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The Effect s of Sex and Internet Usage on Search Efficiency and Effectiveness

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Abstract: **Grounded on the selectivity model that proposes a different information processing style between the sexes, this study investigates the interactive effects of sex and Internet usage on online search efficiency and search effectiveness. One hundred and nine participants (58% female) performed a series of goal-oriented search tasks on websites from various sectors in a laboratory setting. Results show that Internet usage improves men's search effectiveness (number of clicks and time spent performing task) and search efficiency (number of dead ends encountered) but Internet usage has no impact on women's performance. Results mostly support the selectivity model [1] whereby women are comprehensive processors and men selective ones. Managerial as well as theoretical implications of the findings are provided**.

Keywords: Information processing, gender, sex, search efficiency, search effectiveness, web search

I. Introduction

E-commerce has progressed at a phenomenal rate in North America over the last 20 years, but yet some statistics are troubling. The bounce rate and cart abandonment rate are still extremely high: they reached 35% and 57% respectively in 2009 [2]. This means that almost four consumers out of ten clicks off a website after viewing only the first page, and close to 60% of consumers that start a transactional session abandon it prematurely. These figures emphasize the importance of better understanding how consumers process information on the Web. While much research has been done in this area [3-6], few studies have examined the influence of key individual variables. We believe sex might influence search patterns and online task performance because men and women differ in the strategies they use to process information [1]. According to the selectivity model [1], women are comprehensive processors that engage in detailed, elaborative and effortful processing of information. In contrast, men are selective processors. They tend to use various heuristics to streamline the processing of information. Furthermore, the selectivity model suggests that females have more subcategories in memory within which they store information. Males, in contrast, employ broader, more inclusive categories, each containing a comparatively larger number of memory cues [7-8]. Further, Alba and Hutchinson [9] propose that expertise resulting from familiarity with a "product" refines the category structures used to differentiate products, improves the ability to analyse information and to determine what is most important and task-relevant. According to their respective category structures in memory, men could have more to gain from the refinement that develops from experience with the Internet than women do.

Therefore, the goal of this study is to investigate sex differences in search performance (efficiency and effectiveness) on the Internet while adults are assigned to the same goal-oriented tasks. We propose that Internet experience will interact with sex in defining task efficiency and effectiveness. To our knowledge, this study is the first to investigate sex differences in search patterns and performance on the Internet while adults are assigned to the same goal-oriented tasks. In an era where personalizing the consumer's experience online is believed to be a key element contributing to customer satisfaction and loyalty [10] and where technology allows for redesigning marketing practices to be more customer-centric [11], investigating sex differences in search strategies and performance on the Internet is definitely informative.

II. Literature review and hypotheses

A. Sex differences in search patterns

Many studies have highlighted different search patterns between men and women in various contexts. Cleveland et al. [12] investigate men's and women's search patterns when shopping for clothing as a Christmas gift. Patterns differ considerably between sexes, with women acquiring more information than males. In contrast, men are more apt to seek the assistance of store sales personnel than females. These differences tend to support the idea that women exert more effort and, consider more information when searching, while men simplify their search process by partly subcontracting their process, at least in the Christmas shopping domain. Search patterns in computer-related technologies have attracted the attention of researchers in the fields of information systems, education and marketing. The Internet grants users great flexibility; they can search according to their own style. Many studies, often involving children, suggest that sex might be a major predictor of

search patterns on the Web. For example, Leong and Hawamdeh [13] assert that boys find Web pages lengthy to read, spend more time scrolling through the pages and are especially impatient when pages contained only text instead of pictures with captions. Large et al. [14] support the above results but report that boys spend less time on individual pages, check more hypertext links per minute, and in general, are more active online (frequency of mouse clicks) than girls. They also find that boys tend to perform more page jumps per minute, use the Stop button more, and tend to click on more hits from a search engine's result page. However, the total time spend online do not vary between the sexes. Similarly, Roy and Chi [15] find that boys tend to filter information early in the search cycle while girls tend to pursue a particular line of search, drilling down into documents. The search pattern adopted by females lead to poorer knowledge gains in the search task compared with the males' performance [15]. Roy and Chi's results might also be explained by women's not keeping on target and letting themselves be drowned in by irrelevant (but potentially interesting) material, as Ford et al. [16] observe.

Studies on the impact of sex on search patterns provide, however, only limited evidence because they use a general search on the Web on a particular subject and do not measure efficiency or effectiveness within the same specific target task on the same website. However, collectively, the literature seems to indicate that females' search strategies on the Web might be more detailed, while males' strategies appear more straightforward, similarly to what Cleveland et al. [12] report in a shopping task.

B. An explanation of sex differences: The selectivity model

How can these sex differences in search patterns and task performance be reconciled? Considerable research proposes that the difference may partly lie in different information-processing strategies adopted by each sex. Meyers-Levy [1] introduces the selectivity model, which argues that men and women differ in effort, attention to details and elaboration when processing information**.** Men are selective processors: they do not generally engage in comprehensive, extensive processing of all available information. Instead, they employ various heuristic devices that serve as surrogates for more detailed processing. Men tend to focus on the most salient cues and do not pay attention to subtle (sometimes disconfirming) details [7-8]. In contrast, women are comprehensive processors who tend to assimilate all available information and elaborate more on it. Women are also more likely to notice and elaborate on subtle cues. This difference across sexes emerges not because males encode fewer cues than females but most likely because women elaborate more extensively on the cues, which increases their accessibility for subsequent use [7].

The selectivity model also suggests that females have more subcategories in memory within which they store information. Males, in contrast, present broader, more inclusive categories, each containing a comparatively larger number of memory cues [7-8]. This memory advantage is believed to give women an advantage over males on information accessibility. This accessibility advantage, coupled with more extensive experience with comprehensive processing of information, is supposed to be particularly salient when processing multiple cue information [17]. Performing goal-directed search tasks on the Internet requires that users process many different pieces of information and is then highly appropriate to observe such manifestations.

C. The moderating role of task demand and Internet usage

In the context of financial auditing, O'Donnell and Johnson [18] and Chung and Monroe [19] observe an interaction between sex and task demands on measures of effectiveness and efficiency. As task demands increased, males' success rate in judging the adequacy of audit documents deteriorate while women's success rate is unaffected [19]. Sex differences emerge only under high task demands. In the same vein, O'Donnell and Johnson [18] find that males examine significantly more information cues as task demands increased. Task demands have no such effect on women, as the number of pieces of information examined by women does not differ significantly across conditions. Similar results are observed with respect to time taken to complete the task. What is quite consistent in the literature is that women bring their comprehensive, detail-oriented processing to the task, independently of its demands. Women are thus highly predictable contrary to men, who tend to use selective processing, even when tasks would require a more comprehensive strategy. Further, their performance deteriorates in such cases.

We believe that Internet usage may mimic the effect of task complexity on search efficiency and effectiveness when users have to perform goal-oriented tasks on the Internet. Increased familiarity with a "product", and the resulting expertise, reduces the cognitive effort required to perform a task, refines the category structures used to differentiate products and improves the ability to analyse information and to determine what is most important and task-relevant [9]. Evidence related to an Internet search context shows that, with increased experience, consumers reduce the number of pages they view on a given site, but experience does not impact the time spent per page [3]. This added experience then translates into the consumers' remembering where to go to find what they are looking for and not wasting time on irrelevant pages. Considering men's and women's cognitive category structure and their respective information processing strategies, men may have more to gain from the refinement of the cognitive structures that comes with Internet usage intensity that women do. This should translate in Internet experience improving men's search performances (efficiency and effectiveness) to a greater extent than women's.

D. Hypotheses

The literature review suggests that men and women have different search patterns and that sex and Internet usage should interact in defining some measures of search efficiency and effectiveness. However, as mentioned above, experience does not impact the time spent per page [3]. Based on the conceptual foundations reviewed, we posit the following hypothesis:

H1: Women spend more time per page than men during web search tasks

Measures of efficiency in comprehension processes are often conceptualized as time spent processing material [20],

[18] or number of cues examined [18]. We opted for similar indicators adapted to a Web context. We propose that sex will interact with Internet usage in such a way that:

H2a: Internet usage has no impact on the number of clicks for women.
H2b: Men decrease the number of clicks significantly when Internet usage is high (increased efficiency) compared to when Internet usage is low.

H3a: Internet usage has no impact on the time women spend performing a task.
H3b: Men spend significantly less time accomplishing a task when Internet usage is high (increased efficiency) than when Internet usage is low.

Search effectiveness in the context of a goal-directed search on the Internet can be measured by various indicators: quality of choice, knowledge gains and, success in accomplishing a specific task. Since tasks do not always entail a choice between brands and in order to keep our indicators close to the search process and in line with prior research, we opted for two indicators of search performance: a) success in completing the goal-oriented task and b) the number of dead ends encountered during the task. A dead end is an unsuccessful attempt to find information that consumers encounter while shopping or browsing on a website. Dead ends occur either because consumers make a wrong judgment on the structure of the website or because the website has a poor semantic structure [21] and they cause frustration. Therefore we propose that:

H4a: Internet usage has no impact on the number of dead ends encountered by women.
H4b: Men significantly decrease the number of dead ends encountered when Internet usage is high (increased effectiveness) compared to when Internet usage is low.

H5a: Internet usage has no impact on women's success rate.
H5b: Men's success rate is significantly higher when Internet usage is high (increased effectiveness) than when Internet usage is low.

III. Method

A. Sample and procedure

One hundred and nine Internet users (58% females) were recruited from a panel of consumers. Subjects were invited to a laboratory where they performed goal-oriented tasks on two or three websites from different industries. On each site, they were assigned a precise task to perform. Participants were randomly assigned to the various websites. Traditionally, shopping has been characterized as a female activity for some product categories such as grocery, home furniture and children's apparel [22]. In order to avoid confusing the effect of shopping expertise and sex, we carefully chose tasks that were not part of the traditional ones assumed by women. Sites chosen include insurance, home improvement center, traveling, technology and banking, which are domains where decisions are taken conjointly or are traditionally associated with males' interests [22-23]. The sites and the required tasks are presented in table 1.

Table 1. Nature of the experimental tasks.

Type of site	*Task*	*Women*	*Men*
Bank	Gather information for a loan	15	19
Insurance	Get a quotation for car insurance	21	18
Airline	Book a flight for two to Vancouver, CA	14	17
Travel agency	Book a flight for two and make hotel arrangements	16	14
Home improvement center	Choose a new lawnmower	18	24
Phone company	Find information about the current rate for a specific cell phone	24	17
ISP	Find information about broadband capacity	17	17
DVD retailer	Buy the latest Harry Potter DVD	20	9
Electronic equipment	Buy a 4 mega-pixel digital camera	20	20
# of tasks performed		165	155

Consumers were paid 50$ in exchange for their participation. During their navigation, participants were asked to verbalize their every thought. This approach, inspired by Simon [24] and Ericsson and Simon [25], is known as protocol analysis. It has proven to be very useful for website analysis [26]. First, participants did two warm-up tasks to practise verbalizing their thoughts and to become familiar with the laboratory environment. Participants then performed the experimental tasks. They could interrupt the navigation at any time, for any reason. For each task, navigation data were recorded in AVI format (video and sound sequence) using CAMTASIA software, and navigation logs (time per page, number of pages, downloading time, etc.) were simultaneously recorded. Following navigation on each website, participants completed an online questionnaire measuring Internet usage, experience with the website visited, as well as demographic information.

B. Measure of the variables

Sex and Internet weekly usage were the independent variables**.** Sex is the biological sex reported by the participant. Weekly Internet usage is measured using an ordinal scale ranging from (1) 5 hours or less to (7) More than 50 hours.

For each task performed, the dependent variables (time spent per page, number of clicks, time to accomplish the task, number of dead ends and success rate) were measured by two independent analysts to ensure reliability. They reviewed each video file, and observed the time spent per page (once downloading was completed), the number of pages visited, how long it took subjects to complete the task (excluding downloading time), and whether they had successfully completed it. Because participants could click onto and off of a page which was being downloaded, the number of clicks is slightly higher than the number of pages. For a dead end to be counted, two conditions had to be met: first, the video had to show that the participant needed to go back or migrate to another part of the site, and second, they had to concomitantly verbalize the fact that they did not intend to go where they had gone. These two conditions ensured that not all navigational loops were categorized as dead ends. Analysts agreed in most instances and the main researcher's interpretation prevailed to resolve the few

differences between judges. Finally, for each dependant variable, measures for each participant across the sites visited (2 or 3) were averaged. Subjects were then categorized as having either a low or high level of weekly Internet usage. To ensure that cells were adequately populated and not unduly imbalanced, subjects were split at 10 hrs per week of Internet usage, which corresponds to the average time Internet users spend on the web on a weekly basis [27]. This split procedure resulted in 41.3% of the sample's reporting low Internet usage and 58.7% reporting high Internet usage.

Age and education are key variables that have been found to influence information search and/or search performance in past research online as well as in the more traditional context [28-33]. They were included as control variables to rule out alternative explanations for differences in the dependent variables. However, since tests assessing their direct as well as interactive effects with sex were non-significant, they were dropped from further analyses.

IV. Results

A. Sample description

The large majority (80%) of subjects (men and women) had more than 5 years of Internet experience. They were young and educated and 25% of them had previously navigated on the site visited. Men and women did not differ regarding age and education. However, more men tended to be heavy Internet users while women tended to be evenly split between light and heavy users, a difference that reflects a real variation in the population at the time of the study [27]. Overall, subjects profile was representative of Internet users. Moreover, experience with websites visited did not differ significantly between men and women ($p > 0.1$), ruling out a task expertise effect. Table 2 summarizes these results.

B. Hypotheses testing

We tested our hypotheses with a series of ANOVAs[12] comparing the average scores of men and women on the dependent variables.

Women spent an average of 30.79 seconds per page while men spent only 28.26 seconds. This trend was quite consistent throughout industries, but these differences were not large enough to be significant ($F(1, 108) = 0.9$, $p > 0.1$, one-sided), refuting H1. Women clicked an average of 12.85 times per task and men an average of 15.64 times. The analysis of variance showed a main effect for sex ($F(1, 108) = 4.9$, $p < 0.05$, one-sided) and the interaction between sex and Internet usage was significant ($F(1, 108) = 5.8$, $p < 0.05$).

Table 2. Sample description.

Variable	Items	Men (n=45)	Women (n=64)	Sex difference (p)
Age: mean (std dev.)		33.58 (13.5)	31.42 (12.3)	> 0.1
Education	< college College University	11.1% 31.1% 57.8%	8.0% 31.7% 60.3%	> 0.1
In average, how many hours/week do you use Internet?	10 hrs or less Over 10	28.9% 71.1%	50.0% 50.0%	0.028
Have you ever navigated on the website you just visited?	Yes	23.3%	28.6%	> 0.1

Examination of the simple effects revealed that males in the low Internet usage condition clicked more often than under the high Internet usage condition ($F(1, 44) = 2.9$, $p < 0.05$; *M low usage* =18.1 > M *high usage* = 13.1). For females, there was no significant difference in their activity ($p > .40$) across conditions. Hence, results support H2a and H2b with a positive effect for males' efficiency as Internet weekly usage increase and no effects for females across conditions. Figure 1 illustrates this result.

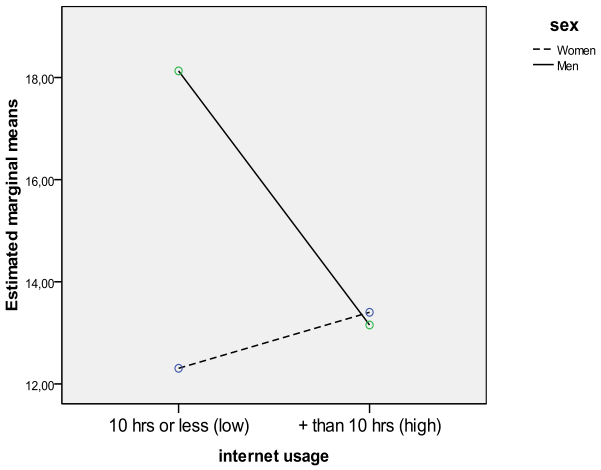

Figure 1. Number of clicks according to sex and Internet usage

Total time required to accomplish a task did not vary significantly across the sexes (*M women* = 340.5, *M men* = 352.9; $F(1, 108) = 0.08$, $p > 0.1$), and no interaction between sex and Internet weekly usage was observed ($p > 0.1$). However, the relevant contrasts showed that men in the low Internet usage condition took significantly longer to accomplish their tasks than those in the high Internet usage condition (M *low Internet usage* = 406 seconds > M *high Internet usage*= 300 seconds, $p = 0.035$, one-sided). For women, there was no significant difference in the time spent ($p > .50$) across conditions. Here again, Internet usage affects men and women differently, improving men's efficiency when performing web search tasks but not impacting women's, which affirms H3a and support H3b. Figure 2 shows the interactive effects.

On average, women and men encountered 4.6 and 5.4 dead ends respectively, during their tasks. This difference was not significant ($F(1, 108) = 1.3$, $p > 0.10$), but again, a significant interaction between Internet usage and sex emerged ($F(1, 108) = 4.1$, $p < 0.05$). Figure 3 illustrates that

[1] Analyses of variance were performed using estimated marginal means to account for unequal group size

[2] Analyses of standardized residuals and of homogeneity of variances across groups were performed and some variables were transformed to satisfy the assumptions of the statistical model underlying the linear model of the ANOVA and MANOVA. Analyses were performed with transformed variables and original ones with no impact on results. Interpretations are then presented on the original data.

men showed an important decrease in the number of dead ends encountered with increased Internet usage (*M high Internet usage* = 4.2, *M low Internet usage* = 6.6, $p < 0.05$) while Internet usage had no such effect for women (*M high Internet usage*= 4.8, *M low Internet usage* = 4.5, $p > 0.60$), supporting H4a and H4b.

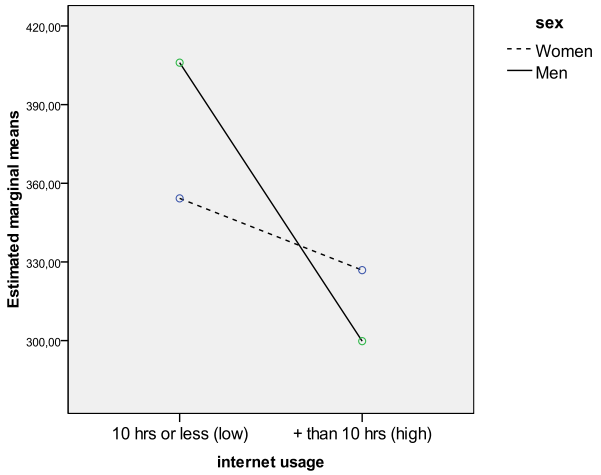

Figure 2. Total navigation time (seconds) according to sex and Internet usage

Women and men successfully completed the assigned task 68.8% and 66.8% of the time, respectively. This difference is not significant ($F(1, 108) = 0.06$, $p > 0.10$), and no significant interaction was noticed between sex and Internet usage ($F(1, 108) = 2.1$, $p > 0.10$). Simple contrasts show that women's success rate is not significantly impacted by Internet usage (*M high Internet usage*= 0.70, *M low Internet usage* = 0.676, $p > 0.60$), supporting H5a. A similar pattern was observed for men, refuting H5b. Table 3 summarizes the results of the study.

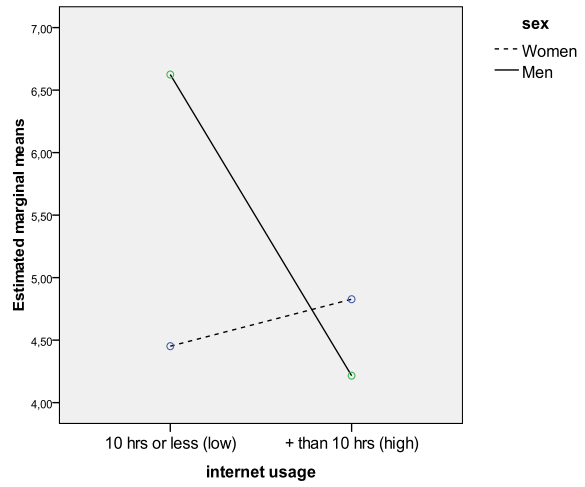

Figure 3. Number of dead-ends encountered according to sex and Internet usage

Table 3. Summary of results.

Variables	*Hypothesis (Women vs Men)*	*Result*
H1: Time per page	W>M	Not supported
H2: Internet weekly usage and clicks	W: no relationship M: negative relationship	Supported Supported
H3: Internet weekly usage and total time	W: no relationship M: negative relationship	Supported Supported
H4: Internet weekly usage and dead ends	W: no relationship M: negative relationship	Supported Supported
H5: Internet weekly usage and success rate	W: no relationship M: positive relationship	Supported Not supported

V. Discussion

Overall, results mostly support a differential information processing strategy between men and women using the Internet, consistent with the selectivity model [1] whereby women are comprehensive processors and men selective ones. Results also parallel findings from O'Donnell and Johnson [18] and Chung and Monroe [19], who observed interaction between sex and task complexity on auditing tasks.

As expected, increased Internet usage had a positive impact on men's efficiency (decreasing the number of clicks and total time spent) and effectiveness (number of dead ends) while increased Internet usage had no such impact on women. Success rates between males and females were not significantly different across Internet usage conditions ($p=0.17$). Note that the success rate does not depend solely on effectiveness, but also on perseverance with the task. Therefore, men appear to search somewhat less efficiently and effectively than women when they lack Internet experience, because they get trapped in more dead ends, resulting from poorer judgment about the structure of the website. Women, in contrast, apply their comprehensive processing to the task, whatever experience with the medium they have. Therefore, owing to their comprehensive strategy, and their less inclusive category structures to organize information, women's efficiency and effectiveness are not as influenced by experience (Internet usage) in an Internet context. Men's tendency to process information heuristically renders them less efficient and effective when they lack experience. Viewed differently, men gain more from the refinement of the cognitive structures that comes from higher Internet usage, probably because women already use more differentiated and, narrower category structures.

These findings make important contributions to the field of sex-based differences in information processing strategies on the Internet regarding two important dimensions. First, this is the first study to document sex differences on efficiency and effectiveness when adult consumers perform specific search tasks on the Internet with the same goal in mind. Second, an interaction between sex and Internet usage with respect to the level of activity reported and the number of dead ends encountered to accomplish Internet tasks had never been documented before. The parallel between our findings and studies performed in a substantially different setting (auditing) reinforces the assumption that familiarity

(or task demands) interacts with sex so as to influence measures of efficiency and effectiveness.

These results have interesting managerial implications. The influence of differential information processing between men and women during Internet searches is more likely to manifest itself in reduced usage of the medium. Hypermedia systems and websites can be developed to be flexible [34] and adapt to diverse individual differences and to avoid frustration that comes with incurring dead ends. For example, navigational support tools such as (1) direct guidance, (2) personalized feedback and (3) adaptive annotation where the user can find additional information about the content behind hyperlinks are tools that have been proposed by Fan and Macrediel [35] in order to accommodate different information seeking strategies between the sexes in the e-learning context. Similar help measures could be useful adaptations to improve men's performance under specific conditions. Other promising avenues are tailoring search results or websites to individual's preferences, needs and information processing strategies, which are nowadays possible via with the development of technology and data mining models [34], [36]. Explicit personalisation performed by the user is a mechanism [37] to be put forward that may be particularly relevant for men in web search. In a large scale study, Arcand et al. [38] has shown that site personalisation and ease of use are more closely connected for men than for women when they search for information on the web. They argue that "customization tools provide a way to avoid processing a vast quantity of information, which is consistent with males' tendency to use shortcuts to streamline information processing [38], [1]. Therefore, functionalities allowing users to do research "their way", such as providing filters with their own search criteria or searching within saved research would be to implement first and prior for sites targeting at male patrons. Urban et al. [39] go a step further and propose that technology can now implicitly adapt websites design according to the way people process information. "Morphing the web" as they explain allows web design to be empathetic to individual differences across users. Using that technology, the website "learns" the information processing style of the consumer as he (she) clicks along the pages and adapts the communication patterns accordingly.

In a nutshell, adapting websites to information processing differences across the sexes might help reduce somewhat the bounce rate and cart abandonment rate when users are searching for information as well as avoid frustration and the negative outcomes (site desertion, negative word-of-mouth) related to frustration in real web search settings. This is especially relevant for male users with limited experience with Internet.

V1. Limitations and suggestions for future studies

As with all behavioural research, there are limitations to this study that need to be addressed. First and foremost, task complexity and Internet usage should both be manipulated in a future study in order to disentangle their respective effect and provide further evidence of an interaction with sex in an Internet context. Second, the size of the sample used for this research was quite modest (n = 109). Because a large number of sites were used, the result was a small number of observations per site, which may substantially limit the generalization potential of these findings. The limited sample size also reduced the power of analyses. The results of this study should not be interpreted as evidence of a global, sex-specific superiority in cognitive reasoning for a particular task. The selectivity hypothesis does not predict that one sex will make better decisions than the other. It suggests only that females will, under certain conditions, use a different strategy than males to process information. Finally, other variables that could influence search strategy and judgment (familiarity or involvement with product category, contextual/social factors and other individual variables such as need for cognition) have not been included in this study and would be worth investigating.

In conclusion, men and women are impacted differently by Internet usage when searching for information on the web. These results are coherent with the selectivity model developed in cognitive psychology [1]. We hope these results will improve managers' and web designers' understanding on how men and women seek information on the Internet. More importantly, because sex is a variable that is easily accessible in a marketing context, we hope online businesses will benefit from these actionable insights in tailoring their strategies to their target customers.

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