Where in the Cloud is my Data? Location and Brand Effects on Trust in Cloud Services

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ABSTRACT

We all hold stereotypes about different locations across the world. Do these stereotypes affect our attitudes toward cloud services when we are told the location of the servers storing our data? And, does it matter if the cloud services are provided by a well-known brand? To answer these questions, a 2 X 11 experiment was conducted to examine the effects of location and brand cues on users' reaction to cloud services. Brand authority of the hosting company had a positive effect. More importantly, location of the cloud servers also affected outcomes, in that users tended to prefer some locations (e.g., US, Europe, Oceania, China) over others (e.g., Russia) for storing their cloud data. These findings have theoretical implications as well as design suggestions.

KEYWORDS

Cloud service; privacy; security; authority; location

1 INTRODUCTION

While cloud services offer many benefits, especially in affording remote storage of files, they also pose challenges to the privacy of users' personal data. When users sign up for cloud services, they inevitably give up control over the security of their personal data [10]. The lack of control and trust in cloud services have been among the common reasons why users are hesitant to save their information in the cloud [7].

How can cloud services alleviate users' concerns about the security of their data and earn their trust? One possibility is to provide 'credibility cues' on the interface of cloud services that address two primary questions in users' minds: Where is my data being stored? And, who is protecting my data? In other words, interface cues that reveal the location of their storage facility and also the authority (or known expertise) of storage service can potentially alleviate users' concerns. We test this proposition by grounding our work in the persuasion literature in communication and psychology, and experimentally testing if the authority of the hosting companies (i.e., low- vs. high-authority company) and the locations of their data centers (i.e., 11 different cities and countries around the world) make a difference to users' reactions to the cloud service, including their perceived security, usability, attitudes, and behavioral intentions.

Past research in social cognition has shown that humans are cognitive misers [4] who make decisions that maximize efficiency at the cost of thoroughness, often based on cues that trigger cognitive heuristics (i.e., rules of thumb such as "experts' statements can be trusted"). When sharing files via Google Drive or Amazon Web Services, for instance, users far too often skip the privacy terms and conditions and rarely think about the consequences in order to expediently access the services. That is, users' information sharing decisions do not always result from effortful thinking, but may occur due to expedient decision-making in the heat of the moment (e.g., [6]). Guided by this heuristic approach, the current study explores the psychological effects of interface cues on users' decision-making in the context of adopting cloud services.

According to the MAIN model [13], cues on the interface can trigger a variety of different heuristics (or mental shortcuts), shaping user judgments of the credibility of the interface and its contents. Considering that a major obstacle for adoption of cloud services is that users are provided with little information about where their data are stored and who has access to the database (e.g., [15]), location cues can prove quite influential in shaping user perceptions of the safety of their data by triggering the similarity heuristic [13]. However, perceptions of similarity can run the whole gamut, from social distance [8] to perceived differences in infrastructure and even political culture. In fact, it is recommended to check if the data center is located in a city or country where the location is not at risk of being compromised, when choosing a service for stable and secure data sharing [2]. For instance, if the data center is in a location that is highly affected by crime or is politically unstable, the security of user data and stable connectivity cannot be guaranteed. Therefore, the psychological effect of distance is not purely linear or a direct function of the geographical distance between the user and the cloud storage facility.
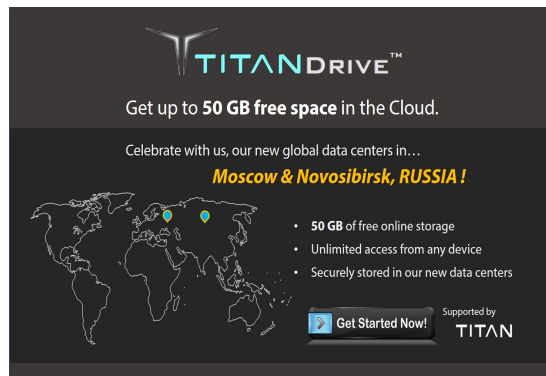
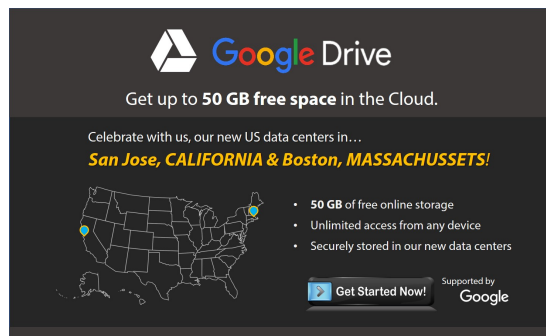Figure 1: Low authority cue with Russia location cue condition.

Figure 2: High authority cue with US urban location cue condition.

If a particular location evokes similarity at any level, however much that is based on stereotypes of that location and/or its people, that similarity will likely affect users' perceptions of a new cloud service situated in that location. Based on this literature and the MAIN model, we propose the following hypotheses for study:

H1a-d: Users' (a) perceived security, (b) usability, (c) attitudes, and (d) behavioral intentions toward a new cloud service will vary as a function of the physical location of its data centers.

In addition to testing the hypothesized effect of location cue, this study explores another interface cue that may affect users' decision-making when adopting new cloud services, namely authority cue. The credibility literature has long shown that authority figures or experts influence perceptual, attitudinal, and behavioral change [13]. The backing of an authoritative source (e.g., popular tech company such as Amazon and Google) may serve as a cue assuring users about the safety of the service when deciding to upload their data to the cloud. In particular, when websites or virtual agents identify themselves as an expert, specialist, or some type of authority source, users are likely to show more positive attitudes and behaviors toward the web sites, agents and their content (e.g., [14]). Hence, we propose the following hypotheses:

H1a-d: When a new cloud storage service is provided by a company of high (vs. unknown or low) authority, users will perceive the service as (a) more secure and (b) usable, show (c) more positive attitudes, and (d) greater behavioral intentions to use the service.

Obviously, some locations are better known than others. Some cities are more notorious for crimes than others. Some countries have closer ties with one's own than others. Some countries share the same political culture as ours. It is likely that all these social perceptions may factor into our perceived credibility of a cloud storage facility. However, will these perceptions change if the security of our data is guaranteed by a known authority? We examine this with the following research question:

RQ1a-d: Will there be any interaction effects between location cue and authority cue on (a) users' perceived security, (b) usability, (c) attitudes, and (d) behavioral intentions toward a new cloud storage service?

2 METHOD

In order to test the hypotheses and answer the research questions, a 2 (authority: low vs. high) X 11 (location: cities in various regions and countries around the world) between-subjects full-factorial experiment was conducted. A total of 473 participants residing in US were recruited from Amazon Mechanical Turk (MTurk). Each participant was exposed to a product announcement page regarding a new cloud storage service randomly assigned to them. Afterwards, they completed a questionnaire containing the measured items.

2.1 Experimental Stimuli

Based on the factorial design of this study, 22 versions of the product announcement were created. The authority cue was manipulated by 2 different company brands. In the high authority cue condition, we used the name of a well-known cloud storage service, Google Drive ($N = 233$).

Table 1: Measured Variables.

Variable	Example items	Statistics
Perceived Security of the New Cloud service	"I would feel secure sending my personal information to this online storage."	$\alpha = .96$ (4 items), $M = 4.18$, $SD = 1.53$
Perceived Usability of the New Cloud Service	"It will be easy to manage my personal data within this site."	$\alpha = .95$ (8 items), $M = 4.84$, $SD = 1.22$
Attitudes toward the New Cloud Service	"Worthless-Valuable" "Unappealing-Appealing"	$\alpha = .93$ (7 items), $M = 5.40$, $SD = 1.21$
Behavioral Intentions toward the New Cloud Service	"I would like to use the online file storage service in the near future."	$\alpha = .95$ (4 items), $M = 4.16$, $SD = 1.68$
Perceived Similarity	"I think the countries where the new data centers are located are similar to the country where I live."	$\alpha = .95$ (3 items), $M = 3.86$, $SD = 1.77$
Perceived Authority	"I think this company is a legitimate expert in the field."	$\alpha = .93$ (3 items), $M = 4.48$, $SD = 1.45$

In the low authority cue condition, we created a fictitious new cloud storage service brand called Titan Drive ($N = 240$). To manipulate the location cue, 11 different regions or countries were chosen to be included in the product announcements: US urban (San Jose, California & Boston, Massachusetts; $N = 39$), US rural (Mobile, Alabama & Chattanooga, Tennessee; $N = 49$), Europe (Stockholm, Sweden & Oslo, Norway; $N = 43$), Oceania (Sydney, Australia & Auckland, New Zealand; $N = 52$), India (Mumbai & Kolkata; $N = 33$), China (Guangzhou & Ningxia; $N = 57$), Japan and Korea (Tokyo & Seoul; $N = 45$), Russia (Moscow & Novosibirsk; $N = 41$), South America (São Paulo, Brazil & Bogotá, Colombia; $N = 42$), Middle East (Riyadh, Saudi Arabia & Doha, Qatar; $N = 30$), Africa (Dakar, Senegal & Windhoek, Namibia; $N = 47$). The different regions and countries ostensibly indicated the locations of the company's new data centers where users' data can potentially be stored. The product announcement shown to each participant contained an authority cue (either high or low) and a location cue (one of 11 locations). For example, in Figure 1, the company name, Titan, serves as the low authority cue and Russia serves as the location cue, whereas in Figure 2, Google signals high authority cue with the location cue of US urban regions. Except for these two cues, the design of the announcement was identical across 22 conditions.

2.2 Measured Variables

To measure perceived security of the new cloud service, four items were modified from Salisbury et al. [11]. To measure the perceived usability of the new cloud services, eight items were borrowed from Flavián et al. [5]. Seven items from past research [e.g., 16] were used to measure users' attitudes toward the new cloud service, on a semantic differential scale. Four items from previous scales [9,12] were modified to measure the degree to which users would like to use the service (i.e., behavioral intentions). Additionally, to ensure that the location and authority manipulations were successful, three items were adapted from past research [e.g., 3] to measure the degree to which users felt psychologically close to the locations of the data centers given the current locations they live (i.e., perceived similarity), and another set of three items from [1] to measure the degree to which they perceive the hosting company was authoritative (i.e., perceived authority). All the measured variables were on a 7-point Likert scale (1 = Strongly disagree, 7 = Strongly agree; see Table 1 for example items and statistics).

3 RESULTS

A one-tailed t-test indicated that the manipulation of the authority cue was successful ($t(471) = 10.83$, $p < .001$, Cohen's $d = .996$) in that the level of perceived authority of the company among users in the high authority cue condition ($M = 5.23$, $SD = 1.25$) was significantly higher than that of the low authority cue condition ($M = 3.94$, $SD = 1.35$). For the location cue, an ANOVA test revealed that the different country cues led users to report disparate levels of perceived similarity, $F(10, 462) = 39.73$, $p < .001$, partial $\eta^2 = .27$. In particular, the LSD post-hoc test indicated that not only the 2 US conditions were not significantly different from one another in their level of perceived similarity ($p = .84$), they were also ranked significantly higher in perceived similarity compared to the international location-cue conditions (p's $< .004$).

Table 2: LSD Post Hoc Comparison of Location Cue (The order of the location is based on the means of the user outcomes from higher to lower values. Groups with no alphabet in common differ at p < .05 based on LSD pairwise comparison).

User Outcomes	Location	Mean	
Perceived Security	Oceania, Europe, US Rural, China	4.43~4.56	a
	Japan & Korea, US Urban, Middle East	4.18~4.38	ab
	South America, Africa, India	3.75~4.00	bc
	Russia	3.39	c
Perceived Usability	US Urban, US Rural, Europe	5.12~5.27	a
	China, Oceania	4.97~4.98	ab
	Japan & Korea, South America	4.77~4.94	abc
	Middle East	4.55	bcd
	Africa, India	4.41~4.48	cd
	Russia	4.24	d
Attitudes	China, Europe, US Urban	5.73~5.78	a
	US Rural	5.61	ab
	Japan & Korea, Oceania, India, Middle East	5.13~5.48	abc
	Africa	5.12	bc
	Russia	4.54	d
Behavior-al Intent	China, US Rural	4.53~4.68	a
	Europe, Oceania, Japan & Korea, US Urban	4.31~4.45	ab
	Africa, South America, India, Middle East	3.69~3.84	bc
	Russia	3.34	c

A MANOVA test suggested that location showed main effects on the outcome variables, thus supporting *H1* (Wilks' Λ = .85, $F_{(40, 1742)}$ = 1.96, $p < .001$, partial η^2 = .04). The univariate effects of location cue on the 4 outcome variables are as follows: (a) perceived security ($F_{(10, 462)}$ = 2.64, $p = .004$, partial η^2 = .05), (b) perceived usability ($F_{(10, 462)}$ = 3.57, $p < .001$, partial η^2 = .07), (c) attitudes ($F_{(10, 462)}$ = 4.07, $p < .001$, partial η^2 = .08), and (d) behavioral intentions ($F_{(10, 462)}$ = 2.87, $p = .002$, partial η_2 = .06). Mean comparisons across the locations are shown in Table 2. The authority cue also showed main effects on the outcomes, thus supporting *H2* (Wilks' Λ = .91, $F_{(4, 468)}$ = 11.09, $p < .001$, partial η^2 = .09). Specifically, higher authority cues enhanced (a) perceived security ($F_{(1, 471)}$ = 26.46, $p < .001$, partial η^2 = .05), (b) perceived usability ($F_{(1, 471)}$ = 38.99, $p < .001$, partial η^2 = .08), (c) attitudes ($F_{(1, 471)}$ = 13.75, $p < .001$, partial η^2 = .03), and (d) behavioral intentions ($F_{(1, 471)}$ = 28.78, $p < .001$, partial η^2 = .06). Third, the interaction effect between authority cue and location cues (RQ1) was significant on (a) perceived security ($F_{(10, 451)}$ = 2.88, $p = .002$, partial η^2 = .06; see Figure 3), but not on (b-d) the other user outcomes (p's > .08). The decomposition of the interaction revealed that the company with stronger brand authority cue increases perceived security for most locations. On the other hand, the higher authority cue did not have strong impact when the new data centers were in Europe and India, and even showed negative influence on perceived security for China and Japan/Korea data centers.

4 CONCLUSION

In general, with the aforementioned exceptions, the data suggest that a well-known brand such as Google can have a positive effect on user perceptions of cloud services, confirming the role of the authority heuristic. Such branding effects are quite common in the literature, and it is not surprising that they were found in the cloud context as well. This means users expect well-known companies to be better guardians of their personal data, in part because they presumably face greater reputational harm in the event of data breaches.

What is surprising however is the effect of location cue on user perceptions of cloud services. It seems Americans tend to prefer US, Europe, Oceania and China as locations for storing their cloud data. They perceive the cloud service as not only more secure in these locations, but also find the service more usable, have more positive attitudes toward it and have greater behavioral intentions to enroll in it. Russia was by far the least favored location among the respondents.

These findings suggest that perceptions of cloud services are not solely dictated by distance from the user's own location. Nor does it seem to be based on political systems of the country in which the data center is located—both China and Russia are communist countries, but they scored on opposite ends of the scales. Recent allegations about Russian interference in US elections via social media, hacking and related cyber-activities may have played a role in Russia receiving the lowest ranking in our study. However, if the cloud service is offered by a credible company (Google), this seems to mitigate security concerns somewhat, thereby suggesting a trade-off between authority and location. When the cloud servers are located in a place that is deemed safe by users, the brand of the cloud service matters less, but if the location is controversial, then brand is all too important.
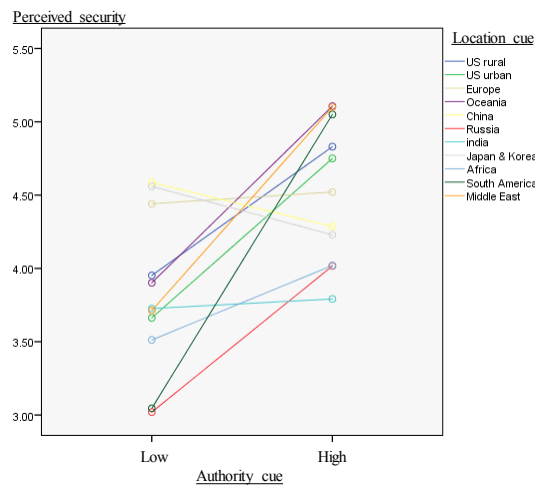
Figure 3: Interaction between location cue and authority cue on perceived security.

More generally, this study demonstrates the psychological significance of revealing cloud location to users. Not only can it increase transparency of cloud hosting services, but also tap into user preferences for housing their data and thereby earn their trust. These findings support the MAIN model by demonstrating that interface indicators of authority and location have powerful cueing effects, triggering stereotypes and cognitive heuristics that shape user decision-making. They also suggest design ideas for interfaces of cloud services, especially in terms of being more transparent about the identity of the custodian and physical location of user data.

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