The Crossmodal Effect of Attention on Preferences: Facilitation versus Impairment

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This article builds a conceptualization for the crossmodal effect of attention on preferences, predicting when and why an irrelevant auditory signal will facilitate or impair preferences for visually processed target products located in the direction of the signal. Extending perspectives on crossmodal attention, this conceptualization posits that the functional tendency to pay visual attention toward an auditory signal will translate to a facilitation effect on preferences. However, given a goal of signal avoidance, crossmodal functionality dictates a lowering of visual attention toward the signal, impairing preferences for targets in that direction. Finally, a two-stage model of involuntary and voluntary attention is invoked to reconcile opposing predictions: an aversive noise is held to produce initial facilitation because of an involuntary appraisal mechanism, before a more deliberative attention-allocation process produces impairment. Results from five experiments support these predictions, contributing to the literature on crossmodal information processing and also that on preference formation.

Suppose that you are standing in a supermarket aisle, choosing between two packets of cookies, one placed nearer your right side and the other nearer your left. While you are deciding, you hear an in-store announcement from your left, about store closing hours. Note that not only is the announcement irrelevant to the product decision in terms of its content, but it is also unrelated in the sense of being presented in a different sensory mode: the product decision in question primarily involves visual processing, while the store announcement engages the auditory mode. Simple intuition would argue, therefore, that your choice of cookies should not be influenced by the in-store announcement.

This article suggests, however, that the intuitive answer may not be the correct one. Rather, in examples such as that above, it argues that the irrelevant store announcement can indeed influence product choice. In documenting such influences, we provide evidence for a novel phenomenon, namely, a change in visually based product evaluations as a function of the spatial correspondence between the product's location along a lateral dimension and the location of an unrelated auditory signal.

Our conceptualization of this phenomenon both draws on and informs past work on crossmodal attention, which has shown that a signal sensed in one modality (e.g., auditory) draws attention to itself in other modalities (e.g., visual) as well (i.e., a facilitation effect on attention; Driver and Spence 1998a, 1998b). The current research builds on this earlier insight and thereby offers several theoretical contributions. First, while the extant literature has obtained robust evidence for facilitation effects on crossmodal attention, we draw on fluency-related insights to show when and why facilitation effects can be obtained for preferences as well. That is, an auditory signal can not only bias visual attention toward itself, but it thereby also enhances preferences for visually processed targets in that direction. Indeed, our theorizing predicts that such preference enhancement can sometimes obtain even if the auditory stimulus itself is an unpleasant one. Second, while past research on crossmodal attention has been based primarily on the notion of involuntary attention (e.g., visual attention is reflexively drawn toward an auditory stimulus), our conceptualization additionally considers the role of voluntary, goal-directed attention. Doing

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so allows us not only to enrich existing perspectives in crossmodal attention itself but also to predict when and why an auditory signal may actually lower preferences for proximal products (i.e., an impairment effect). Finally, the current conceptualization further informs the crossmodal attention literature by examining the possibility of a two-stage attention-allocation process: an involuntary initial reaction followed by voluntary attention allocation (cf. Nummenmaa, Hyönä, and Calvo 2006). As described later, explicitly incorporating such a sequence enables us to provide a theoretical and empirical resolution of how the same auditory stimulus might produce both facilitation and impairment effects on visually formed preferences.

Overall, therefore, the present research not only extends current ideas in the crossmodal attention domain to the realm of preferences but also enriches underlying theoretical perspectives in that domain. From an applied perspective, the obtained results contain direct implications for practitioners as to the interplay between different sensory stimuli in store contexts. Thus, as illustrated in the opening vignette, consumers often have to decide between packaged products located adjacent to each other on a supermarket shelf. We show that in such situations, an unrelated but strategically located auditory stimulus (e.g., a store announcement) can not only draw attention toward itself but also enhance preferences for packaged products located in that direction. Further, this effect is robust enough that it manifests even in (comparatively noisy) field contexts—for example, we show that even a choice between two contiguous vending machines can be significantly influenced by an unrelated auditory stimulus. Collectively, these and other related findings reported in this article add to the toolkit of practitioners aiming to shape consumer preferences.

THEORETICAL BACKGROUND

In order to gain insights into how the location of a nonvisual stimulus may influence liking of a target visual stimulus, we begin by considering how the former may influence the attention paid to the latter. A variety of lab studies have found evidence for a cross sensory facilitation effect: namely, if attention is drawn toward a certain spatial location in one sensory modality (e.g., auditory), this actually increases the attention that is paid toward that location via other sensory systems as well (e.g., visual). In an early study, participants equipped with headphones were simultaneously exposed to two auditory streams, one in each ear, and asked to track the stream that they were hearing in either the right ear or the left ear. Their eyes were found to move in the corresponding direction (i.e., right or left, respectively). Thus, they were found to "look where they listened" (Gopher 1973, 259). Complementing these results, another study found evidence for crossmodal facilitation effects in the reverse direction: participants were found to increase auditory attention in the direction at which they were currently looking (i.e., they "listened where they looked"; Reisberg, Scheiber, and Potemken 1981, 318).

More recently, Driver, Spence, and their coauthors have reported a number of studies providing robust support for such facilitation effects in crossmodal attention (Driver and Spence 1998a, 1998b; Pavani, Spence, and Driver 2000). These cross sensory facilitation effects obtain, regardless of whether attention in the initial modality is drawn by an unexpected event or by a voluntary processing goal (Klein and Shore 2000); they also obtain even when overt movement of sensory organs is not permitted—that is, when attention results simply from the act of mentally focusing toward a target without actually moving one's eyes or ears in that direction (Spence and Driver 1996).

Researchers have argued that this facilitation effect is likely driven by functional reasons (Gopher 1973; Gopher and Kahneman 1971; Reisberg et al. 1981). In daily life, people often need to integrate information from different sensory modalities (e.g., visual, auditory, somatosensory) relating to the same external event or stimulus. For example, when eating a bowl of popcorn, a consumer may derive enjoyment not just from its taste but also from the smell of the butter, the feel of the popcorn in the hands, its visual appearance, and so on (Elder and Krishna 2010). In another example, when trying to decipher a conversation in the context of a loud cocktail party, people typically do not just focus their ears on the target speaker but also orient their eyes in the same direction in order to study the speaker's lip movements (Driver and Spence 1998b). Because we thus often need to orient our different attention systems toward the same spatial location, a learned procedure should develop, such that attending to a particular location in one modality will spontaneously elicit the allocation of attentional resources in other modalities toward that location. In support, cognitive psychologists have proposed that the different attention systems are associated by neural links, which facilitate such spatial synergy between the systems (Driver and Spence 1994, 2004).

The Crossmodal Effect of Attention on Consumer Preferences: Facilitation

The literature on crossmodal attention effects, reviewed above, provides robust evidence for attention links across sensory modalities—however, it is silent as to the likely influence of such an attention bias on preferences for the target object. The current research addresses this issue by arguing that crossmodal attention shifts can influence preferences for target objects that happen to be in the same (vs. different) spatial direction as the nontarget stimulus that induces the attentional shift. We argue, furthermore, that this influence on preferences can take the form of either a facilitation effect (improved preference for target objects in the direction of the nontarget stimulus) or an impairment effect (reduced preference for objects in the direction of the nontarget stimulus).

We first articulate the rationale for a facilitation effect on preferences, which parallels the facilitation effect documented by the crossmodal attention literature. The particular context we focus on in this article is one in which a target object is presented visually while the nontarget stimulus is presented in an auditory mode. As discussed in the introduction, such a context is often present in retail settings. While consumers primarily use the visual modality to process and evaluate store products (e.g., on the basis of packaging), their attention may simultaneously be drawn to unrelated auditory stimuli, for instance, an in-store announcement or an audible conversation nearby. How will attention to such nontarget auditory stimuli influence evaluations of target products?

Because of crossmodal synergies, consumers' visual attention should be biased in the direction of the unrelated, nonvisual stimuli. We argue that because of this attentional bias, the consumer will find it easier to visually process the target product when it is in the same spatial direction as the nonvisual stimulus (rather than being in a different direction). For instance, the shopper in our introductory scenario, who is trying to decide between two adjacent packets of cookies, will shift visual attention toward the packet on the right if auditory attention is drawn toward that side by an in-store announcement emanating from her right. As a result, she will now find the packet on the right side easier to process than the one on the left. If the positive reaction to such increased processing fluency is misattributed to the product (as is often the case; Novemsky et al. 2007; Schwarz 2004), she will exhibit a preference for this packet rather than the one on the left. We label this a facilitation effect on preferences.

Note that we do not mean to suggest that fluency is the only mechanism by which greater attention to a target can produce improved crossmodal preferences. Other parallel mechanisms are certainly possible—for example, a self-perception process (Bem 1972), such that consumers infer greater liking for products to which they pay more attention. An elaboration process can also play a role, such that if the package is favorable in appearance (which is often true in the retail context), more attention should lead to better attitudes because of greater elaboration of a positive feature (Petty and Cacioppo 1986). In acknowledging that attention may influence preferences through several different and simultaneous mechanisms (cf. Janiszewski, Kuo, and Tavassoli 2013), our goal is not to identify a unique and definitive mechanism by which attention in one mode enhances preferences in another. Instead, we hope to document that there is such a crossmodal shift in preferences as a result of crossmodal attention shifts and to provide evidence for one way in which this might happen.

The Role of Voluntary Attention: Crossmodal Impairment Effects

One goal of our research, as articulated above, is to extend the facilitation effects of crossmodal attention to the arena of preferences. Another goal, which has the potential to yield rich theoretical insights, is to examine boundary conditions for such crossmodal facilitation effects. An examination of boundary conditions is particularly important because the facilitation effect that has been robustly identified in the crossmodal attention literature (and that forms the basis for our prediction regarding a facilitation effect on preferences) has the flavor of a "hardwired" effect. Thus, research on crossmodal attention argues that while the facilitation bias may originally have arisen for functional reasons, the process becomes overlearned with repetition, such that the nontarget stimulus (e.g., auditory, in our context) is automatically able to attract attention in other modalities (e.g., visual) toward itself (Spence and Driver 1996, 1997). This explains why even a completely irrelevant secondary (nonvisual) stimulus is able to grab visual attention through a reflexive, involuntary process (e.g., Spence and Driver 1996, 1997; Spence et al. 1998; Theeuwes et al. 1998).

Does this mean, therefore, that visual attention will always get directed toward irrelevant nonvisual stimuli? This article argues to the contrary, by drawing on the distinction between involuntary attention, which is stimulus driven and reflexive, and voluntary attention, which is goal based and deliberative (Nummenmaa et al. 2006; Yantis 1998). Even though involuntary attention-allocation processes do tend toward a facilitation bias (visual attention being directed toward the auditory stimulus), we predict that this bias can be overcome if the individual has a goal of avoiding the auditory stimulus. Note that a goal of this nature can result from either external reasons (as in the case of an irate partner exclaiming, "Don't listen to the TV when I'm talking to you!") or internal reasons (e.g., wishing to lower attention toward an aversive, unpleasant noise; Kahneman 1973; Roth and Cohen 1986).

Pursuing such a goal requires individuals to voluntarily lower attention to the auditory stimulus—and we argue that they should therefore look away from it. This is an unexplored corollary of the classic crossmodal attention result that people look in the direction in which they listen (Gopher 1973). As discussed before, this overlearned tendency has its basis in functional reasons: looking and listening in the same direction helps people to create an integrated, cross sensory representation of a stimulus (Driver and Spence 1998a, 1998b). We propose that the same functional reason should also cause people to look away from the direction in which they do not wish to listen. Otherwise, if they continued to look in the direction of the unwanted auditory stimulus, crossmodal attention links would cause them to retain auditory attention toward that stimulus—since people do not just "look where they listen" (Gopher 1973) but also "listen where they look" (Reisberg et al. 1981).

We argue, therefore, that a goal to avoid the auditory stimulus should cause visual attention to be turned away from it. Further, as noted earlier, our conceptualization proposes that visual attention increases processing fluency for visual targets, thus enhancing preferences. Accordingly, visually based preferences should also now shift away from (rather than toward) the direction of the auditory signal. Reverting to the introductory scenario, if the shopper has a goal to avoid the in-store announcement emanating from her right, this should increase attention toward and preference for the cookie packet on her left side.

In sum, we predict that a motivation to avoid the secondary auditory stimulus should produce impairment effects on visual attention and preferences for target objects in the direction of the auditory stimulus. Support for such impairment effects would argue against a facilitation bias being hardwired and complement current perspectives in crossmodal attention by showing that, given a salient avoidance goal, visual attention may actually be turned away from the auditory stimulus.

Facilitation versus Impairment for Aversive Stimuli: A Resolution

An interesting implication of our conceptualization lies in the impairment thesis it offers for the case of aversive stimuli (e.g., unpleasantly loud noises). We predict that such a stimulus should cause people to look away (and exert a corresponding effect on preferences for visually processed targets). This prediction is of theoretical significance because it is seemingly anomalous from past crossmodal research. While the extant research on crossmodal attention has not explicitly manipulated the valence of the secondary stimulus, an observation of this work suggests that on occasion, such stimuli are likely to have been aversive (e.g., abrupt, loud noises; Spence and Driver 1997). Even so, facilitation effects have been obtained in these studies, with visual attention directed toward the auditory stimulus (Spence and Driver 1997; Spence et al. 1998). Why then do we predict impairment effects?

We suggest that a solution to this dilemma lies in the two-stage nature of attention allocation (Escera, Yago, and Alho 2001; Nummenmaa et al. 2006). This two-stage model builds on an appraisal-coping perspective (Folkman et al. 1986) to posit that involuntary attention precedes voluntary attention. When a novel stimulus is encountered, the individual's immediate and reflexive reaction is to allocate attentional resources toward it, in an attempt to identify and decipher the stimulus. This constitutes the appraisal stage and involves stimulus-driven involuntary attention. Appraisal is followed by the coping stage, in which the individual decides how to react to the stimulus. In this stage, a decision is made as to whether to continue allocating attention to the stimulus or to avoid it (i.e., this stage involves goal-driven voluntary attention; Bradley et al. 2001; Lang, Bradley, and Cuthbert 1997). Illustrating this sequential attention-allocation process, one study found that even when participants were given an explicit goal to look away, an aversive pictorial stimulus initially garnered visual attention toward itself. It was only over time that voluntary mechanisms prevailed, and visual attention was turned away from the picture, in line with the provided goal (Nummenmaa et al. 2006; see also Escera et al. 2001; Theeuwes et al. 1998, for convergent findings).

The two-stage attention model has not, to our knowledge, been applied to the crossmodal arena; rather, it has been restricted to investigating attention processes within a single modality. However, we believe it can generate fruitful insights in the crossmodal context, especially with regard to reconciling the different results obtained in earlier research with the current predictions, namely, facilitation versus impairment effects for aversive secondary stimuli. The aversive secondary stimuli that have led to facilitation effects in past crossmodal research have been momentary in duration (e.g., a sudden and short-lived noise or a sudden, quick flash from an LED device; Spence and Driver 1996, 1997; Spence et al. 1998). We argue that the momentary nature of this stimulus offered the opportunity for only the first stage of the attention-allocation process. Auditory attention was involuntarily shifted toward the stimulus, thus enabling crossmodal facilitation (e.g., visual attention being turned toward an unpleasantly loud but short-lived noise; Spence and Driver 1997).

Given stimulus exposure for a longer duration, however, we predict that both facilitation and impairment effects should sequentially be observed in the case of aversive secondary stimuli. Consider an unpleasant auditory (nontarget) stimulus that lasts for some time. In the first stage, individuals will involuntarily direct auditory attention toward this stimulus; crossmodal links should therefore produce a facilitation effect on visual attention and preferences for visually processed target objects in that direction. Note that this leads to a somewhat counterintuitive prediction: namely, an unpleasant auditory signal will initially exert a positive influence on preferences for proximal target objects. Over time, however, in order to satisfy the goal of avoiding the aversive stimulus, individuals will voluntarily lower auditory attention in that direction. As argued earlier, a functional view of crossmodal attention suggests that this will yield a corresponding shift in visual attention, producing an impairment effect on preferences for visually processed target objects in the direction of the auditory stimulus.

Overview of Experiments

We tested the various implications of our conceptualization across a set of five experiments. First, experiments 1–3 provided evidence for the crossmodal facilitation effect of auditory signals on visually based preferences. Experiments 1 and 2 examined our predictions in the context of a choice between two visual target products (placed on the right and left of a computer screen) and a neutrally valenced auditory stimulus that emanated from either the right or the left side. As hypothesized, greater attention was paid to the product placed along the same lateral dimension as the auditory stimulus; this enhanced attention was found to translate to product preference as well. Both studies also obtained evidence for fluency being a key factor in influencing crossmodal preferences. Experiment 3 replicated our finding in a naturalistic field setting.

The next two studies then shifted focus to isolating a crossmodal impairment effect of attention on preferences. An impairment effect should arise in the presence of a goal to avoid the auditory stimulus; such a goal can either be externally provided (experiment 4) or internally generated (as with an aversive auditory stimulus; experiment 5). Thus, using a similar setup as in experiment 1, experiment 4 obtained an impairment effect when respondents were explicitly asked to avoid listening to the auditory signal while forming judgments of visual target products. In diametric opposition to facilitation effects, attention and preference were now found to be lower for the target product located in the same (vs. different) direction as the auditory signal. Finally, experiment 5 studied the effects of an aversive sound and obtained good support for the two-stage model: attention and preference for a visual target in the same direction were enhanced, given a sound of low duration (facilitation), but declined if the aversive sound lasted for some time (impairment).

EXPERIMENT 1

Experiment 1 provided the first test of our prediction regarding the crossmodal link between attention and preferences. We hypothesized that participants would pay more attention to a visually depicted object on their right (left), given a neutral auditory signal from the right (left), and that this attention bias would induce increased preference for that object.

Method

Two hundred and four undergraduate students in Hong Kong participated in this study for course credit. Participants were run in groups of six; each of them was seated at a desk with a computer screen on which were shown pictures of two hotel rooms. The participant desks were arranged in three rows of two each and were placed fairly close together. A loudspeaker was placed adjacent to the second row, at a distance of 13 feet away from the desks, either on the right or on the left (see fig. 1). Because the desks themselves were close to one another, the distance from each desk to the speaker was about the same (in both the "left" and the "right" conditions). Note that given the placement of the speaker adjacent to the second row of desks, the auditory signal came from the back of one-third of the participants (those in the front row), adjacent to another third (second row), and in front of the final third (last row). We did not expect this difference to influence our preference results, however, because crossmodal synergies in attention obtain, regardless of whether sensory organs are overtly oriented in a particular direction (Spence and Driver 1996).

Participants were given two simultaneous goals: of comprehending a news bulletin that they would hear and of forming impressions of the two hotel rooms on their computer screen, one of which was at the right of the screen and the other at the left. The location of the two pictures was counterbalanced. To begin the experiment, the loudspeaker (placed on either the right or left) played the same news bulletin, lasting for 1.5 minutes, which dealt with recent policies launched by the Hong Kong government.

In a separate pretest, 20 undergraduates from the same subject pool were asked to report the feelings that they experienced while listening to the news bulletin, along a scale from -3 (unhappy) to $+3$ (happy). The mean rating was $-.05$ (not significantly different from zero; $F < 1$), suggesting that the content of news was valence neutral. Another pretest ($n = 30$) showed that, in the absence of any auditory signal, the two hotel rooms were rated as equally attractive (5.59 vs. 5.79; $F < 1$) along a scale from 1 (unattractive) to 7 (attractive); room attractiveness was not influenced by the location in which the room was presented ($F < 1$).

In the main study, as soon as the news bulletin was over, participants were requested to turn off the screen and complete a questionnaire given to them. They were first asked to indicate which of the two hotel rooms they had found more attractive, by circling the appropriate option from two choices described as follows: (i) "The room on the left side

FIGURE 1

SETTING USED IN EXPERIMENT 1

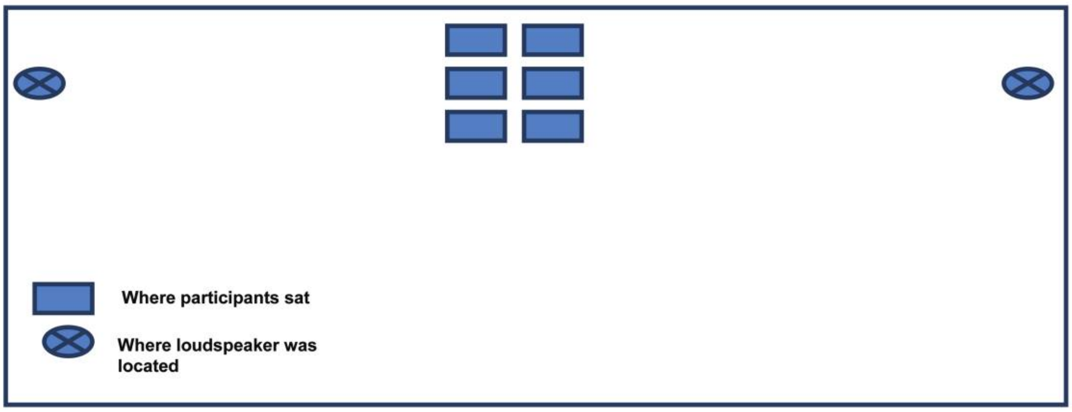

TABLE 1

EXPERIMENT 1: PREFERENCE FOR ROOMS AS A FUNCTION OF NEWS LOCATION

	Location of news		
	Right	Left	Control
Choice of the right-side room (%)	69	43	51
Relative preference for the right versus left room	.69 (1.80)	−.41 (1.88)	.19 (1.84)
Relative attention to the right versus left room	.32 (1.61)	−.52 (1.59)	.13 (1.89)
Fluency:			
Right-side room	1.65 (.98)	1.12 (1.04)	1.53 (1.15)
Left-side room	1.27 (.96)	1.31 (.92)	1.54 (.98)
M_{diff}	.38	−.19	−.01

NOTE.—Standard deviations are given in parentheses.

of the computer screen—room A" and (ii) "The room on the right side of the computer screen—room B." Participants next indicated room preference on a continuous scale from −3 (I prefer room A) to +3 (I prefer room B). They were then asked which room picture had drawn more attention, on a scale from −3 (room A) to +3 (room B). Processing fluency was assessed next. Participants were asked how they felt at the time they examined each of the two pictures, on a three-item, 7-point scale (−3 = "unpleasant," "felt wrong," "difficult to process"; +3 = "pleasant," "felt right," "easy to process"; see Higgins et al. 2003; Kim, Rao, and Lee 2009; Shen, Jiang, and Adaval 2010, for similar measures). Note that participants responded to these three fluency items for each of the two rooms (α_{right} = .81; α_{left} = .75). The difference between the first and the second index provided the relative fluency of processing the right-side room.

Finally, participants were asked to summarize the main topics in the news bulletin and also indicated which direction the news came from, by circling "left side," "right side," or "not sure" (97% responded correctly). They were then thanked and dismissed.

Note that our research focused on examining how shifting the location of the secondary (auditory) signal would influence preference between a pair of visually processed targets, one of which shares relatively greater spatial alignment with the signal than the other. Thus, the comparison that we are interested in throughout is the difference in relative preference between the two options as a function of the auditory signal being on the right (vs. left)—not on how the presence (vs. absence) of the auditory signal itself influences preferences. The presence of the auditory signal is taken as a given; what changes is its location: right versus left. Even so, in order to understand whether participants had a natural tendency to prefer stimuli on the left or right side of screen (our pretest suggests otherwise), experiment 1 also included a control condition in which participants were simply asked to form an impression of the two hotel rooms, without listening to any news. These participants completed the same questions about their reactions toward the two hotel rooms.

Results

Product Preference. We predicted that participants would prefer the hotel room whose picture was in the same lateral direction as the auditory stimulus (i.e., the news source). As shown in the top of half of table 1, this was indeed the case. Participants were more likely to choose the hotel room placed on the right of the screen if the news came from their right side (69%) than from their left side (43%; Wald χ^2 = 8.92, $p < .01$). The control condition, in which participants did not listen to any news, lay between these extremes (51%). On the continuous measure also, preference varied across different conditions ($F(2, 201) = 6.12$, $p = .01$). A linear trend analysis (Keppel 1991) indicated that preference for the right-hand room was highest if the news came from the right side ($M = .69$) and lowest if the news came from the left side ($M = -.41$; $F(1, 201) = 12.17$, $p < .001$), with the control condition in between these extremes ($M = .19$). Moreover, in the control condition, preference for the right-side room did not differ significantly from zero ($M = .19$; $p > .30$), indicating that participants did not have an intrinsic preference for one room over the other in the absence of an auditory signal.

Note that all results in this and later studies have been described from the perspective of the right-side room, simply for ease of exposition—thus, a positive mean above indicates greater preference for the right-side (vs. left-side) room, whereas a negative number indicates the opposite. Put differently, all of these findings hold equally when described for the left-side room—that is, preference for the left-side room is higher when the auditory signal emanates from the left ($M = .41$) versus right ($M = -.69$; $F(1, 201) = 12.17$, $p < .001$).

Attention. According to our conceptualization, the pattern obtained above on target preference stems from visual attention being biased toward the auditory signal. This reasoning was examined by analyzing the data on self-reported attention paid to the right-side versus left-side picture. Higher scores on this item indicate greater attention to the right-side room. As expected, attention varied across different conditions ($F(2, 201) = 4.68$, $p = .01$). Participants reported paying higher attention to the right-side room if the news came from their right versus their left ($M = .32$ vs. $-.52$, respectively; $F(1, 201) = 8.47$, $p < .01$), with the control condition in between these extremes ($M = .13$; not significantly different from zero, $p > .50$).

Subjective Feelings of Fluency. As mentioned earlier, processing fluency was assessed separately for each of the two rooms. Note, however, that we were not concerned with these absolute fluency scores for each room, which might be systematically influenced by factors other than auditory location. Rather, as with the attention and preference measures, our interest lay in examining the relative fluency of processing one room versus the other. This relative fluency was analyzed by computing the difference in fluency scores for the right-side room versus the left-side room (in keeping with the analyses for attention and preference, higher scores thus referred to greater fluency of the right-side room).

As expected, exactly the same pattern of results obtained on this difference-score measure of relative fluency, with sound location exerting a significant influence ($F(2, 201) = 3.35$, $p < .05$). Participants reported greater relative fluency in processing the room picture on the right-hand side when the news came from their right side ($M_{diff} = .38$) than when it came from their left side ($M_{diff} = -.19$; $F(1, 201) = 6.45$, $p = .01$). Again, the control condition lay in between these values ($M_{diff} = -.01$; not significantly different from zero, $p > .90$). Supporting our assumption that this fluency pattern is driven by shifts in visual attention, the relative fluency of processing the right-hand-side room, across all conditions, was found to be positively correlated with the relative attention paid to that room ($r = .52$, $p < .001$).

To examine whether relative processing fluency mediated the observed effect of the auditory signal on product preferences, we conducted a bootstrapping analysis (Preacher and Hayes 2004) in the two conditions in which participants were exposed to an auditory signal (from either their left or right side). The results above already show that both product preference and processing fluency were significantly influenced by the location of the news source. In addition, processing fluency had a significant effect on product preference ($\beta = 1.02$, $t(135) = 10.88$, $p < .001$). Finally, the mean indirect effect through fluency (based on 1,000 bootstrap samples) was significant, with a point estimate of .56 and a 95% confidence interval excluding zero (.17 to .97). Together, these results indicate that the effect of auditory signal location on visually based preferences was mediated by enhanced processing fluency.

Discussion

Experiment 1 provided the first evidence for our conceptualization. A neutral auditory stimulus biased visual attention in the direction of the signal, thereby influencing the fluency of processing visually presented target objects and, ultimately, preferences for those objects. Thus, the picture of a hotel room placed along the participant's right (left) side was preferred when the auditory news bulletin came from the right (left) side. This facilitation effect on preferences manifested even though the auditory signal was completely unrelated to the target products being evaluated.

As noted earlier, the underlying mechanism focused on the difference in processing fluency between the two rooms, and results on this index were supportive of predictions. Even so, two aspects of the findings for absolute fluency merit discussion. First, the fluency means for both rooms in the control (news-absent) condition are high. As table 1 shows, these are as high as the "match" experimental (news-present) conditions, that is, when there is a locational match between the room and the news direction. This is understandable, however. Participants in the control condition were not exposed to any distraction (which the news constitutes—note that participants were explicitly asked to comprehend the news bulletin while evaluating the rooms). Thus, they could process both rooms relatively easily, manifesting in high fluency means and also explaining the lack of a preference difference between the two rooms in this condition—since fluency was equally high for both. It is worth reiterating here that we are not examining the question of whether the presence (vs. absence) of the auditory signal will affect preferences. Rather, given that such a signal is present, our interest lies in examining how changing its location will influence preferences, by biasing attention and processing fluency. Thus, the key comparisons involved the two experimental conditions; the control was only included to check whether there was any systematic bias toward one direction, even without any auditory signal.

Second, and more surprisingly, the absolute fluency for the left-side room itself did not seem to differ with auditory location (table 1). One possible reason for this is that in all our studies, participants always provided their fluency self-reports for the left-side target first, before proceeding to answer the same questions for the right-side target. Thus, while completing the former set of questions, they did not have any reference point on which to base their responses, making it harder for them to accurately capture and report their experienced level of fluency on the provided scales. In contrast, when responding to the fluency measures for the right-side target, a comparison point is readily available in their immediately preceding responses for the left-side target, thus enhancing the extent to which the self-report measure captures movements in actually experienced fluency. It is also possible, as we discuss later in the context of the final experiment, that the self-report measure of fluency (especially when measured separately for the two target objects) is not as sensitive as the measures of attention and preference—each of which was assessed on a single comparative scale. In light of these possible measurement issues regarding the fluency measure, experiment 2 sought to illuminate the underlying process using a moderator approach, as described below.

EXPERIMENT 2

This study had two objectives. The first was that of generalizability: we sought to replicate the findings of experiment 1 using a different product category and also in a context closer to an in-store situation, wherein consumers are sometimes exposed to store announcements while visually processing and evaluating store products.

Of more importance, this experiment sought to enhance confidence in the fluency mechanism underlying the pattern of target preferences. While the mediation results in experiment 1 are largely consistent with this account, experiment 2 provided stronger evidence by examining a relevant boundary condition for the preference results, on the basis of a standard technique for identifying fluency-based effects (Schwarz 2004; Shen et al. 2010). Our conceptualization posits that the increased processing fluency caused by a spatial shift in attention influences preferences because participants attribute the pleasant sensation of fluent processing to the target object itself. If so, the effect of attention shift on preferences should be attenuated if participants are induced to attribute changes in processing fluency to extraneous (target-unrelated) factors.

Method

The study used a 2 (auditory signal direction: left/right) × 2 (extraneous fluency attribution: yes/no) between-subjects design ($n = 150$). A broadly similar procedure as in experiment 1 was used, with the major change involving the addition of the attribution manipulation described later. Participants were told that a cupcake shop would like to know about consumers' reactions toward its cupcakes. On this pretext, they were asked to make an impression of two cupcakes presented on the computer screen in front of them, one on the left of the screen and the other on the right. The location of the two cakes, which had been pretested to be equally attractive, was counterbalanced. Participants were also told that consumers are often exposed to announcements inside a store while they are shopping, and so, to simulate that real-world context, they would hear a promotional message about the store that had made these cakes, while forming an impression of the cakes. This auditory announcement lasted 1.5 minutes and emanated from a loudspeaker that was placed on either the left or the right side of the room. The setup of the room and experimental stimuli (including the location of the screens and loudspeakers) was exactly the same as in experiment 1.

Once the announcement was over, participants were asked to turn off the screen and complete a pen-and-paper questionnaire. In the no-attribution condition, participants went straight to the key dependent variables without any intervening manipulation. These outcome variables were as follows: first, all participants were asked to choose the cupcake that they preferred by circling either A (the left-side cake) or B (the right-side cake). Second, feelings of fluency were measured using the same scales as those used in experiment 1. Third, to measure attention, participants were asked to indicate how much attention each of the two cakes drew from them, along a scale from −3 (little) to +3 (a lot). The difference in the attention to the right-side cake versus the left-side cake provided the relative attention to the right-side cake. Finally, participants were asked whether the store announcement had influenced their choice of cupcake. Note that while the attention measure in experiment 1 preceded the fluency items, this order was switched in experiment 2, in order to address the possible concern that the fluency measure gets biased by completing the attention item immediately before.

Participants in the attribution condition completed the same set of dependent variables, but after an intervening manipulation. The first page of their questionnaire informed them that the experimenters wanted to know whether it was easy or difficult to engage in two simultaneous tasks, that is, listening to the store introduction while making an impression of products. They were told that such feelings of ease/difficulty differed for different people and were accordingly asked to report how they had felt about completing the dual tasks, along a scale from −3 (very difficult) to +3 (very easy). Participants who were thus reminded that engaging in dual tasks simultaneously can produce feelings of ease/difficulty might realize that the feelings that they experienced at the time of processing cupcakes were due to the task nature, rather than arising from the cupcakes themselves (cf. Shen et al. 2010). Consequently, the effect of voice location on cupcake preference should be attenuated in this condition.

Results

Cupcake Choice. We expected that participants in the no-attribution condition would manifest the same pattern of preferences as in experiment 1. That is, they would choose the cupcake located along the same lateral side as the store announcement, because of its greater processing ease. In the attribution condition, however, because participants are likely to attribute their feelings regarding processing ease to the nature of the task itself rather than to the cupcakes, the fluency-driven effect of sound direction on cupcake preference should be reduced.

The data supported these expectations, as revealed by a significant interaction between the attribution manipulation and the direction of the auditory signal (Wald $\chi^2 = 6.27$, $p = .01$). As shown in the top of half of table 2, participants in the no-attribution condition were more likely to choose the cake on the right of their screens if the announcement also came from their right (59%) rather than from their left (26%; Wald $\chi^2 = 8.53$, $p < .01$). However, this effect disappeared when they were reminded that feelings of ease or difficulty might be produced by engaging in dual tasks (54% vs. 63%, in right vs. left conditions, respectively; NS).

Attention. As noted earlier, the difference in attention toward the right-side cake versus the left-side cake was used to assess the relative attention toward the right-side cake. As predicted, participants reported paying more attention to the right-side cake if the announcement also came from the right ($M_{diff} = .43$) than from the left ($M_{diff} = -.42$; $F(1, 146) = 5.79$, $p < .05$). This effect was independent of the manipulation of attribution (.49 vs. −.60 in the no-attribution conditions; .37 vs. −.19 in attribution conditions; the interaction effect was not significant, $p > .35$).

Subjective Fluency. As before, we examined the fluency of processing the two pictures, by examining a relative index

TABLE 2

EXPERIMENT 2: REACTION TO CUPCAKES AS A FUNCTION OF ATTRIBUTION AND VOICE LOCATION

	No-attribution manipulation		Attribution manipulation	
	Voice from the right	Voice from the left	Voice from the right	Voice from the left
Choice of the right-side cake (%)	59	26	54	63
Attention:				
Right-side cake	1.07 (1.10)	.52 (1.38)	1.46 (1.46)	1.00 (1.48)
Left-side cake	.58 (1.53)	1.12 (1.15)	1.09 (1.44)	1.19 (1.31)
M_{diff}	.49	−.60	.37	−.19
Fluency:				
Right-side cake	1.22 (.96)	.97 (.97)	1.65 (1.11)	1.42 (1.22)
Left-side cake	.94 (1.10)	1.42 (.96)	1.26 (1.28)	1.28 (1.35)
M_{diff}	.28	−.45	.39	.14

NOTE.—Standard deviations are given in parentheses.

computed as the difference between the fluency score for the cake on the right side and that on the left side (thus, higher scores on this difference score reflect greater fluency in processing the cake on the right). As expected, participants reported greater relative fluency in processing the cake on the right when the announcement also came from the right ($M_{diff} = .33$) than when it came from the left side ($M_{diff} = -.20$; $F(1, 146) = 4.45$, $p < .05$). This effect was also independent of the manipulation of attribution (.28 vs. −.45 in the no-attribution conditions; .39 vs. .14 in attribution conditions; the interaction effect was not significant, $p > .30$). This suggests, therefore, that the lack of a preference effect in the attribution conditions is not due to any change in the pattern of processing fluency—rather, consistent with our arguments, this boundary condition is due to processing fluency no longer influencing cupcake preferences to the same extent when it is attributed to an extraneous factor.

Mediation analyses were conducted to test the assumption that the preference effects in the no-attribution condition were indeed influenced by processing fluency. As reported above, voice location had a significant effect on both processing fluency and product choice. In addition, fluency itself had a significant impact on preference ($\beta = 3.06$, Wald $\chi^2 = 17.82$, $p < .001$). Finally, the mean indirect effect through fluency (based on 1,000 bootstrap samples) was significant, with a point estimate of 2.26 and a 95% confidence interval excluding zero (.24 to 4.68).

Discussion

Experiment 2 replicated our earlier findings using a different product category and also in a context that bore greater resemblance to an in-store scenario, in that the auditory signal content was about the store. As before, product preference, which was based on visual processing, was influenced by the location of this auditory signal—the cupcake that was placed along the right (left) of the screen was preferred when the announcement came from the right (left). In addition, this experiment again supported the fluency-based account we have posited for our preference findings, by successfully identifying a boundary condition that derives from this account. Sound location no longer exerted an impact on product preferences if participants were induced to attribute feelings of processing fluency to a product-unrelated factor, namely, the nature of the task itself.

Note that this moderation-based evidence represents particularly good support for the fluency account since it is less susceptible to measurement-related concerns. For example, since both attention and fluency in our studies are measured via self-reports, it might be argued that the relationship between the two might be artifactually strong—in particular, that the fluency measure was simply another assessment of attention. Such a critique would not explain the moderation pattern observed in this study, however. If preference results are driven by attention directly without an intervening role of fluency, preferences should not have been influenced (as they were) by a manipulation that was specifically targeted at processing fluency rather than at attention.

Despite the convergent support (from both mediation- and moderation-based approaches) for our posited account, however, we do not wish to claim that fluency is the only mechanism by which location-driven shifts in attention may affect preferences. While fluency clearly appears to play a part, other mechanisms may also be at play, an issue to which we return later.

EXPERIMENT 3

Experiment 3 sought to illustrate the applied implications of our findings showing that an irrelevant auditory stimulus can influence visually based preferences even in a naturalistic field setting. Another difference in experiment 3 (concomitant with it being run in the field) was that we did not explicitly instruct participants to listen to the auditory signal while forming their visually based preferences of the target. Note that facilitation effects are predicted not only when respondents voluntarily attend to the auditory stimulus, as shown in experiment 1, but also in the absence of such a goal (as long as there is not a goal of avoiding the auditory stimulus—a contingency we later examine). A neutral secondary stimulus is itself capable of grabbing reflexive, involuntary attention (Escera et al. 2001); accordingly, a facilitation effect should still obtain. The procedure used in experiment 3 was consistent with this possibility.

Method

The study was conducted in the context of choosing a product from one of two adjacent vending machines, both selling soft drinks. The machines were located in the teaching building on Chinese University of Hong Kong's campus; prior approval was sought from the vendor. A research assistant, who was blind to the hypothesis, placed a speaker on the top of each vending machine and linked the speakers to a notebook computer that was broadcasting a local news bulletin (see fig. 2). The assistant also adjusted the speaker's volume control to ensure that, at any moment in time, only one of the speakers (either the one on the right or on the left) was playing at normal volume, while the other was muted. Because the speakers were placed quite close to each other, the news bulletin was completely audible, even at some distance from the vending machines, irrespective of which of the speakers was muted.

After the assistant completed this setup, she waited at a distance from the machines. For each consumer who came up and bought a product from one of the two machines, the assistant simply observed which machine was chosen. After every set of 10 consumers, she muted the volume on the previously broadcasting speaker and turned up the volume on the previously mute speaker, so as to switch between the two. The assistant made sure she was unobserved while making this quick switch. The experiment concluded after data had been collected for 60 consumer choices.

Results

On the basis of our prior findings, we expected that consumers' visual attention would be directed toward the machine that carried the broadcasting speaker rather than the mute speaker; they would also therefore evaluate it more favorably. As a result, consumers should be more likely to purchase from that machine than they otherwise would.

Results were supportive of this conclusion. We found that consumers were more likely to purchase a drink from the machine on the right when the broadcasting speaker was placed on top of that machine than when it was placed on the one on the left (57% vs. 27%, respectively; Wald $\chi^2 = 5.35$, $p < .05$). Thus, even in a naturalistic setting, where

FIGURE 2

SETTING USED IN EXPERIMENT 3

choice is subject to a variety of influences, the link between auditory attention and visual preferences was strong enough to exert a substantial effect.

EXPERIMENT 4

Together, experiments 1–3 provide good evidence for a crossmodal facilitation effect on preferences, namely, enhanced evaluations of visually processed target products that are located in the direction of an unrelated auditory stimulus. This preference effect is held to arise because of previously demonstrated crossmodal facilitation effects on attention (i.e., the auditory stimulus attracts visual attention toward itself; e.g., Driver and Spence 1998a, 1998b). The self-reported attention data in experiments 1 and 2 were consistent with this premise. Convergent results were also obtained in a posttest (not reported here for reasons of space) that used eye-tracking methodology to show that visual attention is indeed drawn toward the irrelevant auditory stimulus, in a setting similar to that used in experiment 1.

What, however, if visual attention is deliberately turned away from the auditory stimulus, instead of toward it? Our conceptualization suggests that such a reversal of attention might obtain for functional reasons—specifically, visual attention will be directed away from the auditory stimulus given a salient goal to reduce auditory attention to that stimulus. In such an eventuality, the link between attention and preferences that drives the facilitation finding should now result in the reverse (impairment) effect, namely, a decrease in preference for target products located in the direction of the auditory stimulus.

We further argue that such a goal (of directing attention away from the auditory stimulus) might be made salient by either external or internal causes. Experiment 4 examines the former: that is, we seek to identify an impairment effect resulting from externally providing respondents with an explicit goal to ignore the auditory stimulus.

Method

Experiment 4 used a 2 (auditory signal direction: left/right) × 2 (goal: attention vs. avoidance) between-subjects design ($n = 183$). The procedure was the same as that used in the experiment 2, except that before participants listened to the store announcement, they were also given a goal that encouraged attendance to or avoidance of the auditory stimulus. Those in the attend condition were told to listen carefully to the announcement and that they needed to recall the promotional message later, whereas those in the ignore condition were told that they should try not to let the store announcement influence their impression of cupcakes. We predict that the auditory stimulus would exert a facilitation effect on cupcake preferences in the attend condition but an impairment effect in the ignore condition. Note that participants in the latter condition were not even explicitly required to look away from the auditory stimulus; they were simply instructed to try to ignore it. If this relatively simple instruction leads respondents to look away from the signal, this would provide good support for the notion that people look away from the direction in which they do not wish to pay auditory attention.

After the announcement was over, participants responded to the following measures: (*a*) cupcake choice, (*b*) attention paid to each of the cupcakes, and (*c*) processing fluency for each cupcake. Moreover, we also counterbalanced the order of those questions such that the choice measure was provided either before or after the measures of attention and fluency. This was done to address the concern that the attention results in our earlier studies were artifactually biased by the immediately preceding choice measure (i.e., participants gauged their attention level on the basis of their responses to the choice measure). As in experiment 2, difference scores (between the right-side room and the left-side room) were computed to assess the relative attention toward and processing fluency for one room versus the other.

Finally, to check manipulation, participants were also asked to what extent they had tried to (*a*) attend to and (*b*) avoid the store announcement along two separate scales, each going from −3 (not at all) to +3 (very much). These two items were negatively correlated ($r = -.81$, $p < .001$). We reversed the avoidance item and averaged it with the score of the attention item to create an index of auditory attention.

Results

Manipulation Check. As expected, participants were more likely to attend to the store announcement in the attend condition ($M = 1.13$) than in the ignore condition ($M = -1.37$; $F(1, 179) = 120.68$, $p < .001$). This indicated that our external goal manipulation was successful in changing the level of attention paid to the auditory stimulus.

Cupcake Choice. The data for cupcake choice were consistent with our expectations, as shown in table 3. Replicating our earlier facilitation findings, participants in the attend condition were more likely to choose the cake on the right of their screens if the announcement also came from their right (61%) than from their left (30%; Wald $\chi^2 = 9.56$, $p < .01$). More important, however, this effect was reversed and an impairment finding obtained in the ignore condition (44% vs. 65%, in right vs. left conditions, respectively; Wald $\chi^2 = 3.57$, $p = .06$). The interaction between provided goal and auditory signal direction was significant (Wald $\chi^2 = 12.13$, $p < .001$). These results did not depend on the order of questions ($F < 1$).

Attention and Fluency. As predicted, participants in the attend condition reported paying more attention to the right-side cake if the announcement also came from the right ($M_{diff} = .45$) than from the left ($M_{diff} = -.85$; $F(1, 179) = 11.33$, $p < .001$; M_{diff} scores refer to the difference in attention to the right- vs. left-side cake, with higher scores reflecting greater attention to the former). In contrast, the reverse was not significantly true in the ignore condition (−.07 vs. .58, in right vs. left conditions, respectively; $F(1, 179) = 2.25$, $p = .14$). The interaction between goal and

TABLE 3

EXPERIMENT 4: REACTION TO CUPCAKES AS A FUNCTION OF VOICE LOCATION AND MOTIVATION

	Motivation to process the auditory ad			
	Attention		Avoidance	
	Voice from the right	Voice from the left	Voice from the right	Voice from the left
Choice of the right-side cake (%)	61	30	44	65
Attention:				
Right-side cake	1.22 (1.30)	.43 (1.42)	1.07 (1.39)	1.55 (1.08)
Left-side cake	.77 (1.50)	1.28 (1.21)	1.14 (1.17)	.97 (1.49)
M_{diff}	.45	−.85	−.07	.58
Fluency:				
Right-side cake	1.29 (1.23)	.90 (1.03)	1.32 (.95)	1.76 (.80)
Left-side cake	.93 (1.13)	1.21 (1.14)	1.46 (.83)	1.23 (1.15)
M_{diff}	.36	−.31	−.14	.53

NOTE.—Standard deviations are given in parentheses.

auditory signal direction was significant ($F(1, 179) = 11.29$, $p = .001$).

The same pattern obtained for the fluency measure, with a significant two-way interaction being observed ($F(1, 179) = 11.39$, $p < .001$). Participants in the attend condition reported greater relative fluency in processing the cupcake picture on the right-hand side when the news came from their right side ($M_{diff} = .36$) than when it came from their left side ($M_{diff} = -.31$; $F(1, 179) = 6.40$, $p = .01$), whereas the reverse was true for participants in the ignore condition (−.14 vs. .53, in right vs. left conditions, respectively; $F(1, 179) = 5.13$, $p < .05$). Of note, the results for both attention and fluency were independent of whether they were measured before or after cupcake choice, suggesting that participants did not simply infer attention and fluency from their product preference.

With regard to the mediating role of fluency on preferences, the results above already show that both fluency and preferences were significantly influenced by the interaction of provided goal and auditory signal location. Further, fluency was found to have a significant impact on preference ($\beta = 1.94$, Wald $\chi^2 = 41.02$, $p < .001$). Finally, the mean indirect effect of the interaction of provided goal and auditory signal location through fluency (based on 1,000 bootstrap samples) was significant, with a point estimate of .64 and a 95% confidence interval excluding zero (.17 to 1.28). Together, these results indicate that the interactive effect of auditory direction and provided goal on visually based preferences was mediated by enhanced processing fluency.

Discussion

Previous research on crossmodal attention has proposed and found that people have a learned tendency to direct visual attention in the direction of a secondary nonvisual (e.g., auditory) stimulus (Driver and Spence 1998a, 1998b). Our earlier studies in this article agree with this premise and extend it to the realm of preferences. However, our conceptualization further argues that this learned tendency, which results in involuntary allocation of visual attention toward the auditory signal, can be overcome by deliberative goals that have been made temporarily salient. In accord with this thesis, experiment 4 found that given an external goal of ignoring an auditory signal while making visually based judgments, participants turned their visual attention away from the direction of the auditory signal. Further, as predicted, this bias in attention led to a lowering of preferences for the target object (cupcakes) aligned with the direction of the signal (i.e., an impairment effect).

In addition to documenting this impairment effect of an auditory signal on visually based preferences, these results add to the basic literature on crossmodal attention in two ways. First, they demonstrate that involuntary attention allocation toward a secondary stimulus can be overcome by deliberative (voluntary) mechanisms. Second, and relatedly, these findings show that the goal of ignoring an auditory stimulus leads people to also direct visual attention away from it. In other words, complementing the perspective of "we look where we listen," experiment 4 shows that "we avoid looking where we do not wish to listen."

EXPERIMENT 5

The studies reported so far have demonstrated that an auditory signal can produce either facilitation or impairment effects on preferences for visually processed targets located in the direction of the signal, depending on whether the auditory signal induces people to look toward it or away from it. The final study provides a more fine-grained examination of the mechanism underlying this shift in visual attention and the corresponding change in preferences. Building off earlier findings in the context of single-modality attention allocation (e.g., Nummenmaa et al. 2006; Theeuwes et al. 1998), we have proposed a two-stage mechanism for the allocation of visual attention as a function of an auditory stimulus. This model suggests that in order to engage in stimulus appraisal, visual attention is initially drawn involuntarily toward the auditory signal. The stimulus appraisal stage is followed by the coping stage. Here, the respondent makes a decision as to whether to continue looking in that direction or away from it—voluntary attention now takes over.

In order to observe these distinct effects of involuntary and voluntary attention, two procedural aspects need to be in place. First, a temporal manipulation for the auditory signal is required, such that the signal is heard for a very short time versus a longer time, given our argument that involuntary (voluntary) attention allocation prevails in the former (latter) case. Second, since an involuntary process is held to guide visual attention toward the auditory stimulus in the first stage, a departure from this process can only be observed in the second stage if voluntary attention is directed away from the signal. Note that experiment 4 met one of these criteria: in the ignore condition, participants had the goal of looking away from the auditory signal; however, the duration of the signal was not manipulated.

Experiment 5 was therefore designed to satisfy both criteria. A similar procedure was used as in prior studies, with participants forming judgments of two pictures of restaurants on a computer screen while being exposed to an auditory signal from either the right or left. However, the length of time for which the auditory signal (a piece of music) was played was manipulated. The music was played for the usual length of time as in the previous studies (1.5 minutes) or a much shorter time (20 seconds)—pretesting revealed that 20 seconds was deemed just enough time for participants to form a quick impression of the two restaurants depicted on screen.

While the same ignore induction that was used in experiment 4 to turn attention away from the auditory signal could have been used again, we used a different manipulation for greater generalizability, one that motivated avoidance of the auditory signal via an internally generated goal rather than an externally provided one. In particular, the valence of the music was manipulated to be either pleasant or unpleasant. In the latter case, since aversive stimuli engender an avoidance goal (Bradley et al. 2001), participants should develop a voluntary goal of reducing attention in that direction. It is for this unpleasant noise condition, therefore, that the two-stage mechanism should be observed. In the short-time case, because involuntary attention will still direct visual attention toward the unpleasant noise, the usual facilitation effects should be observed (increased attention and preference for the restaurant aligned with music direction). In the longer-time case, however, when voluntary attention takes over, impairment effects should be observed (lowered attention and preference for the restaurant aligned with music direction). In contrast to these opposing predictions for the unpleasant music, involuntary and voluntary processes should both direct visual attention in the same direction (toward the auditory signal), given pleasant music. Therefore, facilitation effects should be observed, regardless of whether the signal is played for a short or long time.

Note that an alternative theoretical perspective, to do with the related ideas of evaluative conditioning (Gorn 1982) and affect transfer (Van Reekum et al.1999), might also be brought to bear on this study. Briefly, this perspective would argue that the feelings elicited by the music will simply transfer to whichever restaurant picture is being attended to at the time, thus systematically influencing choice between the two restaurants. Of importance, this perspective would generate predictions opposed to ours in the specific case of disliked music. Consider first the scenario in which the disliked music is played for a short time. Here, we expect attention to be turned toward the picture that is located in the direction of the music. Since the music is aversive, an evaluative conditioning account would predict lowered preference and choice for this picture as compared to the one in the opposite direction. In contrast, our theorizing, which posits a positive influence of attention on preference, predicts greater choice of the same-direction picture versus the opposite-direction picture.

Similarly, a competing set of predictions can be formulated when disliked music is played for a longer time. Now, attention is posited to be relatively higher toward the opposite-direction (vs. same-direction) picture. Evaluating conditioning would therefore predict lowered preference for the former because of a transfer of negative affect. In contrast, the current conceptualization would predict heightened preference for the opposite-direction picture, simply because it is attended to more.

Experiment 5 thus also serves as a test of these opposing predictions. Given the results so far, our a priori expectation was that the preference data should closely follow the attention data, even for the case of negative music. To reiterate, the conditioning argument would predict the reverse.

Method

The study used a 2 (auditory signal direction: left/right) × 2 (valence of auditory stimulus: positive vs. negative) × 2 (the time for which music was played: short vs. long) between-subjects design ($n = 324$). The procedure was similar to that of experiment 1. Participants were asked to form an impression of two pictures of restaurants presented on the computer screen, one on the left of the screen and the other on the right. The location of pictures was counterbalanced. While forming these impressions, they were exposed to music emanating from a loudspeaker that was placed on either the left or the right of the room. The music was either pleasant or annoying, depending on the condition. The pleasant music consisted of a snippet from a locally popular song, whereas the unpleasant music consisted of a snippet from a song that had been rated very annoying by the audience at http://www.youtube.com. Pretesting confirmed that participants from our pool also perceived the former to be pleasant and the latter unpleasant.

The time duration of music exposure was also manipulated. In the short-period condition, the music stopped after 20 seconds. In the long-period condition, the music lasted for 1.5 minutes, as in our previous studies. After the music stopped, participants were asked to (*a*) choose which of the two restaurants they preferred, (*b*) indicate their relative attention toward each restaurant along a scale from −3 (more attention to restaurant A) to +3 (more attention to restaurant

B), and (*c*) indicate the fluency of processing each restaurant along the same set of three scales as those used in experiment 1. As before, the fluency measure (unlike those for attention and preference) was assessed separately for each restaurant, a point to which we return later.

Results

Attention. We predicted that participants would involuntarily bias their visual attention toward the direction of the music if they listened to it for a short period, regardless of voluntary attend/avoid goals induced by music valence. Only when exposed to the music for a longer period should voluntary attention mechanisms triggered by music valence prevail, such that visual attention would be turned toward (away from) the pleasant (annoying) music. This was actually the case. As shown in table 4, we observed a three-way interaction of music duration, location, and valence on relative attention toward each restaurant ($F(1, 316) = 5.07$, $p < .05$). If participants were only exposed to the music for 20 seconds, they reported paying more attention to the right-side restaurant if the music came from their right side rather than their left side (.15 vs. −.48; $F(1, 316) = 5.56$, $p < .05$; higher numbers indicate greater attention to the restaurant on the right), regardless of whether they listened to pleasant or annoying music (interaction $F < 1$). However, if participants were exposed to the music for 1.5 minutes, the relative attention to the right-side restaurant was contingent on both the location and the valence of music ($F(1, 316) = 7.78$, $p < .01$). In particular, if the music was pleasant, they reported paying more attention to the right-side restaurant when the music came from the right versus left side (.19 vs. −.66; $F(1, 316) = 4.24$, $p < .05$). However, the reverse was true given annoying music: now, the right-side restaurant received lower attention when the music came from the right versus left side (−.52 vs. .29; $F(1, 316) = 3.58$, $p = .06$).

Restaurant Choice. As predicted by our theorizing, the choice of restaurant paralleled the attention data. That is, we observed a significant three-way interaction of the music duration, location, and valence on restaurant choice (Wald $\chi^2 = 7.30$, $p < .01$). When exposed to the music for a short period, participants were more likely to prefer the right-side restaurant if the music came from their right rather than their left (60% vs. 40%; Wald $\chi^2 = 6.83$, $p < .01$), regardless of whether the music was pleasant (67% vs. 46%) or unpleasant (55% vs. 33%). The interaction between the music location and music valence was not significant ($p > .90$). However, when exposed to the music for a longer period, the interaction between music location and music valence on the choice of restaurant was significant (Wald $\chi^2 = 12.69$, $p < .001$). In particular, given pleasant music, participants were more likely to prefer the right-side restaurant if the music came from their right versus left (61% vs. 25%; Wald $\chi^2 = 8.79$, $p < .01$). In contrast, the reverse was true for those exposed to annoying music (33% vs. 59%; Wald $\chi^2 = 4.28$, $p < .05$).

Of importance, the results obtained in the annoying music case, for both the short-period and the long-period conditions, are inconsistent with predictions arising from an evaluative conditioning perspective. As noted earlier, given negative music, evaluative conditioning would predict that the object being attended to while listening to the music should be preferred less—that is, lower choice of the same-side restaurant in the short-time condition and the opposite-side restaurant in the longtime condition. Our choice data exhibit the opposite pattern.

Fluency. Next, we examined results on relative processing fluency, operationalized as the difference in self-

TABLE 4

EXPERIMENT 5: REACTION TO RESTAURANTS AS A FUNCTION OF LOCATION OF MUSIC, VALENCE OF MUSIC, AND TIME

	Short period		Long period	
	Positive music	Negative music	Positive music	Negative music
Choice of the right-side restaurant (%):				
Music from the right	67	55	61	33
Music from the left	46	33	25	59
M_{diff}	21	22	36	−26
Relative attention to the right versus left restaurant:				
Music from the right	.09 (1.67)	.19 (1.68)	.19 (1.98)	−.52 (1.84)
Music from the left	−.46 (1.73)	−.50 (1.50)	−.66 (1.99)	.29 (1.61)
M_{diff}	.55	.69	.85	−.81
Fluency:				
Music from the right:				
Right-side restaurant	1.59 (1.12)	.54 (1.36)	1.73 (1.09)	.81 (1.37)
Left-side restaurant	1.28 (1.00)	.63 (1.23)	1.30 (1.18)	1.25 (1.29)
M_{diff}	.31	−.09	.43	−.44
Music from the left:				
Right-side restaurant	1.54 (1.01)	.47 (1.31)	1.50 (1.12)	.77 (1.29)
Left-side restaurant	1.34 (1.12)	.70 (1.06)	1.99 (.75)	.66 (1.47)
M_{diff}	.20	−.23	−.49	.11

NOTE.—Standard deviations are given in parentheses.

reported fluency of processing the right- versus left-side restaurant. Paralleling the attention data, the three-way interaction of music duration, location, and valence had a significant effect on this relative fluency index ($F(1, 316) = 4.90$, $p < .05$). The results in the 20-seconds condition revealed an unexpected discrepancy from our attention findings, however. While we had expected greater processing fluency for the right-side picture given music from the right (vs. left), no such difference was observed. Instead, participants reported similar relative fluency for the right-side restaurant when the music came from the right versus left side, regardless of whether the music was pleasant ($M_{diff} = .31$ vs. .20, when the music came from the right vs. left side, respectively; $p > .70$) or annoying ($M_{diff} = -.09$ vs. $-.23$; $p > .65$). Possible explanations for this unexpected finding are discussed later.

The expected pattern of results was obtained in the longer time period conditions. That is, when participants listened to music for 1.5 minutes, we found that the relative fluency of processing the right-side restaurant was contingent on both the location and the valence of music ($F(1, 316) = 8.60$, $p < .01$). Given pleasant music, participants reported greater processing fluency for the right-side restaurant when the music came from the right ($M_{diff} = .43$) versus left side ($M_{diff} = -.49$; $F(1, 316) = 7.06$, $p < .01$). However, the reverse was not significantly true if it was annoying music that was played from the right side rather than the left side ($M_{diff} = -.44$ vs. .11; $F(1, 316) = 2.30$, $p = .13$).

Finally, we examined the mediating role of fluency on choice. Because the predicted effects of music location and valence on fluency were obtained only in the longer time period, we analyzed the influence of fluency on choice only in that condition. As predicted, fluency had a significant impact on choice ($\beta = 2.27$, Wald $\chi^2 = 32.81$, $p < .001$). Further, the mean indirect effect of the interaction between music location and music valence through fluency (based on 1,000 bootstrap samples) was significant, with a point estimate of .85 and a 95% confidence interval excluding zero (.29 to 1.80). Thus, when music was played for a relatively long time period, the interactive effect of music location and valence was mediated by fluency.

Discussion

Like experiment 4, this study was also able to identify both facilitation and impairment crossmodal effects of an auditory stimulus on visually based preferences. However, experiment 5 went further in obtaining evidence consistent with a sequential model of involuntary and voluntary attention. A short exposure to the auditory stimulus produced results that speak to the role of involuntary attention. Regardless of music valence (and, therefore, regardless of avoid/attend goals), participants in this condition displayed facilitation effects on attention and preference: the restaurant picture in the direction of the music was both attended to and chosen more. In contrast, given a longer exposure to the music, the obtained results were consistent with a dominant role of voluntary attention. The restaurant aligned with the music direction was attended to and preferred more (less) on exposure to pleasant (unpleasant) music, which should induce a voluntary approach (avoid) goal. To our knowledge, this is the first demonstration of the distinct roles of involuntary and voluntary attention in a crossmodal context and also of the subsequent influence on preferences.

The impairment effects obtained in this study (set along with those shown in experiment 4) are particularly noteworthy because, as described earlier, past work in the crossmodal attention arena has primarily documented facilitation effects. At the same time, the facilitation effects obtained in this study are worth considering. Unlike in experiments 1, 2, and 4, participants in this study were not given a goal of attending to the secondary (auditory) stimulus while forming impressions of the primary (visual) target stimuli. Indeed, in the unpleasant music condition, their goal is likely to have been one of avoidance, if anything. Despite that, but consistent with our ideas regarding the dominant initial role of involuntary attention, facilitation effects were still obtained for the unpleasant music in the short-duration condition. While our impairment findings extend prior crossmodal work, this facilitation effect thus enables a resolution with that research. In particular, the secondary stimulus used in earlier work, even when aversive, has typically been momentary—thus, our conceptualization would also predict the facilitation effects that were indeed documented in past research (Spence and Driver 1996; Spence et al. 1998, etc.).

It is important to reiterate that while ideas relating to evaluative conditioning and affect transfer might be able to explain the choice pattern in the positive music condition, they are unable to do so for the negative music case. Our choice data revealed that even when listening to annoying music, the restaurant being attended to more was liked more—consistent with our theorizing but not with a conditioning perspective. The reason evaluative conditioning might not have been at play in this study is that conditioning typically requires multiple exposures to the unconditioned stimulus (e.g., music), whereas our study used only a single exposure.

Finally, while the attention and choice results were fully supportive of our arguments, the relative fluency data in this study were only partially supportive. There were inconsistencies on two fronts. First, as noted above, music location did not exert any effect on relative fluency in the short-duration case (contrary to predictions and also contrary to the attention and choice results). Second, while the relative fluency pattern in the long-duration case was consistent with predictions, the absolute fluency means were aberrant in one specific condition. Namely, processing fluency for the right-side restaurant did not improve, contrary to predictions, when negative music was played for a long time from the left ($M = .77$) versus right ($M = .81$).

Two reasons may account for these inconsistent findings. First, it is possible that self-report fluency measures are not very sensitive, particularly because, as noted earlier, the fluency measure was assessed separately for each of the two restaurant pictures. Thus, when responding to the fluency items, participants were not required to make an explicit comparison between the two restaurants; having to make such a comparison could have produced heightened sensitiveness, increasing the validity of the measure. Note that the attention and preference measures, in contrast, both required such explicit, trade-off comparisons, and our predictions were supported on both of these measures even in the short time condition. Second, the absolute fluency means for the pictures may be influenced by other factors, reducing the impact of music location. A particularly salient influence in this study is music valence—annoying, intrusive music is likely to make it harder for participants to engage in the simultaneous task of restaurant evaluation. And indeed, the data show that absolute fluency scores were significantly influenced by valence, regardless of music location and duration ($F(1, 316) = 58.08$, $p < .001$).

These two factors (with the second factor being unique to this experiment) may explain why the fluency results in this study were only partially consistent with predictions. We note, however, that other possibilities also exist. It could be, for instance, that visual attention in this condition affected choice through other mechanisms such as self-perception. It would be worthwhile to more closely examine the possible influence of such other mechanisms in future work. At the same time, fluency did exert a mediating role in our previous studies (and results in the earlier attribution study were strongly supportive of a fluency account). It seems, therefore, that fluency is at least one of the key factors driving the influence of visual attention on choice in our context.

GENERAL DISCUSSION

Summary

This research examined how preferences based on visual processing may be influenced by unrelated stimuli that are being contemporaneously processed in another sensory mode, in particular, the auditory mode. Merging insights from three different literatures—(*a*) crossmodal attention links, (*b*) the two-stage mechanism guiding involuntary versus voluntary attention, and (*c*) processing fluency—our conceptualization predicts when and why an auditory signal will enhance or impair preferences for visually processed targets located in the same direction as the signal. This conceptualization suggests that a facilitation effect on preferences will be obtained when individuals attend to the auditory signal, whether for involuntary (e.g., a loud noise) or voluntary (e.g., an explicit goal to comprehend the signal) reasons. In such cases, crossmodal functionality dictates that visual attention should be directed toward the signal, improving evaluations of visually processed targets in that direction because of enhanced fluency. Moving beyond such facilitation effects, however, we argue that visual attention will not always be directed toward the auditory signal. Given a goal to avoid the signal (e.g., as induced by an aversive noise), crossmodal functionality should now dictate turning visual attention away from the signal, producing an impairment effect on preferences for target objects in the direction of the signal. Finally, the two-stage sequence of involuntary and voluntary attention provides an important nuance to this latter prediction: a facilitation effect should initially be obtained because of a reflexive appraisal of the signal, before a more deliberative attention-allocation process produces impairment.

Our findings provide good support for these predictions. The first three studies document a facilitation effect of an auditory signal on visual attention and target preferences; a finding that is also replicated in the appropriate conditions of experiments 4 and 5. As predicted, such facilitation effects are obtained, given an external goal to comprehend the auditory signal while making visual judgments (e.g., experiments 1, 2, and 4), but also in the absence of such a goal (e.g., experiment 3)—as long as there is not a goal of actually avoiding the signal. If there is, our conceptualization predicts an impairment effect of the auditory signal on visual attention and preferences. Experiment 4 documents such an effect for an externally provided avoidance goal, while experiment 5 replicates it for an internally generated goal of avoiding an aversive signal. Of note, however, is that the impairment finding for the aversive sound holds only when it is played for a sufficiently long duration. When it is heard very briefly, it still produces facilitation effects on visual attention and preferences, consistent with our posited two-stage sequence. Finally, our findings across the studies are broadly supportive of processing fluency being a key determinant of the positive influence of visual attention on preferences.

Implications and Contributions

This work contributes along several directions. First, we add to the extant crossmodal literature by building and examining a conceptualization of the crossmodal effect of attention on preferences. This represents, we believe, the first investigation of how attention drawn by one sensory mode can influence preferences in another. Thus, while the extant literature has obtained robust evidence for facilitation effects on crossmodal attention, we are able to document such facilitation effects on preferences—an auditory signal can not only bias visual attention toward itself, but it thereby also enhances preferences for visually processed targets in that direction. Second, we draw on the distinction between involuntary and voluntary attention to contribute to the crossmodal attention literature by documenting theoretically derived boundary conditions for the basic facilitation effect. Specifically, we argue that the reflexive tendency to turn visual attention toward the auditory signal (facilitation) can be overcome, given a deliberative goal of avoiding the signal. In such cases, rather than visual attention being turned toward the signal, crossmodal functionality dictates the reverse, and a subsequent impairment effect is thereby obtained on preferences as well. Third, even though past work on crossmodal attention has primarily documented facilitation effects (e.g., greater visual attention toward an auditory stimulus) and we also document impairment (lowered visual attention toward the auditory signal), our conceptualization is able to reconcile the two sets of findings. Drawing on a two-stage attention-allocation process that is new to the crossmodal arena, we show that involuntary attention yields initial facilitation effects even for aversive stimuli, although later on, voluntary attention allocation leads to impairment.

From an applied perspective, this research adds to the small but growing body of work illuminating the vital role of sensory interactions in shaping product perceptions (Elder and Krishna 2010; Gorn et al. 1997; Krishna and Morrin 2008) and possesses straightforward practitioner implications. In particular, our findings indicate how marketers (and other persuasion agents) may enhance preferences for target objects by drawing attention to completely unrelated objects and events. Of note, we were able to find evidence for this idea not only in the lab but also in the field context of choosing between two vending machines (experiment 3), thus highlighting the applicability of theoretical insights regarding crossmodal preferences. Marketers could use this insight in other ways apart from those studied here. For example, in the store, a salesperson might chat with a consumer who is deliberating over two options. Even if the chat has nothing to do with the products in question, the consumer is likely to end up paying more visual attention to the option that is located near the salesperson and, therefore, will be more likely to choose it.

Future Research Directions

Several interesting avenues exist for further exploration. One obvious possibility has to do with further generalizing the current findings. Thus, while the current studies examined how an auditory signal can shift visually based preferences, our conceptualization argues that similar effects should obtain when attention shifts are caused by signals processed in other senses. Ongoing research in our lab suggests that this is indeed the case. In one study exploring the tactile-visual link, a cup of water was placed on either the left or right side of each participant's desk; they were told that the experiment sought to examine people's ability to estimate temperatures of liquids. On this pretext, participants were asked to dip the hand closest to the cup into it, in order to estimate the water temperature. They were also asked to complete another task at the same time, namely, indicating preferences between two restaurants displayed on their computer screen (one on the right, the other on the left of the screen). We found that participants paid more attention to the right-side restaurant when they used their right versus left hand to touch the water (−.09 vs. −.94; $F(1, 65) = 3.60$, $p = .06$). Also, they were more likely to choose the restaurant on the right if they used the right hand to touch the water than if they used the left hand (49% vs. 24%; Wald $\chi^2 = 4.39$, $p < .05$). These results are supportive of our facilitation predictions in the tactile-visual context. Future research should seek to generalize our findings in other senses as well—such as the sense of smell. It would also be useful for such investigations to explore possible impairment effects: thus, an aversive odor might initially produce involuntary facilitation effects, followed by subsequent impairment.

Future research should also seek to address a limitation of the current work. While the obtained findings are largely consistent with our proposed process—namely, that attention in a particular direction influences preferences along that direction via its effect on processing fluency—there are two reasons to not overinterpret these findings. First, it has to be kept in mind that attention and fluency were both measured through self-reports in all our studies. While other work in our lab has replicated the attention results using less obtrusive eye-tracking methods, future work should also consider assessing fluency using unobtrusive methods. Implicit Association Test–based assessment offers one intriguing possibility in this regard (Forehand and Perkins 2005; Greenwald, McGhee, and Schwartz 1998). Such implicit techniques would also help to address another concern noted earlier, namely, that the self-report measure might be relatively insensitive to subtle changes in experienced fluency.

Second, and relatedly, we would not wish to claim that increased attention influences preference only via increases in fluency. While our results do suggest a key role of fluency (again, with the moderating pattern in experiment 2 findings providing good evidence), it bears repeating that other influence pathways also likely exist (cf. Janiszewski et al. 2013). Future investigations in the arena of crossmodal preferences could fruitfully examine the role of other processes as well.

Finally, while the current research focused on how attention in one direction enhances crossmodal preferences in that direction, there may be situations in which greater attention actually leads to lower product liking. Consider, for instance, a target product that contains predominantly negative features. For such products, it is quite likely that greater attention, by producing an even greater focus on the negatives, will actually heighten product dislike (cf. Petty and Cacioppo 1986)—counteracting the positive influence of mere fluency. Future research examining such a possibility would add to our understanding of the different ways in which attention can exert a crossmodal effect on preferences, an issue that is of clear importance to consumer research but that has been somewhat neglected in our field.

DATA COLLECTION INFORMATION

The data reported in our studies were collected over the past 4 years (starting in 2010) in dedicated behavioral research labs at Chinese University of Hong Kong (CUHK) and Hong Kong University of Science and Technology (HKUST), Hong Kong. These studies were run by several research assistants under the supervision of the first author (Hao Shen), who also conducted the data analyses.

Experiment 1: October 2010 (additional data were collected for this study in February 2012) at CUHK
Experiment 2: March 2011 (additional data were collected for this study in June 2013) at CUHK
Experiment 3: April 2011 at CUHK
Experiment 4: March 2012 at HKUST

Experiment 5: August 2012 at CUHK
Tactile experiment mentioned in General Discussion: November 2010 at CUHK
Posttest mentioned in the beginning of experiment 4: January 2013 at HKUST

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