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Shining in the Center: Central Gaze Cascade Effect on Product Choice

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Consumers' tendency to choose the option in the center of an array and the process underlying this effect is explored. Findings from two eye-tracking studies suggest that brands in the horizontal center receive more visual attention. They are more likely to be chosen. Investigation of the attention process revealed an initial central fixation bias, a tendency to look first at the central option, and a central gaze cascade effect, progressively increasing attention focused on the central option right prior to decision. Only the central gaze cascade effect was related to choice. An offline study with tangible products demonstrated that the centrally located item within a product category is chosen more often, even when it is not placed in the center of the visual field. Despite widespread use, memory-based attention measures were not correlated with eye-tracking measures. They did not capture visual attention and were not related to choice.

Consumers are exposed to horizontally presented arrays of products in various contexts, such as lunch combos pictorially presented in the menu of a fast food restaurant, rows of snack bars in a vending machine, a selection of bottled drinks at a buffet, or a selection of suggested movies from an online service provider (see fig. 1). One of the documented effects when choosing from an array of products is horizontal centrality: the option located in the center is more likely to be chosen. For instance, Christenfeld (1995) demonstrated that people chose the middle option in a number of different contexts, including choice of a bathroom stall in a public restroom, choice of a toilet paper dispenser in the restroom, and choice among a row of arbitrary symbols. In the same study, when choosing among rows of a product displayed on a supermarket shelf, the middle option was preferred 71% of the time. Similarly, Shaw et al. (2000) showed that in making a choice among an array of three alternatives, individuals consistently preferred the middle option. This effect was replicated with highlighters, surveys, and chairs.

Location-driven choice patterns have implications for retail shelf management and point-of-purchase decisions, among other consumer choice contexts. In efforts to understand point-of-purchase decisions, researchers have focused on the drivers (Chandon et al. 2009; Janiszewski 1998; van der Lans, Pieters, and Wedel 2008a, 2008b), strategies (Pieters and Warlop 1999), and stages (Clement 2007; Russo and Leclerc 1994; Russo and Rosen 1975) of the visual search process and have concluded that the ability of a brand to capture and hold consumer attention can be a source of competitive advantage. In fact, using eye-tracking methodology, van der Lans et al. (2008a) demonstrated that competitive advantage on the shelf is generated mostly by in-store factors rather than out-of-store factors (e.g., search goals) with a ratio of 2 : 1. Similarly, Chandon et al. (2009) demonstrated that, at the point of purchase, the brand's horizontal centrality on the shelf has a strong positive effect on brand choice. These findings call for a closer investigation of the effects of location on the visual search and decision-making processes and its relevance to choice.

The current article, in two computer-based eye-tracking studies and an offline lab experiment, progressively investigates

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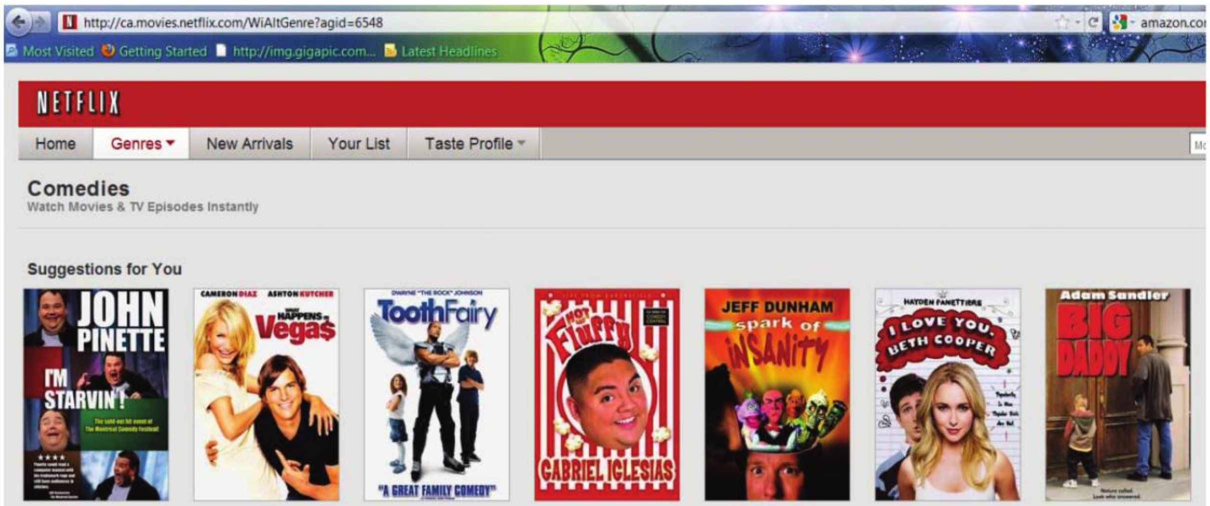
FIGURE 1

ARRAY OF MOVIE SUGGESTIONS (FROM NETFLIX.COM)



how horizontal location affects choice. Visual attention is linked to choice. Interestingly, other research corroborates the impact of horizontal centrality on choice (Valenzuela and Raghubir 2009) but argues against an attention-based explanation. It is suggested that inferences made about the option in the horizontal center determine choice. Therefore, the current project investigates whether horizontal centrality affects (1) how much attention a brand gets, (2) the inferences made about the brand, and (3) whether these factors are related to the impact of horizontal shelf location on choice. Results suggest that the indirect impact of horizontal centrality on choice is through visual attention. The indirect impact of horizontal centrality on choice through brand inferences was not significant. A gaze likelihood analysis (Shimojo et al. 2003) was conducted to understand how visual attention is related to choice. The relationship between visual attention and choice is not a result of an initial tendency to fixate on the center but is related to accelerated fixations in the final seconds of the gaze duration. The brand in the center benefits from a disproportionately more prominent gaze cascade, which is coined the *central gaze cascade effect*. Given the widespread use of memory-based self-reported measures of attention, the effects of horizontal centrality on self-reported measures of attention were also investigated. The results suggested that memory-based attention measures and eye-tracking measures may be related to different constructs. More specifically, in the current studies, memory-based attention measures (unaided recall, aided recall, and multi-item attention measures) did not capture visual attention and were not related to choice. These findings were replicated (study 1B) with shelf displays shifted off the center of the visual field (i.e., the computer screen), confirming that the higher attention paid to the centrally located option is not due to a tendency to look more at the center of the computer screen. Extending the findings to an offline choice context (study 2), it was confirmed that the centrally located item within a product category is chosen more often even when it is not placed in the center of the shelf or the visual field. Taken together, findings emphasize the relationship between horizontal location, visual attention, and choice, as well as the critical role of eye-tracking measures in understanding the visual search and choice processes. Other possible explanations, including initial fixation bias, leader-driven primacy, leader-driven search focus, and marketplace metacognitions are discussed.

EXPLANATIONS FOR THE HORIZONTAL CENTRALITY EFFECT ON CHOICE

Research in visual perception (Locher and Nodine 1973, 1989) demonstrated that individuals have a propensity to look longer at the axis of symmetry when exposed to a symmetric picture. To investigate whether the preference for symmetry leads to the horizontal centrality effect on choice, Shaw et al. (2000) conducted an experiment in which participants were asked to choose a chair among a row of chairs that were all empty (balanced) or occupied on one end (unbalanced). The preference for the chair in the middle was prevalent in both conditions, ruling out the preference for symmetry as an explanation. Shaw et al. (2000) also proposed increased attention as an alternative explanation because the middle option is at the center of the perceptual field. Findings for the attention explanation, using a recall task to measure attention, were not conclusive; a call was made for additional research (Shaw et al. 2000). In recent eye-tracking studies, Chandon et al. (2007, 2009) found that brands located in the (vertical and horizontal) center of a shelf display are noted more and chosen more often, supporting an attention-based explanation. Valenzuela and Raghubir (2009) proposed the *center-stage effect* as an alternative explanation. According to Valenzuela and Raghubir (2009), consumers hold the lay belief that in retail contexts the products placed in central positions are more popular, reflecting the overall quality of the product, which leads consumers to systematically prefer items in the center.

Note that Chandon et al. (2007, 2009) focused on visual attention as the explanation for horizontal centrality, but they did not measure inferences made about the chosen brand. Valenzuela and Raghubir (2009, 2010) reported that the impact of horizontal location on choice is mediated by brand inferences but not by attention. They obtained these results with memory-based attention measures (e.g., recall). Extant research in eye tracking demonstrated that memory-based self-reported measures do not reflect attention accurately in the context of brand choice (Aribarg, Pieters, and Wedel 2010; Chandon et al. 2007, 2009), and they concluded that attention and recall are distinct constructs. In the context of print advertisement, Aribarg et al. (2010) documented that consumers falsely report having attended to a given ad when they have not. In short, the choice or lack of measures and the distinction between the constructs can be the source of inconsistent explanations provided for the horizontal centrality effect on choice. The current research investigates the role of each factor in explaining why horizontal centrality impacts choice, using multiple measures that tap on different conceptualizations of attention (visual attention and memory based) and inferences.

While the connection between inferences and choice is intuitive, could one expect horizontal centrality to lead to choice through visual attention, independent of conscious and articulated brand inferences? Although this question has not been addressed specifically, the connection between articulated, conscious inferences and choice has been questioned. First, individuals are not always able to identify and report the processes that lead to their choices (Johansson et al. 2005; Nisbett and Wilson 1977). When asked to explain the reasons why they have made a specific choice, individuals often provide reports on their cognitive processes that are simply attributions made post choice (Nisbett and Wilson 1977). These attributions tend to be biased such that having made a choice changes a person's preferences (Sharot, Velasquez, and Dolan 2010) to avoid or reduce dissonance effects (Festinger 1957). Second, individuals may make choices without "declarative knowledge" or conscious inferences (Bechara et al. 1997; Shiv et al. 2005). Johansson et al. (2005) presented participants with their choice and asked them to explain the reasons for their choice. In reality, participants were presented with the alternative they had not chosen and led to believe that it was their choice. Participants failed to realize this change, pointing to a choice recall failure. They also provided confabulatory reports when asked to describe the reasons behind their choices. Congruent with the somatic marker hypothesis, individuals observe and interpret their own choices to generate emotions that serve as markers that affect their subsequent judgments (Bechara and Damasio 2005; Bechara et al. 1997; Simion and Shimojo 2006). These findings point to choice without articulated inferences.

More relevant to the link between visual attention and choice, research in visual perception identified a crucial role of visual attention in the final moments of the choice task that shapes individual's preference for the eventually chosen alternative, independent of the effects of memory or prior preferences (Shimojo et al. 2003; Simion and Shimojo 2006). Shimojo et al. (2003) provided gaze pattern analyses that help in understanding the visual attention process behind choice. They found that the role of attention on preference for the eventually chosen option is rapid and concentrated in the final few seconds of the choice task. This reduces the utility of memory-based self-reported attention measures to understand the process (Glaholt and Reingold 2011). Given the low sampling, speed, and accuracy of memory-based self-reports of attention and the problems in introspective reports of choice processes, more objective and accurate process measures are necessary to understand the choice process (Russo 2011). Next, visual attention and its use as a process measure are discussed.

VISUAL ATTENTION, CENTRALITY, AND CHOICE

Process tracing is critical in understanding the elements of decision making. Methods examining the process of information acquisition and decision making (see Kuhlberger, Schulte-Mecklenbeck, and Ranyard [2011] for an overview), ranging from think-aloud procedures and verbal protocols to skin conductance tests, have been used. Eye-tracking procedures and Mouselab have been used to identify the stages, motivators, and determinants of the decision-making process (Coupey, Bodur, and Brinberg 1998; Payne et al. 1992; Pieters and Warlop 1999; Russo 2011; Wedel and Pieters 2000; Willemson, Böckenholt, and Johnson 2011). In retail contexts, Chandon et al. (2007, 2009) suggest the use of eye movements as an indicator of attention as they are sensitive and objective.

In general, physiological response measures (Krugman 1965) such as eye-tracking procedures are a reliable and objective measurement of visual attention (Christianson et al. 1991; Deubel and Schneider 1996; Krugman et al. 1994; Rosbergen, Pieters, and Wedel 1997; Tsal and Lavie 1993; van der Heijden 1992; Wedel and Pieters 2000). Research in neurology supports the link between attention and eye movements (Kustov and Robinson 1996; Mohler and Wurtz 1976). Eye movements on scenes are composed of fixations and saccades (Rayner 1998). Fixations are the brief moments in which the eye is stable and information is extracted from the scene. Saccades are movements of the eyes that last about 20–40 milliseconds (Matin 1974; Rayner 1998; Pieters and Wedel 2008). During a saccade, vision is suppressed

(Matin 1974; Rayner 1998), and the eye is redirected to a new fixation (van der Lans et al. 2008b). A fixation lasts about 200–400 milliseconds on average and in general ranges between 50 milliseconds to a second (Pieters and Warlop 1999; Rayner 1998). Eye fixations are instrumental in acquiring information from the perceptual field (Anstis 1974; Sanders and Donk 1996). For example, in reading, typically, relevant information is acquired during the first 50–70 milliseconds of a fixation (Rayner 1998), while in viewing web pages visual attention can be assessed within 50 milliseconds (Lindgaard et al. 2006). Recent research in ad perception documented that an ad can be perceived in a single fixation of less than 100 milliseconds. Consumers can identify what they are looking at (an ad vs. editorial material) even when the information presented is deliberately blurred (Pieters and Wedel 2012). These findings are consistent with research in visual perception. In brief, with 90% accuracy, briefly presented images of natural scenes (e.g., beach, forest) can be identified (Castelhano and Henderson 2008; Rousselet, Joubert, and Fabre-Thorpe 2005). Grill-Spector and Kanwisher (2005) found that 65 milliseconds were needed to identify an object with accuracy, while there were no differences in detection and categorization at 17, 33, 50, 68, or 167 milliseconds. Individuals were accurate in detecting and categorizing typical objects in each time frame. Both reached a ceiling of 90% accuracy after 80 milliseconds of single exposure. The sequence of fixations (gaze pattern) also provides information about the visual search process (van der Lans et al. 2008b). In this respect, visual attention is a systematic process that is accessed via the study of eye movements: eye fixations, saccades, and gaze patterns and durations (Christianson et al. 1991; van der Heijden 1992; van der Lans et al. 2008b).

Visual Attention and Choice

Attention is involved in all marketing efforts (Milosavljevic and Cerf 2008). Visual attention, captured through eye movements, is a significant predictor of brand choice (Maughan, Gutnikov, and Stevens 2007; Pieters and Warlop 1999). Recent evidence suggests that looking at an item for longer can lead to higher choice likelihood (Armel, Beaumel, and Rangel 2008; Krajbich, Armel, and Rangel 2010). In a binary choice task between familiar options, individuals were more likely to choose the snack food option that they looked at more, after controlling for preexisting preferences for each option (Krajbich et al. 2010).

In visual research, Shimojo et al. (2003) demonstrated that just prior to the choice there is a progressively increasing bias in the likelihood that the observer's gaze will be directed toward the chosen stimulus; they termed this the *gaze cascade effect*. Particularly, individuals display an "avalanche of fixations on the to-be-chosen object" in the final seconds of the gaze duration (Changizi and Shimojo 2008, 1512). In explaining this effect, Simion and Shimojo (2006) argue that the gaze pattern is intrinsically involved in preference formation by way of a dual process with a feedback loop: the more the individuals look at a stimulus, the more they like it, and the more they like it the more they look at it. This dual process shapes the preference for the eventually chosen option. Although the gaze cascade effect addresses the link between choice and final gaze patterns, no argument has been made about the role of the location of the choice options, namely, horizontal centrality on the gaze cascade effect.

Centrality Bias in Visual Attention

In general, eye fixations are directed at the informative elements of a scene (Antes 1974; Buswell 1935; Mackworth and Morandi 1967; Parkhurst, Law, and Niebur 2002; Russo 2011; Yarbus 1967). When a scene appears, the natural initial response is to look at the center of it; this has been called the *central fixation bias* (Tatler 2007; Tatler, Baddeley, and Gilchrist 2005). The central fixation bias occurs regardless of how the informative features of the scene are distributed (Tatler 2007). Two main reasons motivate this bias. First, the center of the scene is unconsciously considered the optimal location to extract information as individuals expect to find informative elements at this location even when there is none. This is referred to as the photographer bias and is observed when individuals have had no previous exposure to the scene (Tseng et al. 2009). Second, there is a predisposition, called the orbital reserve, that is an innate preference for eye movements that place the pupils in the central position (looking straight ahead) rather than elsewhere (Paré and Munoz 2001). This causes a re-centering bias to emerge as soon as the pupils leave the central position. Independent of the cause, individuals are predisposed to look at the center of a given visual field (Ho-Phuoc, Guyader, and Guérin-Dugué 2010). Therefore, the tendency to look more at the center could explain the horizontal centrality effect on choice. The current research investigates the links between central fixation bias, gaze cascade effect, and horizontal centrality in a consumer choice context. Note that the horizontal centrality effect is relevant when the number of alternatives is greater than two, yet earlier research demonstrating the gaze cascade effect focused on binary choice sets.

METHODOLOGY

Overview

Using an eye-tracking methodology, studies 1A and 1B explored the effect of horizontal centrality on choice likelihood and how this effect is linked to increased visual attention and/or inferences. These studies also examined the process of visual attention and how it is involved in the choice process. Study 2 extended the generalizability of the findings to an offline context.

Pretest

In order to test the effect of horizontal centrality on brand choice, a number of steps were taken to control for extraneous factors that could affect brand choice, such as brand familiarity, experience with product category, or visual features of each brand in the display. A pretest was conducted to develop a planogram, resembling a retail store shelf display, with brands that are not different from each other in terms of brand familiarity, purchase likelihood, and brand inferences, such as quality or expertise.

In order to eliminate brand familiarity, fictitious brand names were created. A search of secondary data confirmed that none of these or similar brand names were used in fast-moving consumer goods (FMCG) markets available to the target population at the time of data collection. The brands were presented in box packages that included the brand name and product information.

To improve external validity and to create realistic distinctions among the brands, as in retail environments, a different background color was used for each brand package. Brighter areas (packages with higher luminance) may increase the readability of brand information (van der Lans et al. 2008a). A pretest was conducted to select different background colors and to eliminate potential effects of the background color on readability. Participants completed the pretest ($N = 58$) as part of a larger unrelated PC-based study using SSiWeb. Ten different colors were developed using the HSL (hue, saturation, luminosity) color format, changing only the hue dimension of the color to assure that all colors were matched on color contrast. Each color patch was presented with the brand name and attribute information, as they would appear in the planogram, using the same font color (black). Participants were asked to rate the readability of the information on each patch on a 7-point scale (1 = easy to read, 7 = difficult to read). After comparing the readability scores of each color, three colors that did not vary on readability (all $t < .84$, $p > .10$) were chosen, and these were applied as background colors for each brand.

STUDY 1A

Participants

Sixty-seven undergraduate students at HEC Paris participated in this study for extra credit. After eliminating four participants due to technical problems in eye tracking and incomplete measures, the analyses were conducted with the remaining participants ($N = 63$). The average age was 20.4 (SD = 0.8), and 54% were females.

Design and Procedure

Each participant was seated in front of a Tobii 1750 eye-tracker. The Tobii 1750 eye-tracker screen is 17 inches wide, with a resolution of 1,280 × 1,024 pixels and a frequency of 50 hertz (hz; i.e., the screen is refreshed 50 times per second). As participants view the stimuli shown on the screen, a discreet infra-red camera—located below the screen—records participants' eye gaze unobtrusively. This camera tracks the exact location of eye fixations on the screen at any moment. Prior to any recording, the eye-tracking device is calibrated. In the calibration phase, each participant is asked to follow a series of blue dots moving along the screen. Participants can wear reading glasses or contact lenses. They are free to move their heads freely within a region of 30 centimeters × 15 centimeters × 20 centimeters and a distance of 60 centimeters from the screen. There are no physical restrictions on head gear. After the calibration phase, participants reviewed the stimuli. Viewing time was not constrained. Vitamin supplements and meal replacement bars were used as the stimuli. Each participant reviewed two product categories, made a choice, and responded to a questionnaire. The order of the product categories was randomized.

Stimuli

Participants were presented with two separate planograms (3 × 3 matrix design). The brands were organized in columns to isolate the effect of horizontal position. Each brand had an equal number of facings (three). Specifically, there were three variants of each brand. The presentation of each brand was counterbalanced across columns to isolate the effect of horizontal centrality from potential brand effects. The brand names used were fictitious: Priorin, Alpecin, and Labrada for vitamins, and Bega, Niran, and Salus for meal replacement bars.

Participants were asked to carefully review each product on the screen as if these were on the store shelf and to hit the enter key when they were done reviewing and were ready to make a choice. Once the participants hit the enter key, the stimulus disappeared from the screen, ensuring that any further visual processing is stopped, and participants indicated their choice. Upon completion of the choice task, a survey measuring evaluations of the brands was administered.

More specifically, participants were asked to indicate the option they chose by checking the box that matched the position of the product on a 3 × 3 matrix that mirrored the planogram. Participants were also asked to write the name of the brand they chose. This was followed by the measurement of the inferences made about each brand, including the ones not chosen. The inference measures were adopted from earlier research that found that the effect of horizontal centrality on choice is through brand inferences (Valenzuela and Raghubir 2009). These measures were obtained at the brand level instead of the brand-variant level. Consumers are more likely to form inferences about brands rather than variants (Cowley and Mitchell 2003; Keller 1993). In addition, obtaining measures for all nine brand variants in the planogram would significantly increase the demands on the participants and hinder the quality of the measures.

More specifically, the inference measures included quality (1 = low quality and 9 = high quality), popularity (1 = low and 9 = high), and attractiveness (1 = not at all and

9 = extremely) ratings. Participants were next asked to indicate how much "market share" each brand had in the product category and how much "retail space" they would allocate to each if they were a store manager, using a constant sum scale. These two measures assessed whether participants thought other consumers would find the brand attractive (Valenzuela and Raghubir 2009). Participants also indicated how much attention they think each brand and package captured, using two items, both on 9-point scales (1 = no attention and 9 = full attention).

In addition to this interval-level brand-specific attention measure, to compare memory-based attention measures with visual attention measures, unaided and aided recall measures related to the choice task were included following the inference measures. First, an unaided recall measure asked participants to write the name of the brand they chose. Next, an aided recall measure asked participants to check the brand they chose from the list of brands provided. Finally, participants responded to questions related to product category familiarity, marketplace metacognitions (i.e., lay beliefs about shelf location), purchase history, and demographics.

Results

Horizontal centrality had an impact on visual attention. The brands in the horizontal center received more frequent eye fixations, and overall they were looked at longer (total duration) over the course of the entire search process. To ensure information acquisition per each fixation, fixations that lasted less than 100 milliseconds were eliminated (Pieters and Wedel 2012). The results did not change when fixations below a 200-millisecond cutoff were eliminated. This is consistent with Pieters and Wedel's (2012) finding that information extracted from a fixation does not improve above 100-millisecond fixations.

Overall, on each alternative in the planogram, there were more than two fixations; each brand variant was noted and reexamined. Next, the distributional properties of fixation frequency and duration data were observed. Given the count nature of fixation frequency, Freeman-Tukey transformation was used to satisfy normality assumption (Bar-Lev and Enis 1988; Freeman and Tukey 1950). For total fixation duration, a natural log transformation was used (Willemsen et al. 2011). After the transformations, both visual and formal tests of the transformed variables indicated that the normality assumption was satisfied. These transformed measures were used in the subsequent analyses.

Results of an ANOVA revealed a significant effect of horizontal centrality on visual attention captured by the eye-tracking measures and choice but not on the brand inferences that were measured or memory-based attention measures ($p > .10$). Specifically, in total, brands in the horizontal center received more frequent eye fixations (60.9 vs. 48.7; $F(1, 375) = 13.47$, $p < .01$, partial $\eta^2 = .035$). Overall, they were also looked at longer, as indicated by the total duration of fixations on each brand (15.1 seconds vs. 12.6 seconds; $F(1, 375) = 5.37$, $p < .05$, partial $\eta^2 = .021$). A logistic regression analysis with choice as the dependent variable and left (1 = left, 0 = right) and center (1 = center, 0 = otherwise) as the independent variables ($\beta = .76$, Wald $\chi^2(df = 1) = 8.01$, $p < .01$) revealed that being in the horizontal center improved the choice likelihood. Overall, horizontal centrality increased choice frequency by 18.0%. A brand located in the center had a choice frequency of 45.3%, whereas a brand that was not in the center had a choice frequency of 27.3%. Being at the left or right of the display did not affect choice ($\beta = -1.61$, Wald χ^2 $(df = 1) = .32$, $p > .10$). To verify that the brand names did not lead to any biased evaluations, brand name was included as a control variable, and brand name did not have an effect on choice ($p > .10$).

Next, a multiple mediation analysis was conducted to examine if attention and/or brand inferences were involved in the process of the horizontal centrality effect on choice. A multiple mediation analysis was conducted with multiple mediators included in a single model using a nonparametric bootstrapping strategy (Preacher and Hayes 2008). Brand choice (1 = brand chosen, 0 = otherwise) was the dependent variable. The independent variables related to horizontal shelf location were center and left.

As explained earlier, various brand inference measures were collected upon completion of the choice task. An exploratory factor analysis revealed that the brand inference measures loaded on two separate dimensions. Quality, popularity, and attractiveness of the brand represented one dimension, and market share and retail space allocation of the brand represented a second dimension, explaining 76% of the total variance in inferences. The first dimension reflects individual inferences, while the latter reflects consumers' inferences about how the market would evaluate the brand. Two composite inference indexes were created by averaging these items: individual inferences and market-level inferences. Both individual inferences ($\alpha = .81$) and market-level inferences ($r = .75$) were included in the mediation analysis as separate mediators. Visual attention, measured using the total duration of eye fixations on each brand, was included as the third mediator. Finally, the two self-reported items that assessed the attention each brand captured were averaged into a composite score as the memory-based measure of attention ($r = .90$). This index was included as the fourth mediator.

The multiple mediation analysis was conducted using SPSS macro modules with bootstrapping of 5,000 samples (Preacher and Hayes 2004). Horizontal centrality significantly increased the total duration of fixations on the brand (a path, $\beta = .20$, $t = 2.04$, $p < .05$; see table 1). There was no significant effect of horizontal centrality on individual inferences, market-based inferences, or memory-based measures of attention (a′ path, all $p > .10$). More relevant results of the test are bootstrapping results for the indirect effects. The indirect effect of horizontal centrality on choice through visual attention (total duration of fixations on the brand) was significant ($p < .05$), indicated by a 95% confidence interval that did not include zero. However, the indirect effects of

TABLE 1

STUDIES 1A AND 1B: MEDIATION OF THE HORIZONTAL LOCATION–BRAND CHOICE RELATIONSHIP

	Study 1A			Study 1B		
	Coefficient	*t*-value	*p*-value	Coefficient	*t*-value	*p*-value
A. Horizontal center → mediators (a paths):						
Attention (eye tracking)	.20 (.10)	2.04	< .05	.25 (.13)	1.90	.06
Attention (self-reports)	.04 (.21)	.20	.84	.44 (.26)	1.67	.10
Brand inferences (individual)	.03 (.17)	.19	.85	.27 (.20)	1.29	.20
Brand inferences (market)	−.66 (.17)	−.56	.57	2.67 (1.60)	1.67	.10
B. Mediators → brand choice (b paths):						
Attention (eye tracking)	.33 (.15)	2.22	< .05	.53 (.27)	2.01	< .05
Attention (self-reports)	−.10 (.10)	−1.04	.30	−.05 (.13)	−.37	.71
Brand inferences (individual)	.32 (.12)	2.61	< .01	.13 (.17)	.75	.45
Brand inferences (market)	.04 (.01)	3.23	< .01	.09 (.02)	4.32	< .01
C. Center → brand choice (c′ path)						
Center	.88 (.24)	3.63	< .01	.60 (.36)	1.66	.10
D. Center → brand choice (c path)						
Center	.84 (.23)	3.66	< .01	.76 (.32)	2.36	< .05

	E. Boot sampling results for indirect effects (a × b paths)				
	Data	Bootstrap	Bias	SE	95% CI
Study 1A:					
Attention (eye tracking)	.066	.068	.002	.047	[.01, .19]
Attention (self-report)	−.005	−.007	−.002	.034	[−.11, .04]
Brand infererences (individual)	.011	.012	.001	.063	[−.11, .16]
Brand infererences (market)	−.024	−.025	−.001	.047	[−.14, .06]
Study 1B:					
Attention (eye tracking)	.130	.147	.017	.107	[.01, .41]
Attention (self-report)	−.022	−.027	−.001	.080	[−.26, .09]
Brand infererences (individual)	.034	.035	.001	.078	[−.07, .28]
Brand infererences (market)	.253	.274	.021	.187	[−.06, .68]

NOTE.—Dependent variable is brand choice. Attention is represented by natural log transformed total duration of fixations on the brand. Results with total number of fixations (fixation frequency) using 100-millisecond or 200-millisecond minimum cutoff levels are similar. Measures of fit for the model measures for study 1A are McFadden = .101, CoxSnell = .120, Nagelkerke = .167. Measures of fit for study 2B are McFadden = .180, CoxSnell = .205, and Nagelkerke = .285. Standard errors are in parentheses.

horizontal centrality on choice through individual-level inferences, market-level inferences, and memory-based attention were not significantly different from zero (at $p < .05$; see table 1). When the same mediation analysis was replicated with total number of fixations on the brand (fixation frequencies) as the visual attention measure, the results were similar. Combined, these findings showed that the positive impact of horizontal centrality on choice is related to visual attention but not the brand inferences assessed in the current study. The results also suggested that self-reported measures of attention are not related to choice. Comparison of visual- and memory-based attention measures are revisited later.

Participants also indicated their likelihood of purchasing each brand. The same multiple mediation analysis was repeated with purchase likelihood as the dependent variable. The results were similar to those with brand choice. Horizontal centrality had a significant impact on visual attention, as measured by the total duration of fixations on the brand ($p < .05$) but not on brand inferences or memory-based attention (both $p > .05$). The bootstrapping results revealed that the indirect effect of horizontal centrality on choice through total duration of fixations on the brand was significant ($p < .05$). Neither individual-level nor market-level inferences nor memory-based attention revealed a significant indirect effect of horizontal centrality on choice. The results with purchase likelihood as the dependent variable using the same mediators were consistent when the total number of fixations on the brand was used to capture visual attention.

The mediation analysis was repeated with left as the independent variable. There were no significant effects of left on any of the mediator variables with vitamins and meal replacement bars (all $p > .10$). The indirect effects based on bootstrapping results were not significant. The results with left as the independent variable were similar when either total duration or total number of fixations on the brand were used to capture visual attention and when choice or purchase intention was used as the dependent variable. These results further demonstrate that the horizontal center of the planogram, not the edges, receive more visual attention.

Although the mediation analyses revealed that the visual attention that a brand receives is related to the effect of horizontal centrality on choice, it is not clear how. Two explanations about the visual attention process, both related to the timing of visual attention, are plausible. It could be the initial fixations clustered in the center of the display and/or the final fixations that merge into a gaze cascade that instantiate the observed choice for the item located in the horizontal center. Earlier research in eye tracking has identified that people have a tendency to focus on the central location in a scene in the first few fixations before they look at other locations as the initial central fixation provides an optimal location for extracting the maximum amount of information from the display (Tatler 2007). Thus, initially, the center of any display gets more visual attention. This could be related to choice. Shimojo et al. (2003) pointed to another attention bias in the visual search process that is not a function of the location of the options. They showed that in the final moments of visual search, visual attention on the chosen alternative is heightened, presenting a progressively increasing gaze bias toward the chosen stimulus (gaze cascade effect). Increased visual attention on the chosen option at the end of the gaze duration could also be involved in the choice process. Both of these biases may explain the role of visual attention on choice. The gaze patterns were analyzed to investigate the predictions.

GAZE PATTERN ANALYSES AND RESULTS

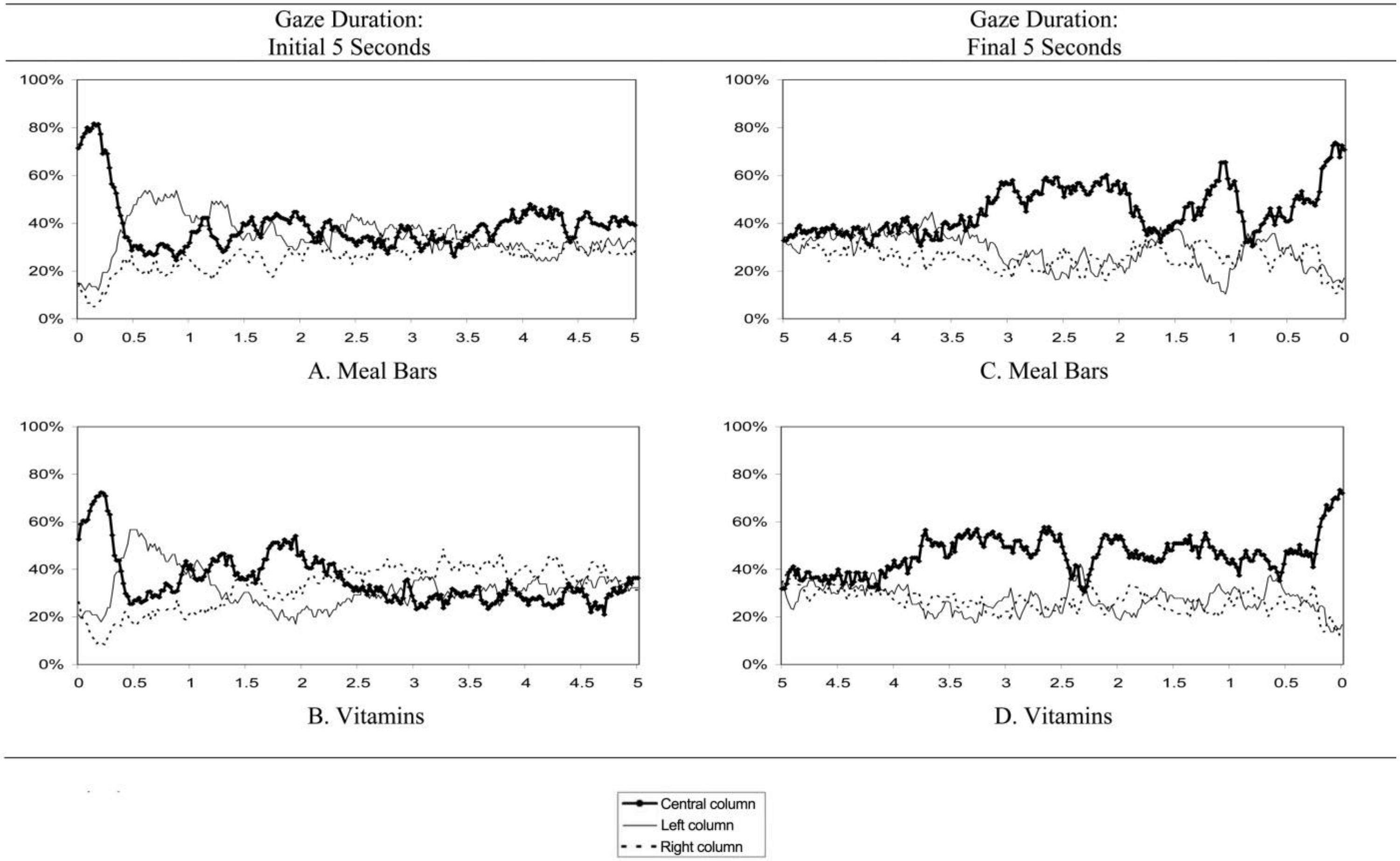
Gaze patterns are informative of the visual attention process as they represent the temporal pattern of fixations, including very short fixations (e.g., 20 milliseconds). The initial analyses revealed, overall, a higher level of visual attention on the centrally located brand through the entire gaze duration (total duration and number of fixations). To understand whether this pattern is due to initial or final tendencies to focus visual attention on the centrally located brand, the following analyses addressed two questions: (1) Is there a greater tendency to focus on the horizontal center (compared to left or right) in the initial few seconds and/or final few seconds of the gaze? (2) Does the higher visual attention on the horizontal center in the initial or final few seconds of the gaze duration drive the effect of attention on brand choice?

Based on the gaze likelihood analysis introduced by Shimojo et al. (2003), likelihood curves for fixating on each column of the display (i.e., the brand at the left, center, and right of the display) were developed. This analysis consisted of dividing the overall gaze duration into time bins and analyzing the position of the gazes within each bin. The proportion of gazes on a certain horizontal area (left, center, or right) in each sample (time bin) was plotted to form a likelihood curve over the duration of the gaze. Participants' eye movements were recorded at a rate of 50 samples per second; therefore, each time bin covered 20 milliseconds. Detection and categorization of visual stimuli is accurate in fixations as brief at 17 milliseconds (Grill-Spector and Kanwisher 2005), and overall categorization accuracy is ensured between 20–100 milliseconds (Loftus and Harley 2004; Loftus and McLean 1999). Therefore the use of a 20-millisecond time bin allows accounting for each fixation in which information would have been extracted. Guided by Shimojo et al. (2003), each sampling point was coded such that one indicated that the participant's gaze was directed at the focal column and zero indicated that the gaze was directed elsewhere on the planogram. The likelihood of fixating on the focal column at each sampling point was obtained by averaging these values across participants. The likelihood curves of fixating on each column in the initial and final 5 seconds (250 sampling points each) of the gaze duration were plotted for each product category. Note that Shimojo et al. (2003) focused on a shorter time period (1.5–2 seconds) as the overall gaze duration was much shorter in their choice context (on average 3 seconds) compared to the average gaze duration in the current study (more than 35 seconds in both categories). This is due to task differences; the task in Shimojo et al. (2003) was to choose between two options, whereas participants were exposed to nine options in the current study. Moreover, the use of a 5-second interval is more informative and consistent with other research on gaze patterns (Glaholt and Reingold 2009; Simion and Shimojo 2006). Figure 2 presents the resulting likelihood curves. Note that, to account for the possible impact of sampling points on the pattern of results, the same gaze pattern analyses were replicated with 40 milliseconds, 100 milliseconds, and 200 milliseconds bins. In each case, the results were similar.

As demonstrated in figure 2, the likelihood of fixating on the (horizontal) central brand (compared to the brand on the horizontal edges) was higher at the beginning of the gaze for both product categories, consistent with the central fixation bias (Tatler 2007). This effect was particularly prevalent in the first 0.5 second of the gaze. In order to test whether this difference was significant, the total number of gaze positions within the first 5 seconds of the gaze duration that were focused on the central brand were compared with the total number of gaze positions focused on those brands on the left and right edges of the display (see table 2, panel A). Both contrasts (center vs. left and center vs. right) were significant (both $p < .01$). This verified that an initial central fixation bias is prevalent. When the first 0.5 second was removed and the analyses were replicated, the initial central fixation bias was much less prominent. Orienting oneself may be the reason for the initial fixations. When the contrasts were tested for other initial time bins, specifically for the first 0.5, 1, 2, 3, and 4 seconds, the results were similar.

FIGURE 2

STUDY 1A: LIKELIHOOD OF LOOKING AT EACH COLUMN DURING THE INITIAL AND FINAL 5 SECONDS



NOTE.—The likelihood to look at the central, left, and right columns is represented by the bold, solid, and dashed line, respectively.

TABLE 2

STUDY 1A: COMPARISON OF GAZE LIKELIHOODS

Product category/contrast	Panel A								
	First 1 second			First 3 seconds			First 5 seconds		
	Mean difference	*t*-value	*df*	Mean difference	*t*-value	*df*	Mean difference	*t*-value	*df*
Meal bar:									
$P_{Center} - P_{Left}$	.104*	1.93	(50)	.032*	1.63	(150)	.050***	4.10	(250)
$P_{Center} - P_{Right}$	.310***	7.36	(50)	.182***	10.78	(150)	.141***	12.65	(250)
Vitamin:									
$P_{Center} - P_{Left}$	.067*	1.71	(50)	.102***	6.58	(150)	.045***	4.25	(250)
$P_{Center} - P_{Right}$	.276***	9.17	(50)	.127***	8.05	(150)	.031**	2.54	(250)
	Panel B								
	Last 1 second			Last 3 seconds			Last 5 seconds		
	Mean difference	*t*-value	*df*	Mean difference	*t*-value	*df*	Mean difference	*t*-value	*df*
Meal bar:									
$P_{Center} - P_{Left}$	.253***	9.43	(50)	.267***	19.86	(150)	.179***	15.99	(250)
$P_{Center} - P_{Right}$	.267***	9.44	(50)	.267***	22.03	(150)	.209***	22.21	(250)
Vitamin:									
$P_{Center} - P_{Left}$	.244***	10.27	(50)	.229***	21.92	(150)	.202***	23.68	(250)
$P_{Center} - P_{Right}$	.266***	11.50	(50)	.245***	25.17	(150)	.208***	25.90	(250)

NOTE.—The mean differences represent the mean difference between the probability to look at column *x* (P*x*) and column *y* (P*y*). Results with the first and last 0.5, 2, and 4 seconds are similar and significant. Degrees of freedom (*df*) for the *t*-values are in parentheses.

*$p < .10$.

**$p < .05$.

***$p < .01$.

The likelihood curves for both product categories (fig. 2) also revealed a higher tendency to fixate on the centrally located brand (compared to the brands on the left or right) within the final 5 seconds of the gaze duration. The comparison of the total number of gaze positions that were focused on the centrally located brand with the total number of gaze positions that were focused on the brands on the left and right end of the display within the final 5 seconds of the gaze duration also revealed significant differences ($p < .01$, panel B of table 3). Replication of these contrasts for the last 4, 3, 2, 1, and 0.5 seconds provided similar results. Although the gaze cascade effect demonstrated that there is a sudden escalation of gazes on the to-be-chosen option just before choice (Shimojo et al. 2003), the findings reported here suggest a different effect, referred to here as the *central gaze cascade effect*: participants were more likely to fixate on the centrally located brand (compared to the brands on the left or right) in the final few seconds of the gaze duration.

The gaze patterns explained above suggest that individuals have higher frequencies of fixations on the centrally located brand at the beginning and at the end of the gaze, but it is not explained whether the likelihood of choosing the central brand is driven by initial or final fixation densities. To answer this question, the horizontal location of the chosen brand (left, center, right) was regressed on the proportion of initial fixation densities on the centrally located brand using a multinomial logistic regression. More specifically, the proportion of fixations on the centrally located brand and all fixations in the initial 5 seconds of the gaze were calculated and used as the predictor. This regression was repeated with the proportion of fixation densities on the centrally located brand and all fixations in the final 5 seconds of the gaze as the independent variable. Finally, the regression analysis was replicated for other time intervals, specifically, the initial and final 0.5, 1, 2, 3, and 4 seconds. The results are presented in table 3. The coefficients in table 3 represent odd-ratios that compare the probability of choosing a brand located in the center to the probability of choosing a brand located at the left or right end of the shelf display. Overall, the results presented here suggest that the initial central fixations do not increase the likelihood of choosing the centrally located brand in any of the time frames (initial .05–5 seconds, at $p < .05$). However, for the final time frames (final .05–5 seconds), the results were more consistent: the higher the proportion of fixations was on the center, the higher the probability was to choose a centrally located brand. To test the impact of sampling duration, the analysis was replicated using a wider and more conservative sampling point (200-millisecond time bin). The results were similar.

The central gaze cascade effect compared to the gaze cascade effect (Shimojo et al. 2003) refers to the accelerated gazes that are concentrated at the centrally located brand, more than the ones located at the left or right, in the final seconds of the choice task, regardless of the chosen alternative. The gaze cascade effect may be amplified for the central brand, that is, if the chosen brand is in the center as opposed to left or right, a more pronounced gaze cascade

TABLE 3

STUDY 1A: IMPACT OF CENTRAL COLUMN FIXATIONS ON THE PROBABILITY OF CHOOSING THE CENTRALLY LOCATED BRAND

	A. Initial gaze					
Odd-ratios (Exp(β))	First 5 seconds	First 4 seconds	First 3 seconds	First 2 seconds	First 1 second	First 0.5 second
Meal bar:						
Central / left	.310	.250	.445	.390	.453	.778
Central / right	1.772	1.473	2.956	3.007	2.899	2.733*
R^2	.030	.034	.050	.071	.101	.082
Vitamins:						
Central / left	1.039	1.002	1.021	2.295	1.579	.930
Central / right	2.151	2.435	2.871	4.567	1.753	.820
R^2	.008	.013	.025	.052	.015	.002
	B. Final gaze					
	Last 5 seconds	Last 4 seconds	Last 3 seconds	Last 2 seconds	Last 1 second	Last 0.5 second
Meal bar:						
Central / left	8.979**	4.789*	3.312	3.403*	6.088***	3.950**
Central / right	8.208**	4.588**	4.026*	6.009**	5.901***	3.126**
R^2	.134	.094	.084	.151	.243	.162
Vitamins:						
Central / left	10.033***	6.820***	6.369***	5.238***	3.947**	3.700**
Central / right	3.839*	2.722	4.038**	4.052**	3.117*	1.951
R^2	.191	.153	.172	.176	.138	.132

*$p < .10$.
**$p < .05$.
***$p < .01$.

may be prominent. The central gaze cascade effect and the gaze cascade effect may be operating additively.

To understand the role of each effect, the data were reanalyzed using both chosen and not chosen brands in the data and gaze likelihood in the last 5 seconds of the gaze duration as the dependent variable. Specifically, choice (whether the brand was chosen = 1 or not = 0), central location (center = 1, other = 0), and choice × central location interaction were used as the independent variables. Gaze likelihood was used as the dependent variable, following an arcsine transformation to satisfy normality assumption, as in Willemson et al. (2011). In brief, finding only a significant impact of choice but not center would indicate that the effect is merely a gaze cascade effect (as in Shimojo et al. 2003). Finding only a significant interaction effect would indicate that the observed effects are the result of an amplified gaze cascade effect for the central location. The analysis revealed that the findings are driven by both the horizontal location of the brand ($\beta = .14$, $t = 2.60$, $p < .01$) and whether the brand was chosen ($\beta = .33$, $t = 6.03$, $p < .01$). The interaction effect of choice and central location was not significant ($p > .10$). Results were similar when the analyses were repeated for the last 4, 3, 2, 1 and .05 seconds of the gaze duration.

Overall, the gaze analyses revealed: (1) there is a higher tendency to fixate on the centrally located brand in the first few and last few seconds of the gaze duration; (2) however, the cascading central fixations observed in last few seconds, but not the initial central fixations, increase the likelihood of choosing a brand located in the center. Additional multiple mediation analyses provided further support. When the visual attention measures in the earlier mediation analysis were replaced by the total number of fixations (fixation frequency) in the first 5 and final 5 seconds of the gaze duration, again the indirect effect of horizontal location on choice was significant through visual attention in the final 5 seconds and not in the initial 5 seconds. Repeating the mediation analysis for other time periods (4, 3, 2, 1, .05 seconds) revealed similar results. Once again, to account for the possible impact of sampling points on the results, the analyses were repeated with a more conservative bin (200 milliseconds). The results were similar.

Overall, the analysis of the visual attention process suggests that the initial search process, namely, the central fixation bias, does not explain why individuals are more likely to choose the centrally located brand. (3) More importantly, the results suggest a central gaze cascade effect: individuals are more likely to progressively focus on the horizontal center of the shelf display in the final few seconds of the gaze duration. The central gaze cascade effect operates in addition to the gaze cascade effect and improves the likelihood of choosing the central brand.

MEMORY-BASED ATTENTION RESULTS

Earlier research demonstrated that although horizontal centrality increased choice likelihood, it did not affect recall, used as a measure of memory-based attention (Valenzuela and Raghubir 2009, 2010). It is generally agreed that attention precedes awareness, such that it is possible that a stimulus is attended to, but has not reached awareness, and thus it is not recalled or reflected in memory-based measures of attention (Rosbergen et al. 1997). Furthermore, individuals are also known to forget what they have attended to (Milosavljevic and Cerf 2008). Nonetheless, preattentively or unconsciously processed stimuli, in other words, even short subliminal stimuli exposures of a few milliseconds, can impact preference and choice even when they are not recalled (Fitzsimons et al. 2002). The effects could be by way of priming (Bargh 2002; Shah and Kruglanski 2002) or mere exposure (Janiszewski 1993; Zajonc 1980). Recent research comparing visual attention measures and memory-based attention measures suggested that individuals are poor in recalling which ads (Aribarg et al. 2010) or products they viewed (Chandon et al. 2009). These findings suggest that visual- and memory-based attention are distinct constructs (Aribarg et al. 2010; Chandon et al. 2007, 2009).

Recall that in the current study unaided and aided choice recall measures were administered upon completion of the choice task and the inference measures. The accuracy of the unaided recall measure was poor: 44.9% and 55.2% for vitamins and meal replacement bars, respectively. The poor performance of the unaided choice recall measure can be due to the use of fictitious brand names and lack of familiarity. Consistent with this reasoning, the aided recall measure performed better: 73.9% and 71% (for vitamins and meal replacement bars, respectively). Additionally, in the current study, memory-based attention was measured using two items that provide a more sensitive self-reported attention measure beyond recall. The composite score based on these two items had a low significant correlation with the total duration of the fixations on the brand ($r = .154$, $p < .01$) and total number of fixations on the brand ($r = .183$, $p < .01$). Recall that these variables were included in the mediation analysis reported earlier and that the analyses revealed no significant effect of horizontal centrality on the self-reported measures of memory based attention. Similarly, horizontal centrality also had no significant impact on unaided and aided choice recall measures ($p > .10$). To see the convergence between the visual- and memory-based attention measures, the unaided recall measure was regressed on the total duration of fixations on the chosen brand. The coefficient of the total duration of fixations was not significant for vitamins or meal replacement bars (both $p > .10$). When the analyses were repeated with aided recall as the dependent variable, the results were similar for both product categories. The above regressions were repeated with the total number of fixations (frequency) on the brand as the measure of visual attention, and again none of the coefficients were significant (all $p > .10$).

STUDY 1B

Study 1A revealed that horizontal centrality is a predictor of brand choice. The effect is related to increased visual attention that the brands in the horizontal center get as opposed to inferences made about them. In other words, visual attention captured by eye-tracking measures was involved in predicting the effect of horizontal centrality on choice, while the individual- and market-level inferences measured in the current study were not. Although the horizontal center seems to be a hub for visual attention, it is looked at more both during the initial and final phases of the search process; only the final gazes that were progressively directed more at the center facilitated choice. Additionally, visual attention measures did not converge with the memory-based attention measures, corroborating earlier work that reported that individuals cannot accurately recall and report their visual search processes.

Study 1B was conducted to investigate whether the effect of horizontal central location on choice and the central gaze cascade effect is explained by horizontal centrality of the brand or by centrality on the computer screen. In a brief eye-tracking study using meal replacement bars as the stimulus, study 1B extended the design of study 1A by introducing planograms that were shifted off the center of the computer screen (left and right). These planograms were reduced in size and shifted to the left or right of the screen by 50%, such that the centrally located brand in the array was not located in the center of the screen. In other words, the center of the computer screen on which the stimuli were shown did not correspond to the center of the product array that was displayed. The design, procedures, and measures were similar to those of study 1A in that brand location on the shelf and the direction of the shift were counterbalanced.

Participants

Sixty-four undergraduate students at HEC Paris participated for extra credit (average age was 22.33 [SD = 1.46)]; 57.4% were females).

Results

The data transformations and analysis procedures were similar to those of study 1A. The horizontal location in the array was coded into two dummy variables, center and left. The direction of the shift on the computer screen was also coded into a dummy variable (1 = left, 0 = right). At the aggregate level, the brand in the horizontal center of the product array received overall more frequent eye fixations (57.38 vs. 49.30; $F(1, 189) = 4.67$, $p < .05$, partial $\eta^2 = .024$), as well as longer total duration of fixations (14.5 vs. 12.5 seconds; $F(1, 189) = 3.60$, $p < .10$, partial $\eta^2 = .019$), than the brands at the edges. As in study 1A, for each analysis, reported results converged when a 200-millisecond cutoff was used to qualify a fixation. Furthermore, a brand was more likely to be chosen when it was in the center of the product array (44.4%) than at the left (23.8%) or right (31.7%) of it ($\chi^2(2) = 6.47$, $p < .05$) even when the display was shifted, regardless of the direction of the shift (left or right). The preference for the central option in the array was robust. As in study 1A, for each analysis conducted, total duration and number of fixations provided converging results; therefore, for parsimony, the subsequently reported results use total duration of fixations as the objective measure of visual attention.

A multiple mediation analysis, as in study 1A, using a nonparametric bootstrapping strategy (Preacher and Hayes 2008) was conducted. Brand choice (1 = brand chosen, 0 = not chosen) was the dependent variable, and horizontal centrality in the array was the independent variable. Individual brand inferences, market-level brand inferences, memory-based self-reported attention, and visual attention based on eye-tracking measures were included as mediators. The direction of the shift (left/right) of the planogram on the computer screen and the brand name were included as covariates; however, they had no significant effect on brand choice or purchase likelihood (all $p > .10$). The results converged with findings from study 1A. The impact of horizontal central location within the product array on brand choice was related to total duration of fixations on the brand ($p < .05$) and not related to either individual- or market-level brand inferences or self-reports of attention (all $p > .05$). When the same mediation analysis was repeated using purchase intention as the dependent variable, the total duration of fixations on the brand again was the only variable that was related to the effect of horizontal centrality within the product array on choice ($p < .05$). The findings were similar when the mediation analyses were replicated using total fixation frequencies on the brand as the measure of visual attention and brand choice or purchase intentions as the dependent variable ($p < .05$). The results verify that the centrally located option in an array is preferred more and that it gets more attention. The increased visual attention is involved in subsequent choice. Each mediation analysis result reported converged when a 200-millisecond cutoff was used to qualify a fixation.

The gaze patterns were analyzed to verify that the central gaze cascade effect emerges (as in study 1A) and is involved in the choice-making process. Overall, the gaze analyses revealed that for all final time frames (final 0.5–5 seconds) the central gaze cascade effect is prevalent and robust, converging with the results of study 1A. The center of the product array received a higher and progressively increasing proportion of fixations in the last moments of the gaze duration prior to choice ($P_{Center} - P_{Left} = .167$; $t(1, 250) = 25.61$, $p < .01$, and $P_{Center} - P_{Right} = .098$; $t(1, 250) = 15.33$, $p < .01$, for the final 5 seconds). The probability of selecting the centrally located brand was higher as a function of these final gazes focused at the center.

Discussion

The results from study 1B converged with the results from study 1A. The findings were robust even when the planogram was shifted off the center of the computer screen. Overall, the results verified that the centrally located item in a horizontal array gets more visual attention and that the central gaze cascade effect that emerges in the final moments of the gaze duration is involved in the choice-making process. Study 2 replicates the findings related to the impact of horizontal centrality on choice in a more realistic offline choice context.

STUDY 2

In retail contexts, products are surrounded not only by products from the same category but also by products from different categories. Consequently, the centrally located product in the array of products in a particular product category may not necessarily be in the center of the shelf space and the consumers' visual field. It is important to understand whether a product placed in the center of an array of products within a category, but to the right or left side of the shelf, would still be chosen more often. Testing this notion was the primary purpose of study 2. Replicating the earlier findings in a different choice context with tangible product packages also eliminates common method as an alternative explanation in the previous computer-based studies.

Participants

Eighty-four undergraduate students at Concordia University participated for extra credit. Average age was 22.21 (SD = 4.41); 51.2% were females.

Design and Procedures

Study 2 was a 3 (product location within category: left, center, right) × 2 (product category location on the shelf: left, right) between-subjects experiment. The focal product category, energy drinks, was presented in a horizontal shelf layout in an array of three alternatives. The three brands of energy drinks (Cebion, Niran, and Viba) were fictitious. They were created for the purposes of the current study; each brand had one feature attribute (i.e., high intensity, extended endurance, muscle recovery; see fig. 3). Both the brands in the array and the featured attributes for each brand were rotated to eliminate any brand- and/or attribute-based effects. To manipulate the location of the product category on the shelf (left or right), filler products from other categories were included on the same shelf, such that the focal product category was either on the left or right side of the display. Data were collected one participant at a time. Participants were positioned in the middle of the display such that the category that they were asked to choose from was to their right or left. Participants remained positioned in the middle of the display as they completed the choice task. They were asked to carefully review and choose one of the three energy drinks. More specifically, participants were not allowed to reorient themselves such that the energy drinks would be in the center of their visual fields.

Results

The horizontal location of the brand within the product category was coded into *categorycenter* (1 = center and 0 = otherwise). The location of the product category on the shelf with respect to the filler items was coded into *shelfleft*

FIGURE 3

STUDY 2: FOCAL PRODUCT ARRAY

(1 = left and 0 = right). A binary logistic regression was conducted with choice (1 = chosen, 0 = not chosen) as the dependent variable and categorycenter and shelfleft as independent variables. If the results reported in study 1A are an artifact of the procedures (i.e., the center of the screen instantiates more visual attention as opposed to the center of the product category), this analysis should yield no significant effect of horizontal centrality within the category on choice. The analysis revealed a significant, positive main effect of categorycenter on choice ($\beta = 1.62$, Wald $\chi^2(1) = 7.42$, $p < .01$). The main effect of product location on the shelf (shelfleft) was not significant ($\beta = .17$, Wald $\chi^2(1) = .99$, $p > .10$). The shelfleft × categorycenter interaction was also not significant ($\beta = -.46$, Wald $\chi^2(1) = 2.56$, $p > .10$).

Discussion

Results showed that the centrally located brand within a product category is chosen more often even when it is not placed in the center of the shelf or the visual field. Replicating the findings with tangible products using a different product category in an offline experiment speaks to the robustness of the horizontal centrality effect and suggests that the preference for the centrally located option in an array is not an artifact of screen-based presentation. In conjunction with the findings from study 1B, these results suggest that consumers, in making a choice within a product category, isolate this category from the surrounding area and focus on its center even when the category is not in the center of their visual field.

GENERAL DISCUSSION

A positive effect of horizontal centrality on choice was found across three different studies and product categories (vitamins, meal replacement bars, and energy drinks). The effect was linked to visual attention. Two eye-tracking studies that simulated a retail shelf layout confirmed that visual attention is related to how horizontal centrality impacts choice, whereas brand inferences were not related. Note that the use of unfamiliar but experimentally manipulated to be equivalent brands contributes to the elimination of the effects of existing brand inferences and allows focusing on the specific effect of horizontal centrality in instantiating increased visual attention and brand inferences. That is, in the absence of objective criteria to form brand inferences upon, any inferences that emerge could be attributed to horizontal centrality since the location of the brand is the only differentiating attribute. In the current project, horizontal centrality was linked to choice only through visual attention. Gaze patterns were investigated to understand the process. The analysis of the gaze patterns revealed that the tendency to progressively look more at the central option right before choice (central gaze cascade effect) was involved in the choice process and the preference for the centrally located brand. The choice of the centrally located brand was not due to the initial tendency to fixate in the center or a common method artifact. The effect of horizontal centrality on visual attention and choice was robust when the product category was not in the center of the shelf display and the visual field.

Although the current research seems to contradict past research that did not find any effect of horizontal centrality on attention (Shaw et al. 2000; Valenzuela and Raghubir 2009), note that in those studies' memory-based attention measures were used to assess attention. Corroborating these findings, memory-based attention measures did not correlate with visual attention measures, and they failed to capture the effect of horizontal centrality on brand choice. Using recall as the only measure of attention is acknowledged as a problem by Valenzuela and Raghubir (2009). The results from the current studies converge with research that distinguish eye-tracking-based measures of visual attention and memory-based measures of attention (Aribarg et al. 2010; Chandon et al. 2009; Deng and Kahn 2009; Pieters and Wedel 2008).

Overall, findings revealed that increased visual attention, received as a result of horizontal central location, is involved in brand choice. Although counterintuitive, this finding is not unprecedented. Recent research in neuroscience reported that higher visual attention can lead to higher choice likelihood (Krajbich et al. 2010). Controlling for past experience and familiarity through experimental design and presenting a choice task among nondominated options, the current research provided similar results and contributed to the understanding of the effects of visual attention on choice. In the current study, the effect of horizontal centrality on choice was not related to brand inferences captured by the measures included. Note that these results do not suggest that inferences are not related to choice but that the indirect effect of horizontal centrality on choice is not through articulated inferences captured in the current studies.

As in earlier research that documented that the center of a scene gets more attention (Tatler 2007; Tatler, Baddeley and Gilchrist 2005; Tseng et al. 2009), participants were more likely to look at the items located in the center both at the beginning and the end of the visual search process. However, additional mediation analyses revealed that the initial central fixations do not explain choice. Instead, progressively increasing gazes on the center of the display in the final seconds of the visual search process are related to choice. Further analyses showed that the observed visual attention pattern in the final seconds of the search process is not solely driven by the increase of gazes on the to-be-chosen alternative (gaze cascade effect) but is driven by the horizontal central location (central gaze cascade effect). The increased fixation tendency on the central option in the final moments of the gaze duration is an additive outcome of the central gaze cascade effect (central location) and the gaze cascade effect (choice). This finding reiterates that the causal inferences about visual attention and choice should be made cautiously.

What motivates the observed patterns of visual attention? Potential explanations were explored. The accelerated gazes directed at the center can be due to a feedback loop that is instantiated by the tendency to look at the center of the display at the initial phases of the visual search process. In other words, the central fixation bias could initiate a feedback loop that leads to an amplified gaze cascade effect for the central option in the final stages of the decision. In order to test this explanation, the proportion of fixation densities on the central brand during the final 5 seconds was regressed on the proportion of fixation densities on the central brand during the initial 5 seconds, using data from studies 1A and 1B. Results showed no impact of the initial fixations on the central gaze cascade effect (all $p > .10$) with either data set. The data did not support this explanation at any of the time frames (initial and final 0.5, 1, 2, 3, 4, and 5 seconds).

Other process-tracing research has also identified an increasing pattern of attention in the final stages of the decision process, similar to the results reported here. Recently Willemson et al. (2011) traced attention, using Mouselab, and argued that increasing attention focused on the chosen option in the final stages of the decision process may reflect conscious and ongoing comparisons to a reference option. This process suggests dynamic value construction (Lichtenstein and Slovic 2006) through comparison. According to the value construction perspective, an option within the choice set emerges as an initial "leader," and the emergence of the initial leader leads to two types of effects: (*a*) leader-driven primacy and (*b*) a leader-focused search. Once a brand is identified as the early leader in a choice context between two brands, in leader-driven primacy, the biased evaluation of the attributes provide support for the leader and bias choice (Carlson, Meloy, and Russo 2006). In other words, new information is collected and distorted such that there is a biased and more favorable evaluation of the leading option (Brownstein 2003; Montgomery 1983; Montgomery and Svenson 1983; Russo, Meloy, and Medvec 1998; Willemson et al. 2011). In leader-focused search, predecision information search is biased in favor of the initial leader not to support and differentiate the leader (the initial preference) but to save effort in evaluating alternatives particularly when preferences are weak (Carlson and Guha 2011). Leader-focused search is marked by increased preference for information about the leader regardless of the valence of information or the credibility of the information source (Carlson and Guha 2011).

Based on the value construction perspective, an alternative explanation in the current context is that brands located in the horizontal center of the array may have an advantage in emerging as the initial choice leader, leading to biases in information search as observed in leader-driven primacy (Carlson et al. 2006) and leader-focused search processes (Carlson and Guha 2011). Both processes would predict that the initial leader will receive more visual attention, will be evaluated more favorably, and will be recalled better. In the current research, the brand in the center was chosen more often and received more visual attention; however, it was not evaluated more favorably, as captured by the inference measures included or recalled more often. Although not explicitly designed to test this prediction, this mixed finding suggests that leader-driven explanations for horizontal centrality require further exploration. Identifying the role of horizontal centrality on how a leader emerges and what motivates predecisional distortion is beyond the scope of the current article. Future work could manipulate the underlying mechanisms, such as goal of consistency (Carlson and Russo 2001; Russo et al. 2008; Simon, Krawczyk, and Holyoak 2004) and the goal of saving cognitive resources (Carlson and Guha 2011), to better understand how leader-driven effects are involved in linking attention to horizontal centrality and choice.

A top-down structure of visual search process based on marketplace metacognitions (lay beliefs) could provide an alternative explanation. Neider and Zelinsky (2006) pointed to how scene contexts guide eye movements during visual search processes and argued that the scene context causes a top-down biasing of the visual search behavior. They suggested that "scene constraints are grounded in semantic knowledge of the world (e.g., knowing that parked cars do not float in the air), and as such are likely to be represented and accessed differently than implicitly learned configural information" (614). Recall that Valenzuela and Rahgubir (2009) documented that consumers hold lay beliefs about how retail environments are organized (i.e., they believe that more popular options are placed in the center). Therefore, one could expect consumers' context-specific knowledge to lead them to focus more on the center of a display in the final seconds of the search process. To test this explanation, an additional measure in study 1A, representing consumer's contextual knowledge, was examined. Participants had rated "On the supermarket shelf, I believe that most popular products are placed always in the middle" on the same 9-point scale as used in study 1A. Overall, the participants held this belief, as revealed by a mean of 5.8, significantly above the scale midpoint ($t(62) = 3.99$, $p < .01$). Correlations of this belief with the proportion of fixation densities on the central brand for all time intervals, specifically, the initial and final .05, 1, 2, 3, 4 and 5 seconds, were computed. There were no significant correlations (all $p > .10$), suggesting that the retail-specific semantic knowledge regarding centrality did not explain the central gaze cascade effect. Additional research is required to further understand why the central gaze cascade is prevalent.

A unique aspect of the current work is that the brands included in all three studies were fictitious. They were all unfamiliar to the participants, and as established by the pretests, they were not different from each other in terms of quality and packaging. That is, none of the options dominated, and diagnostic information other than shelf location was eliminated. Given that participants had never seen the brands presented in this research, the eye fixations could not have been a result of previous exposure or other memory-based factors such as previous purchase. The unique effects of horizontal shelf location were isolated. Therefore, the studies presented here provide a much less confounded account of the horizontal centrality effect on attention and choice. Horizontal centrality leads to higher brand choice because items in the center of a display get more attention, although they are not evaluated more favorably. Note that consumers are more likely to draw inferences about brands using irrelevant, nondiagnostic information, such as their lay beliefs, if and when the brands are unfamiliar (Broniarczyk and Alba 1994; Raghunathan, Naylor, and Hoyer 2006). As such, using unfamiliar brands allows for a stronger test of the link between shelf location and brand inferences. By eliminating preexisting preferences, use of unfamiliar brands also contributes to understanding the effect of visual attention at the point of purchase. Future studies could replicate and extend the findings presented here using familiar brands and account for the effects of out-of-store elements to show the comparative effect of shelf location. The use of familiar brands can also contribute to the understanding of the effect of familiarity and memory on visual attention.

Finally, the impact of horizontal left (or right) location on visual attention and choice is ambiguous in the previous literature. Nisbett and Wilson (1977) found that the rightmost option in an array was preferred. Ducrot and Pynte (2002), on the other hand, argued that items to the left of center are noticed more than those items to the right. The effects of the horizontal edges on the visual search and choice process were also examined. In the current studies, there was no significant advantage of horizontal left or right location on choice.

In summary, new directions to understand the impact of horizontal centrality on choice as well as visual attention and search processes were presented. Given the findings, marketers need to consider where their product is placed on the retail shelf both online and offline. Results have implications for any context in which options are presented in a horizontal array. One interesting implication, contrary to common belief, is that the brands that are first in display (in left-to-right or right-to-left direction of search) are not at an advantage. Further research is needed to investigate the generalizability and the robustness of the horizontal centrality effect in different contexts, with other product categories and choice options, and with different levels of top-down as well as bottom-up effects. Similarly, there are other dependent variables of interest that may be influenced by horizontal centrality (e.g., satisfaction with choice) that may extend the long-term effects of point-of-purchase factors. In the current studies, consumers, in making a choice within a product category, isolated the focal category from the surrounding such that they focused on its center even when the category was not in the center of their visual field. Note, however, if it is not possible to visually differentiate the focal product category from the surrounding, this effect may not emerge as observed here. This alternative presentation style should be investigated in future work, possibly in a field study.

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