882) = 361.22, p < .001$), and the effect of by-alternative boundaries on decreasing perceived variety under cognitive load ($M_{\text{persuasive intent}} = 5.08$ vs. $M_{\text{no intent}} = 4.21; F(1, 882) = 124.82, p < .001$), were weaker. These findings show that when consumers believe retailers use visual boundaries to persuade, effects of visual boundaries and cognitive load on perceived variety can be weakened and even reversed—such that under high cognitive load, consumers resist (rather than follow) the guidance of visual boundaries.

**Discussion**

Study 2 identifies retailer intent as a moderator of the interaction between visual boundaries and cognitive load. Consistent with Study 1, Study 2 demonstrates that, when consumers do not hold specific beliefs about retailer intent, cognitive load and visual boundaries interact to affect perceived variety such that under high cognitive load, perceived variety is greater (lesser) when visual boundaries separate attributes (alternatives) but these effects are not significant when cognitive load is low. However, these effects are moderated when consumers hold specific beliefs about retailer intent. In particular, visual boundary effects under high cognitive load are boosted when consumers believe that retailers use visual boundaries to assist navigation but weakened and even reversed when consumers believe retailers use visual boundaries to persuade. Results also show that, when consumers perceive retailer intent as assistive, visual boundary effects are detected even under low cognitive load. This suggests that, when consumers believe retailers use visual boundaries to assist navigation, even those under low cognitive load follow the guidance of visual boundaries when processing product information. In contrast, when consumers under cognitive load believe retailers use visual boundaries to persuade, they seem to react against the boundaries. Moreover, our results did not reveal any significant effects of visual boundaries on perceived processing fluency ($p's > .10$); ruling out processing fluency as an alternative explanation.

**Study 3: Controlling for Number of Attribute Levels and Attribute Order**

Studies 1 and 2 demonstrate that visual boundaries interact with cognitive load to affect perceived variety. Study 3 is designed to address two alternative explanations for these effects. First, given that in Studies 1 and 2 the first attribute had a different number of levels than the other attributes in the product matrix, one might argue that visual boundary effects may not occur when all attributes have the same number of levels. Further, given that attributes were presented in the same order in all conditions, one might argue that the effects may not occur if attributes are presented in a different order. To address these concerns, in Study 3, we: (a) kept the number of attribute levels constant and (b) manipulated attribute order. Finally, to further enhance generalizability, we (c) induced a more externally valid manipulation of cognitive load.

**Method**

Five hundred and seventy-six undergraduates (mean age = 22; 53% female) completed this study in a behavioral lab. Participants were randomly assigned to one condition in a 3 (visual boundaries: separating alternatives vs. separating attributes vs. control) × 2 (cognitive load: low vs high) × 2 (attribute order: regular vs. reverse) between-subjects design.

To increase the generalizability of the research, we induced cognitive load through a consumption-relevant task. In particular, we asked participants to either memorize a twelve-item (high cognitive load) or a two-item (low cognitive load) shopping list which they would be asked to later recall. Next, participants completed an ostensibly unrelated study, in which they were instructed to imagine that they were visiting an online store to search for chocolate truffles. They then viewed a table of five types of chocolate truffles defined by five attributes (flavor, chocolate, calories, sugar, and place of origin). As in Studies 1 and 2, visual boundaries were manipulated through color blocks.
(medium and light green) separating chocolate truffle types or chocolate truffle attributes in the boundary-present conditions. Color blocks were absent in the control condition.

Further, to control for the potential impact of the number attribute levels, every attribute had five possible levels. In addition, attribute presentation order was manipulated such that in the regular order condition, the order was flavor, chocolate, calories, sugar, and place of origin, whereas in the reverse order condition, the order was place of origin, sugar, calories, chocolate, and flavor. Perceived variety (Cronbach’s alpha = .74) and cognitive load \((r = .71)\) were measured as in Studies 1 and 2.

**Results**

**Manipulation check**

Results confirmed that participants in the high cognitive load condition who memorized a twelve-item shopping list felt that the task was harder \((M = 5.20)\) compared to those in the low cognitive load condition who memorized a two-item shopping list \((M = 3.01); F(1, 574) = 403.29, p < .001\).

**Perceived variety**

Central to our theorizing and consistent with Studies 1 and 2, ANOVA results revealed a significant interaction between visual boundaries and cognitive load on perceived variety \((F(2, 564) = 19.09, p < .001)\). Paired comparisons showed that, under high cognitive load, relative to the control condition \((M = 4.46)\), by-attribute boundaries increased perceived variety \((M = 5.15); F(1, 564) = 29.73, p < .001)\) while by-alternatives boundaries decreased perceived variety \((M = 3.85; F(1, 564) = 22.77, p < .001)\). However, under low cognitive load, participants did not perceive significant differences in variety regardless of whether visual boundaries separated attributes \((M = 3.26)\), alternatives \((M = 3.26)\), or were absent \((M = 3.39; F < 1, p > .30)\).

As in Studies 1 and 2, the main effect of visual boundaries on perceived variety was significant \((F(2, 564) = 35.31, p < .001)\). Planned comparisons showed, relative to the control condition, participants perceived more variety in the by-attribute condition \((M_{\text{control}} = 3.93 \text{ vs. } M_{\text{attribute}} = 4.30); F(1, 564) = 18.86, p < .001)\) but less variety in the by-alternative condition \((M_{\text{control}} = 3.93 \text{ vs. } M_{\text{alternative}} = 3.56); F(1, 305) = 16.30, p < .001)\). Perceived variety was also greater under high \((M = 4.49)\) versus low cognitive load \((M = 3.37); F(1, 564) = 236.23, p < .001)\). Finally, our results did not reveal a significant main effect of attribute order \((F < 1, p > .86)\), or interactive effects between attribute order and visual boundaries \((F (1, 564) = 1.26, p > .28)\), attribute order and cognitive load \((F < 1, p > .43)\), or attribute order, visual boundaries, and cognitive load \((F (1, 564) = 1.48, p = .23)\), on perceived variety.

**Discussion**

Study 3 not only provides further support for the impact of visual boundaries and cognitive load on perceived variety but also enhances the generalizability and external validity of the current research. Consistent with Studies 1 and 2, our findings suggest that under high cognitive load, by-attribute boundaries increase perceived variety and by-alternative boundaries decrease perceived variety but these effects are not prominent under low cognitive load. Moreover, Study 3 generalizes results from Studies 1 and 2 by making the number of attribute levels identical across product attributes and showing that similar results are found regardless of attribute presentation order. Study 3 further enhances generalizability by manipulating cognitive load through a more consumption-relevant and externally valid task.

**General Discussion**

As visual boundaries are widely used in both online and offline environments, understanding their impact on consumer behavior is important. Many retailers use visual boundaries to increase the aesthetic appeal of online environments (Breeze and Lewis 2012). Despite an extensive body of research showing that structural changes to information display format, choice architecture, and display orientation can affect decision making, little is known about the effects of simple visual cues that do not change the way choice sets are structured. Although it seems unlikely that simply using color blocks between alternatives or attributes should be consequential, this research demonstrates that such seemingly innocuous visual boundaries have important effects on consumer decision making. Our results suggest that visual boundaries provide guidance to consumers about how choice sets should be evaluated. Under cognitive load, this affects consumer perceptions of variety. Our results also demonstrate that consumer perceptions about why retailers use visual boundaries can further moderate these visual boundary effects.

Study 1 shows that, when consumers are under high cognitive load, visual boundaries separating attributes increase perceived variety while boundaries separating alternatives decrease perceived variety. Study 2 extends Study 1 to further identify retailer intent as a moderator of the effects of visual boundaries and cognitive load on perceived variety. Findings show that visual boundary effects are strengthened when consumers believe retailers use visual boundaries to aid consumer navigation but reversed when they believe visual boundaries are used to persuade consumers to make purchases. In addition, Study 2 also rules out alternative explanations for our results based on information orientation and processing fluency. Finally, Study 3 replicates the visual boundary effects, rules out attribute level and attribute order as alternative accounts for these effects, and enhances the generalizability of visual boundary effects using a more consumption-relevant cognitive load task. Across the three studies, our results suggest that visual boundary effects hold under both task-irrelevant (e.g., memorizing a number) and task-relevant (e.g., memorizing a shopping list) cognitive load.

**Theoretical and Practical Implications**

This article adds to prior research on information organization (Jarvenpaa 1989; Kahn and Wansink 2004), choice architecture
(Lamberton and Diehl 2013), and orientation (Deng et al. 2016) that has focused on how structural aspects of choice sets affect decision making. In contrast to prior research, we propose and find that visual boundary effects occur even in the absence of changes to underlying information structure. Consistent with the idea that contextual aids are more likely to be relied on when people face cognitive load, visual boundary effects are stronger under high cognitive load.

Drawing on prior research on context effects (Barth 1982; Meyers-Levy and Tybout 1997; Schwarz 1994) and retailer intent (Gupta, Yadav, and Varadarajan 2009; Forehand and Grier 2003), we also provide evidence that visual boundary effects are moderated by perceptions of retailer intent. Insights into the contingent nature of visual boundaries in choice environments add to research on contingent use of environmental cues (Huh, Vosgerau, and Morewedge 2014; White, Dahl, and Ritchie 2016).

This work also enriches research on visual representation (Jarvenpaa 1989; Lurie and Mason 2007) and adaptive decision making (Payne, Bettman, and Johnson 1993). Prior research suggests that changes in task or contextual characteristics in choice environments can shift information processing and choice behavior (Payne, Bettman, and Johnson 1993). Our work adds to this research by showing that simply adding visual boundaries to a product matrix (without changing information structure) can dramatically affect consumer behavior. As such, this research moves beyond the aesthetic role of visual design elements (Baker, Grewal, and Parasuraman 1994; Bitner 1992; Wang, Minor, and Wei 2011) and offers a new vista for studying the connections among simple environmental cues and consumer behavior.

Lastly, by exploring the impact of visual boundaries, our research contributes to a small but growing body of research examining the effect of boundaries on consumer behavior. For example, research on social reference groups suggests that social boundaries associated with in- versus out-groups has an impact on brand associations and purchase intentions (White and Dahl 2006). Other work shows a physical boundary effect of ceiling height on the sense of freedom and judgment and evaluation of products (Meyers-Levy and Zhu 2007). Similarly, research demonstrates that aisle width can influence consumers’ perceptions of choice variety (Levav and Zhu 2009). We show that, in the same way that social boundaries regulate social behavior, and physical boundaries govern physical behavior, visual boundaries serve as implicit communication tools between the retailer and consumers. This affects consumer perception in systematic ways.

From a managerial standpoint, our findings are important since they show how simple design choices affect consumer perceptions. For instance, perceived variety can be increased through the use of visual boundaries that separate product attributes rather than offering more products. The success of such tactics, however, is likely to depend on consumers’ cognitive load and consumer beliefs about why retailers use visual boundaries.

Limitations and Future Research

It is important to point out some of the limitations of this work. First, in the current work, we focused on visual boundaries separating product types versus product attributes; for experimental control, our studies were limited to examining color blocks. Other types of visual design elements, such as shape, texture, typography, and form; and a variety of design principles, including gestalt, space, hierarchy, balance, contrast, scale, dominance, and similarity; may affect consumer decision making in different ways. Future research could extend the current work to a broader scope of visual design elements and design principles. In addition, our research suggests that visual boundary effects are likely to vary depending on the extent to which they convey a retailer’s assistive versus persuasive intent. In particular, our results show that visual boundaries that consumers view as serving navigation rather than persuasive purposes have different effects on variety perceptions. It would be interesting for further research to further explore other potential boundary conditions for visual boundary effects.

Second, our findings suggest that the impact of visual boundaries is stronger when consumers face cognitive load. It would be interesting to examine how other types of boundary effects (such as effects of social or physical boundaries) are affected by cognitive load. Future research could also explore whether effects of visual boundaries depend on motivation and involvement. Given that consumers are more motivated to engage in extensive information search for high-involvement products (Beatty and Smith 1987), one hypothesis is that effects of visual boundaries will be stronger for low-involvement (low-motivation) products. Examining this research question would identify additional contingencies for visual boundary effects and offer important insights to marketing practitioners about how to effectively utilize visual boundaries across product categories (i.e., for high vs. low-involvement products).

Third, although we studied perceived variety, visual boundaries may affect other dimensions of consumer behavior. For example, if visual boundaries between attributes motivate by-attribute processing that reduces tradeoffs among different attributes (Bettman et al. 1993), they may lead to greater choice deferral or preference for a no-choice option; especially under high choice conflict (Dhar and Nowlis 1999). Moreover, it would be interesting to investigate how a consumer’s search goal might interact with visual boundaries and cognitive load to affect consumer behavior. For example, if a consumer has a goal that leads her to search a choice set by attributes (vs. alternatives), this would lead to greater congruity with visual boundaries separating attributes (vs. alternatives), reducing information processing costs that affect consumer behavior; especially under cognitive load. Future research could explore these research questions. More generally, this research points to the growing importance of understanding the relationship between visual presentation and consumer behavior. Rather than viewing visual design as solely aesthetic, it is important to examine how visual cues affect consumer behavior.
Appendix A. Examples of Visual Boundaries.
Appendix B. Study 1 Stimuli.

No Visual Boundaries

<table>
<thead>
<tr>
<th>No Visual Boundaries</th>
<th>Visual Boundaries Separating Products</th>
<th>Visual Boundaries Separating Attributes</th>
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Appendix C. Manipulation of Retailer Intent in Study 2.

[Essay in the assistive intent condition]:
According to the latest study conducted by the Center for Design Research at Stanford University, web designers often use color palettes to help consumers navigate a website. The right color combination can make a website more accessible and useful. The study shows that 98% of professional web designers place "ease of navigation" above other considerations when making color decisions.

[Essay in the persuasive intent condition]:
According to the latest study conducted by the Center for Design Research at Stanford University, web designers often use color palettes to persuade consumers to buy products that the seller wants them to buy. The right color combination can make a website more persuasive. The study shows that 98% of professional web designers place "persuasion" above other considerations when making color decisions.

[Essay in the control condition]:
According to the latest study conducted by the Center for Communication Research at Stanford University, Americans express a clear preference for getting their news on a screen—though which screen that is varies. TV remains the dominant screen, followed by digital. Still, TV news use is dramatically lower among younger adults, suggesting further shake-ups to come.

Appendix D. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jretai.2019.03.001.

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