

Spatial Cognition & Computation

An Interdisciplinary Journal

ISSN: 1387-5868 (Print) 1542-7633 (Online) Journal homepage: <http://www.tandfonline.com/loi/hsc20>

Spatial Metaphors of Web Use

Teenie Matlock, Spencer C. Castro, Morgan Fleming, Timothy M. Gann & Paul P. Maglio

To cite this article: Teenie Matlock, Spencer C. Castro, Morgan Fleming, Timothy M. Gann & Paul P. Maglio (2014) Spatial Metaphors of Web Use, *Spatial Cognition & Computation*, 14:4, 306-320, DOI: [10.1080/13875868.2014.945587](https://doi.org/10.1080/13875868.2014.945587)

To link to this article: <https://doi.org/10.1080/13875868.2014.945587>



Accepted author version posted online: 12 Aug 2014.
Published online: 12 Aug 2014.



Submit your article to this journal [↗](#)



Article views: 171



View related articles [↗](#)



View Crossmark data [↗](#)



Citing articles: 4 View citing articles [↗](#)

Spatial Metaphors of Web Use

Teenie Matlock,¹ Spencer C. Castro,¹ Morgan Fleming,¹
Timothy M. Gann,¹ and Paul P. Maglio¹

¹Cognitive and Information Sciences Department, University of California,
Merced, California, USA

Abstract: When the web became popular, people had to develop ways to talk and think about it. In the mid-1990s, we analyzed spatial language in “web talk.” We found that people described pages as places, and search as motion, both passive and active motion. Here we investigate web talk nearly two decades later. Our analysis reveals that some spatial language has stayed the same, and some has changed. Of special interest is how far fewer motion verbs are used nowadays. We argue that people naturally produce spatial metaphors when talking about new technological domains, and that over time, the most useful elements persist.

Keywords: metaphor, motion verbs, spatial language, web use

1. INTRODUCTION

When the World Wide Web was invented in 1989, it enabled people to access and transmit information via computers connected to the Internet with unprecedented ease and on an unprecedented scale. Within a few years, even people with limited technical skills could access information on “the web” by typing keyword queries into search engines and visually searching through human-organized catalogs (see Berners-Lee, 2000). Science fiction writer Arthur C. Clarke had foreseen a network of networks not unlike the web three decades before the web was developed by Tim Berners-Lee. In a *Popular Science* article, he predicted that one day there would be a console that would “bring the accumulated knowledge of the world to your fingertips”

Correspondence concerning this article should be addressed to Teenie Matlock, Cognitive and Information Sciences Department, University of California, Merced, 5200 N. Lake Road, Merced, CA 95343, USA. E-mail: tmatlock@ucmerced.edu

(see von Braun, 1970).¹ Over the past couple of decades, the web has become part of the fabric of everyday life. Billions of people all over the world now use it for work, research, banking, entertainment, shopping, socializing, dating, and more.

As the web became popular in the mid-to-late-1990s, people needed to find ways to talk about it and conceptualize it. In little time, various metaphors, especially spatial metaphors, were recruited to describe web applications and web use. Some of these metaphors are still around, and others no longer exist. The “web” itself is a metaphor that emphasizes the natural incremental growth of linked information over space and time. The original web browser, “Mosaic,” is now extinct, but its coinage was consistent with the idea of expansion, in that case, piecing together more and more disparate chunks of information into a coherent whole.

Many companies appealed to motion metaphors in branding and advertising early web applications and search engines. Some companies displayed images of animals that moved through space to retrieve information for web users. The logo for metasearch engine Dogpile, for instance, featured an image of a dog with a ball in its mouth alongside the slogan, “Go fetch.” The logo for the Lycos search engine featured the silhouette of a dog and the slogan “go get it!”² Other ads for web applications emphasized that users could actively search for information themselves (instead of using a “dog” or other web client to find and retrieve it). The logo for Netscape Navigator, for instance, displayed a large ship steering wheel with a starry sky and horizon in the distance, offering web users the chance to be at the helm and explore infinite possibilities. Ads for search engine WebCrawler often implied “motion,” especially with the slogan “search before you surf.” Metaphorical motion was also implied in ads for search engine Magellan and web browser Internet Explorer, both of which highlighted volition, exploration, and discovery.

The media also used motion metaphors in the 1990s and early 2000s, for instance, in TV news broadcasts, talk shows, and other programs. Statements such as, “come to our website,” “navigate the web,” and “surf the World Wide Web” became ubiquitous, and so did statements such as, “take a ride on the information superhighway” and “traffic jam on the information superhighway.” In fact, the phrase “surf the net” can be traced back to the early 1990s, when the Internet was first privatized (Armour-Polly, 1992).³

¹Vannevar Bush’s vision of MEMEX in the 1940s (Bush, 1945), a personal information repository in which information relevant to a single user would be linked for quick access, was similar to the web. The idea of creating hyper-linked information resources via a network of computers was first operationalized independently in the 1960s by Doug Englebart (1962) and Ted Nelson (1965).

²It is likely that dog metaphors were inspired by Apple’s Fetch, one of the oldest FTP clients on the Internet.

³The web is often mistakenly thought to be the same as the Internet, even though it is only one of many services offered by the Internet (Ryan, 2010).

It is no accident that companies and the popular media used metaphor to describe early web applications and web activity. Metaphor is often used in the realm of computer technology, where it can inform design (Faulkner, 1998; Norman, 1999) and help computer users form coherent mental models of how computers work (see Hsu, 2006). The desktop metaphor for Windows-based user interfaces is a good example of this. This metaphor spawned the conventional practices of “opening” and “closing” documents and “filing” them in “folders” as well as “moving” them into “trash cans” for disposal. It continues to shape the way we talk about and think about basic personal computers today (see Blackwell, 2006; Smith et al., 1982).

Spatial metaphors in particular can aid understanding of nonspatial phenomena, for instance when mapping multiple dimensions of a text corpus to a two-dimensional representation of topics (Kuhn, 2007). More generally, metaphor is known to help people make sense of information in technical or scientific domains (Dunbar, 1999). It helps people learn physics (Pulaczewska, 2011), mathematics (Núñez, 2011), and the dynamics of electricity (Gentner & Gentner, 1983).

Metaphor is useful in all these cases because it draws on our interactions in and with physical space, including moving or seeing others move from one place to another (Gibbs, 1994; Gibbs & Matlock, 2008; Johnson, 1987; Lakoff & Johnson, 1980, 1999). This is evident in everyday discourse. People use metaphors to talk about time, as in “Christmas is in front of us” and “We’ve just passed winter solstice” (Boroditsky, 2000; Clark, 1973; Evans, 2004; Gentner, 2001); elections, as in “Obama is sprinting to the finish line,” and “Romney is slipping behind” (Matlock, 2012, 2014); numbers, as in “Seven comes before eight” and “As x approaches infinity, y approaches 1” (Lakoff & Nunez, 2000; Matlock, Holmes, Srinivasan, & Ramscar, 2011; Winter & Matlock, 2013); illness, such as cancer (see Reisfield & Wilson, 2004), as in “I began to think of my recovery like a time trial in the Tour (de France),” said by cancer patient Lance Armstrong; and relationships, as in “We are drifting apart” and “They are close” (Matthews & Matlock, 2011). In all these cases, words about physical space and movement are used to discuss things that may actually have little to do with physical space or motion.

2. EARLY WEB TALK: 1990s

In the mid-1990s, we conducted interviews to investigate how people would naturally talk about the web and conceptualize it (Matlock & Maglio, 1996; Maglio & Matlock, 1998, 1999). Our predictions were in line with popular claims that humans typically ground their understanding of unfamiliar, abstract information in terms of basic experiences in the world, particularly their physical experiences with space and motion (e.g., Johnson, 1987; Lakoff & Johnson, 1980, 1999). In our study, we anticipated that people would describe websites as places and web browsing in terms of movement because

people are constantly searching for, locating, and grasping objects in physical space.

In one of our first studies on web discourse, conducted in 1996 at the University of California, Santa Cruz, we asked 23 students to sit at a desktop computer and use the web for a few minutes. The experimenters took care not to use spatial terms in setting up the task, and all spatial terms on the browser interface were removed. Immediately after, we asked them to talk about what they had done (Maglio & Matlock, 1999). Twelve participants were experienced web users, and 11 were inexperienced web users.⁴ Although it may be difficult to imagine today, in 1996, many people had little or no experience using the web. In this case, inexperienced users were defined as those who reported less than six months of web use.

In analyzing the 1996 interview data set, we discovered that participants often used spatial metaphors to describe web use. (Note that this study was conducted right before the web was widely popularized on TV and in other media. Many participants had only heard of the web.) Participants often talked about websites as places. For example, one individual stated, "The 100% top websites seemed like a good place." Another reported, "It brought me to, um, this place like, uh, where they had choices." In both instances, "place" was used to refer to a website. We also observed that some participants used "there," as in "I decided to go there" and "I went there to check out who's teaching what classes for next quarter." In both cases, "there" referred to a website. We also noted that sometimes participants described websites as three-dimensional places that could be entered and exited. In describing a Yahoo! search, one participant stated, "I tried to search for the movie 'Ransom,' but it was not found so I exited [...]." Another participant who had used Yahoo! reported, "I backed out and did a different search."⁵

In our analysis, we discovered interesting differences between experienced and inexperienced web users. One observation was that experienced and inexperienced users differed on how they described web actions. Experienced users often described themselves as actively moving toward information spaces, as in "I went to Yahoo!" or "I went to a catalog under religious studies [...]," and "I went to net search because that seemed like a good wholesome opportunity for going somewhere else." Inexperienced users were less consistent in with search descriptions. They sometimes described themselves as moving toward information, as in "I went to this one thing called, um, Yahoo!" and "I went into the, um, Brian's tattoo something or other," they also talked about an unspecified web entity bringing them information, as in "It brought me to, um, this place like, uh, where they had choices" and "It takes you to various topics." Inexperienced web users also talked about

⁴One participant's data was not analyzed because of failed Internet connectivity during the task.

⁵In Maglio and Matlock (1999), we also discussed how such descriptions reflected a tendency to view some information sources as containers.

themselves as passive recipients of information. In doing so, they talked about information being brought, given, or shown to them, as in “It brought me the information,” “Then it gave me some names [. . .],” and “It was gonna show, I guess, tattoos of his body.” Inexperienced web users sometimes discussed pages as suddenly appearing and showing them information, for instance, “The screen came up with lots of Chewbacca home pages” and “Lots of Sting, uh, home pages came up, and then I picked one that interested me.”

In Maglio and Matlock (1999), we also analyzed how participants talked about inside and outside actions. Inside web actions were actions taken “inside” the web, for instance, going to or doing activities in websites, for instance, “I went to the Psychology web page” and “There’s a little photo gallery, [in] which I spent most of my time, uh, playing around.” Outside actions were physical actions that are external to the web, for instance, typing in a URL on the keyboard or manipulating the mouse or other input device. We found that inexperienced web users often explicitly mentioned outside actions in their descriptions. For instance, they mentioned typing, as in “I typed in ‘Edward Dorie’” and “I filled in something different.” They also talked about using the mouse to click on things, as in “I just happened to click when I saw a photograph” and “I clicked on, uh, grapes and it brought me to this place.” They also talked about pressing buttons, as in “I, um, pressed buttons” and “I filled in, um, ‘Sting’, and pressed ‘Enter’.” Sometimes they blended inside and outside actions, for instance, “I clicked into it,” used to describe a situation in which the user clicked on an icon that “took” them to information. Inexperienced users mentioned outside actions about twice as often as experienced users.

For the current article, we returned to the interview data from Maglio and Matlock (1999) and analyzed how motion verbs were used.⁶ In re-analyzing the data, we noted that participants frequently used motion verbs to describe information access. Specifically, 100% of the experienced 1996 web users and 73% of inexperienced web users generated motion verbs in their descriptions.

Some of these motion verbs were goal-oriented, as in “I went to Cowell,” “I got to the search page again,” and “I left the dream study web site and went to the San Francisco New page.” Other motion verbs were not especially goal-directed. For instance, one participant talked of “floating around the web.” Another reported having “surfed many different areas within the topic of movies.” Another reported to have been “going in circles.” Both groups used an impressive range of verbs. Inexperienced users generated 8 different motion verbs (of the 31 motion verbs they produced), and experienced users, 14 different motion verbs (of the 46 motion verbs they produced). The most frequent motion verb used by both groups of participants was “go”

⁶In the original analysis, we focused on verbs that were used to express inside and outside actions, verbs of containment (e.g., “have,” “contain”), and on whether the verb implied agency in the user or the web. We did not examine the distribution or semantics of motion verbs per se.

(precisely, “go,” “went,” “going”). Precisely, of all the motion verbs generated by experienced users, “go” was used about 59% of the time, and other verbs, such as “surf,” “exit,” “leave,” “float,” “come,” and “drop by,” about 41% of the time. For inexperienced users, these proportions were about 58% and 42%, respectively.

In our re-analysis of motion verbs in the 1996 data, we also investigated how often participants used passive motion language. Here we are referring to phrases that suggested that some web entity played an active role and took them to a website or brought them information, as in “It takes you to various topics” versus phrases that suggested that the user was an active, volitional agent, as in “I went to a lot of sites, um, randomly and looked at them.” As shown in Figure 1, of all motion verbs used, experienced users generated passive motion language about 4% of the time (versus 96% active motion language), and inexperienced users produced passive motion language about 23% of the time (versus 77% active motion language). A chi-square test of significance indicated that this was a reliable difference, $\chi^2(1) = 5.96$, $p = .02$ (Pearson’s, two-tailed).

In sum, the results reported in Maglio and Matlock (1999) suggested that early web users anchored their understanding of web use in terms of physical space and movement (see also Maglio & Matlock, 1998; Matlock & Maglio, 1996). They viewed browsing activities as motion, suggesting the metaphor “OBTAINING INFORMATION IS MOVING THROUGH SPACE.” They viewed websites as places, sometimes three-dimensional places, suggesting

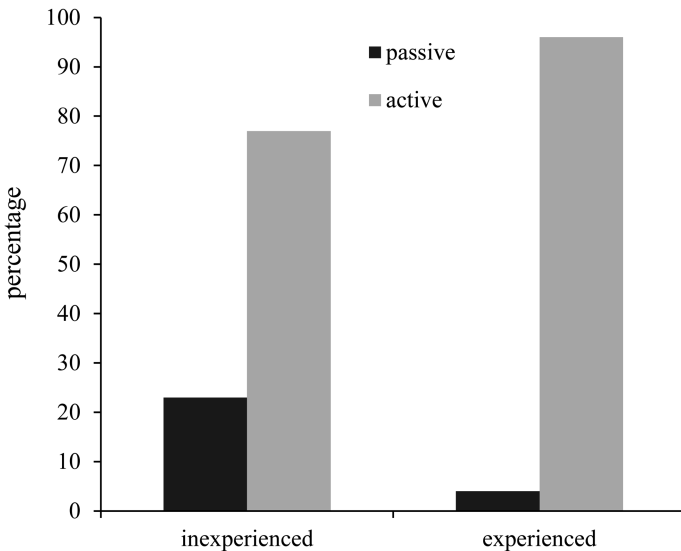


Figure 1. Proportion of passive motion and active motion verbs used by experienced and inexperienced web users in the data set from the 1990s.

the metaphor “WEB SPACE IS PHYSICAL SPACE.” We also found that inexperienced web users were less likely to view themselves as active, volitional “movers” than experienced users.

In related work, we discovered that early web users tended to describe browsing in terms of horizontal motion rather than vertical (Matlock & Maglio, 1996). We argued that this made sense given the ubiquity of actual horizontal movement in the world (e.g., walking across rooms). Less often do we experience vertical motion, for instance, (e.g., climbing ladders) (see also Gibbs & Matlock, 2002). The results were consistent with other early research on how people ground their understanding of the web in terms of physical space. In Maglio and Barrett (1997), for instance, participants did challenging web searches one day, and were required to recall their search paths a day later. In brief, they were able to correctly recall search paths if they had used a few of the websites they previously visited as anchor points, analogous to the way people use anchor points to navigate in physical space (see Couclelis, Golledge, Gale, & Tobler, 1987; Sorrows & Hirtle, 1999). Maglio and Barrett (1997) also noted that people relied on routine web search patterns (e.g., using a specific start page or search tool) to retrace routes, similar to how people rely on familiar routes in physical space (e.g., Tversky, 1993).

3. MODERN WEB TALK: NOW

In the current study, we are also interested in how people talk about web experience now, two decades later. Do we see the same metaphors? In particular, how much metaphorical motion is there now, and what does it look like? We expected to see some similarities in web talk, but we also expected to see some differences, especially given improved and expanded web capabilities and faster connectivity.

As in Maglio and Matlock (1999), participants in the current study (data collected in 2013) used the web, and then described what they had done in an interview immediately afterward. The experimenters took care not to use spatial terms in setting up the task, and all spatial terms on the browser interface were removed. A total of 16 University of California, Merced, undergraduates (6 male, 10 female) volunteered, and received extra credit in a social sciences course. All were experienced web users with native proficiency in English (5 were English-dominant bilinguals). It was impossible to find students who had never used the web. These experienced web users sat at an Apple Macintosh computer that displayed the UC Merced homepage on the Safari web browser. After using the web for 10 minutes, they were interviewed and video-recorded by an experimenter. Each participant was asked: “Tell me what you did. Try to provide as much detail as possible.” If a participant said very little, the experimenter said, “Could you elaborate on what you did?” or “Tell me what else you did.” The experimenter never used metaphorical

language. After the recorded interviews were transcribed, three authors coded and analyzed the data independently. Participants also completed a survey about web use, and in doing so, reported using the web 5 hours per day for about 9 years on average and that Yahoo!, Google, Facebook, and YouTube were their favorite websites.

Our analysis focused on motion verbs generated by participants in their interviews about web use. A total of 94% of our participants used motion verbs in the current data. Overall, there were 38 instances of motion verbs (out of 228 verbs overall). The only motion verb used was “go” (precisely, “go,” “went,” “going”). One person used “go” to search for information about Muammar Qudafi: “I pretty much went to Wikipedia to read about his history a little bit.” Here “went to,” conveyed goal-directed motion to a specific information source. Another web user used it to refer to accessing information about sports: “I went to NBA.com.” Still another person used “go” in the context of discussing fraternity websites: “Then I went to some, like, fraternity sites.” And one participant used “go” to express shifting activities: “I just went back and forth between Facebook, UC Merced, our Fraternity site, Gmail for our Fraternity, and I checked my email on Yahoo, then, uh, I went on to YouTube. . . .” Some participants also used “go” to refer to accessing social media websites. In one case, a participant said, “I went on Facebook.”

Here we see that the use of motion verbs has changed dramatically over the past two decades. Experienced web users in 1996 mixed “go” (59%) with other motion verbs, such as “surf,” “back out,” “exit,” and “leave” (41%), but in 2013 they used only “go” (100%) and no other motion verb (0%), as shown in Figure 2. A chi-square test of significance showed that this was a reliable difference, $\chi^2(1) = 28.88, p < .0001$ (Pearson’s, two-tailed).

In our analysis of the new data, we also looked at agency. We were interested in whether web users would use any passive language, such as “It brought me to . . .,” in 2013. An analysis revealed no single instance of passive motion language. All motion verbs were first person and volitional, such as “I went to the LA Times” and “I went to Yahoo!”

How did 2013 participants describe information access when they did not use “go”? In some cases, they used “look” or “find,” as in “I’m looking for intelligence in general, like species that show different levels of intelligence,” and “I tried to find something that relates to [. . .] politics.” In other cases, they used “check” or “checked out,” as in “I checked out the Mr. Olympia site.” Sometimes they talked about a series of websites they encountered, for instance, “There’s something about Netflix . . . and something about the company, and then there was an article about a flu shot.” This is consistent with what participants did in 1996 (e.g., “I looked under health and fitness” and “I found the marine lab”).

Last, only one 2013 participant used the verb “click,” and it was when there was a connectivity problem, i.e., “It took a long time to load [. . .] said it wasn’t connected to the internet [. . .] then I waited for a little bit and I clicked on one of the top things that was on there.”

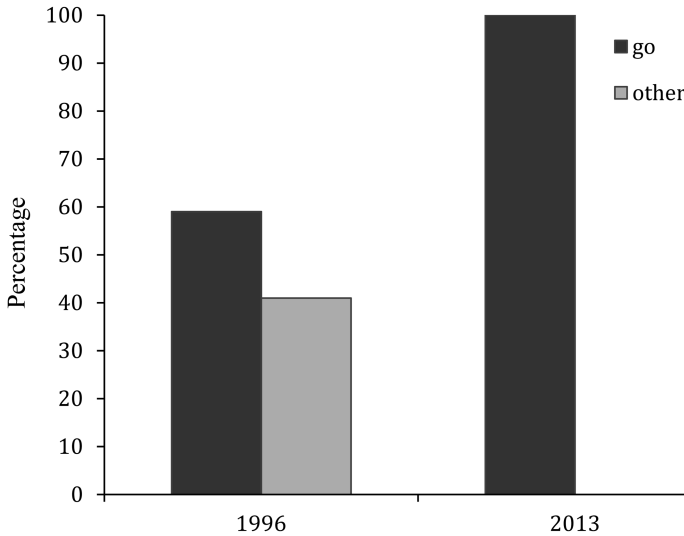


Figure 2. The use of “go” relative to other motion verbs in the mid-1990s versus 2013 (experienced web users only).

4. DISCUSSION

In Maglio and Matlock (1999), we discussed the results of the first study on how people talked about the World Wide Web. We observed that people naturally used spatial metaphors to describe web use. We noted that both experienced and inexperienced web users talked about websites as locations, and that they generated motion verbs to talk about accessing information on the web. Based on this, we argued that early web users relied on two conceptual metaphors to structure their thinking about the web, specifically, “WEB SPACE IS PHYSICAL SPACE” and “OBTAINING INFORMATION IS MOVING THROUGH PHYSICAL SPACE.” We analyzed the set of motion verbs people used to metaphorically describe information access in our old data set and compared it to what people did in the new data set. In brief, people used to use a wide range of motion verb phrases (e.g., “go,” “float,” “surf,” “back out,” “drop by”), but now they use only “go” (e.g., “went to Wikipedia,” “went to the LA Times”). Why the shift from many different motion verbs to only one? Why did “go” persist? In what follows we attempt to provide some explanations.

First, “go” is one of the most basic motion verbs in any given language (see Miller & Johnson-Laird, 1976; Talmy, 1975). It is often used to metaphorically express a state change, for instance, “Prices are going up,” “The meeting went downhill,” “It’s unclear where this story is going,” and “His emotional state is going from bad to worse.” It is also semantically

extended to express mental states and mental processing, as in “I need to go over that idea again” (see Sweetser, 1991). Critically, in none of these cases does “go” refer to physical motion (in contrast to “I used to go from work to school on foot”). It is also common for the verb “go” to semantically extend to a future tense marker via grammaticalization across languages,⁷ as in “I’m going to call you tomorrow” and “We are going to think about a new approach” in English (Bybee, Pagliuca, & Perkins 1991; Heine, Claudi, & Hünemeyer, 1991). The frequent semantic extensions of “go,” including its extension to search and browsing, mirrors a general trend: High frequency, basic vocabulary items tend to take on new meanings over time, not low frequency, specialized vocabulary (Traugott & Konig, 1991).

Second, the wide range of motion verbs used in describing web use in the 1990s may also relate to technological limitations and hit-and-miss connectivity back then. Note that web users often had to connect to the Internet via slow and unreliable dial-up modems on desktop computers in the home or at work (National Telecommunications and Information Administration, 1999). They had to use search engines, such as Altavista, that were far less robust than Google and other search engines of today. In addition, often people had to spend a good deal of time doing searches, often by typing in URLs and by clicking on multiple links to reach a bit of information, thus, motivating the use of “float” and other manner of motion verbs. With Google and other advanced search engines, immediacy is the norm. Information is just “there” and there is no need to talk about or think about how “movement” or even “search” occurs.

Third, in the 1990s there was much uncertainty around web use. Even when people were “surfing” the web, they were often unsure about where to go and how to get there. People had no clue about what did and did not exist on the web in the early days. Questions such as, “Is there a photo of Yosemite Valley?” and “How about a website that can convert inches to centimeters?” were common. Today, the web is loaded with all kinds of information, and people know how to get around. They are constantly connected to the web, and use web applications on mobile devices, such as smartphones and tablets (see StatCounter, 2014). They use Amazon, eBay, and other e-commerce sites to locate, select, and purchase clothing, furniture, groceries, and other goods. They use Facebook, LinkedIn, and social networks to connect to friends and colleagues. They use Netflix and youtube.com to watch movies, TV shows, and other streamed media. People are much better at search than they were 20 years ago.

In the current study, we also looked at whether people are still using passive language to talk about “motion” on the web. We wanted to know whether they are still using language such as, “It brought me to . . .” We

⁷Grammaticalization is a dynamic process whereby a word gradually takes on a grammatical function over time (see Heine, Claudi, & Hünemeyer, 1991; Hopper & Traugott, 2003; Traugott & Heine, 1991).

observed that no participant in our 2013 data set used passive language. This makes sense given that nowadays people constantly do searches, and rarely have to wait more than a second for each result, a stark contrast with web use in 1996, when people were less experienced, using limited search engines, and waiting much longer for results.

The role of user-interface metaphors, especially spatial metaphors, has long been a topic of debate, especially in the realms of design and learning (e.g., Carroll & Thomas, 1982; Erickson, 1990). A number of source domains could have been recruited to metaphorically structure how people think and talk about the web (e.g., newspapers as source domains, Golovchinsky & Chignell, 1997; or books as source domains, Hsu, 2005). However, they were not. Both our old and our new data show that the source domains of physical motion are natural and productive (see also Dørum & Garland, 2011). And as people's understanding of a technology changes, some elements of its original metaphoric conceptions continue to play a role in learning the environment (see Carroll & Mack, 1985). That people did not talk about clicking on icons or typing in URLs in the 2013 data (versus 1996 descriptions such as "I could just type it in, and it'll give me something I wanted" and "I was just like clicking through to see what it had") suggests that paying attention to the interface itself has disappeared. As a result, web actions seem to be seamless and unmediated (Chalmers & Andgalani, 2004). Users now have a more implicit conceptual understanding of what they are capable of accomplishing, and so no longer focus on how they interact with the interface.

When the web was new, people had to develop new ways to talk about it and think about it. Spatial metaphors were useful because they allowed people to ground their understanding of the new, amorphous network or information in terms of what was familiar and rooted in their everyday embodied experience, including experience with movement (Maglio & Matlock, 1999). Today, the web is a place that offers users speed and ease of access. People talk about it and think about it differently now. They no longer use metaphorical terms like "float" and "surf" or literal terms like "click" and "press 'Enter'" because it is no longer useful to do so. Basic spatial language like "go" has persisted because it reflects immediacy and ease of information access.

In the years to come, it will be interesting to see where web talk goes from here. Will "go" be the only motion verb used in another 20 years? Will spatial metaphor have any utility by then? Or will information access be so immediate that no spatial metaphor is needed? Until we get there, there is more work to do on spatial metaphors in web talk. One interesting line of research could entail looking at spatial metaphors in languages other than English. It is known that motion verbs such as "go" are used in web talk in French, Spanish, and a few other languages (see Meyer, Zaluski, & Mackintosh, 1997), but large-scale comparative work has yet to be done. Extending this type of research to other languages could help expand our knowledge of how spatial metaphors evolve in new domains, in this case,

a domain that has rapidly gone from a clever technological invention to a lifeline that allows us to work, educate, play, and exist across geographical, temporal, and cultural boundaries.

REFERENCES

- Armour-Polly, J. (1992). Surfing the Internet: An introduction. *Wilson Library Bulletin*, 66(10), 38–42. Available at <http://www.gutenberg.org/ebooks/49>; accessed July 9, 2014.
- Berners-Lee, T. (2000). *Weaving the Web. The original design and ultimate destiny of the World Wide Web*. New York, NY: Harper Collins Publishers, Inc.
- Blackwell, A. F. (2006). The reification of metaphor as a design tool. *ACM Transactions on Computer-Human Interaction*, 13, 490–530.
- Boroditsky, L. (2000). Metaphoric structuring: understanding time through spatial metaphors. *Cognition*, 75, 1–28.
- Bush, V. (1945). As we may think. *The Atlantic Monthly*, 176, 101–108.
- Bybee, J. L., Pagliuca, W., & Perkins, R. (1991). Back to the future. In E. Traugott & B. Heine (Eds.), *Approaches to grammaticalization, Vol. II*. (pp. 17–58). Amsterdam: John Benjamins.
- Carroll, J. M., & Mack, R. (1985). Metaphor, computing systems, and active learning. *International Journal of Man-Machine Studies*, 22, 39–57.
- Carroll, J. M., & Thomas, J. C. (1982). Metaphor and the cognitive representation of computing systems. *IEEE Transactions on Systems, Man and Cybernetics*, 12, 107–116.
- Chalmers, M., & Andgalani, A. (2004). Seamful interweaving: Heterogeneity in the theory and design of interactive systems. In *Proceedings of the 2004 ACM Symposium on Designing Interactive Systems* (pp. 243–252). Cambridge, MA: ACM Press.
- Clark, H. H. (1973). Space, time, semantics, and the child. In T. E. Moore (Ed.), *Cognitive Development and the Acquisition of Language* (pp. 27–83). New York, NY: Academic Press.
- Couclelis, H., Gollidge, R. G., Gale, N., & Tobler, W. (1987). Exploring the anchor-point hypothesis of spatial cognition. *Journal of Environmental Psychology*, 7(2), 99–122.
- Dørum, K., & Garland, K. (2011). Efficient electronic navigation: A metaphorical question? *Interacting with Computers*, 23, 129–136.
- Dunbar, K. (1999). The Scientist InVivo: How scientists think and reason in the laboratory. In L. Magnani, N. Nersessian, & P. Thagard, P. *Model-Based Reasoning in Scientific Discovery* (pp. 89–98). New York, NY: Plenum Press.
- Engelbart, D. C. (1962). Augmenting Human Intellect: A Conceptual Framework. AFOSR-3233 Summary Report, SRI Project No. 3579. Menlo Park, CA.

- Erickson, T. D. (1990). Working with interface metaphors. In B. Laurel (Ed.), *The art of human-computer interface design* (pp. 65–73). Reading, MA: Addison-Wesley.
- Evans, V. (2004). *The Structure of Time: Language, Meaning and Temporal Cognition*. Amsterdam: John Benjamins.
- Faulkner, C. (1998). *The Essence of Human-Computer Interaction*. Hemel Hempstead, UK: Prentice-Hall.
- Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M. Gattis (Ed.), *Spatial Schemas and Abstract Thought* (pp. 203–222). Cambridge, MA: MIT Press
- Gentner, D., & Gentner, D. R. (1983). Flowing waters or teeming crowds: Mental models of electricity. In D. Gentner & A. L. Stevens (Eds.), *Mental Models* (pp. 99–129). Hillsdale, NJ: Lawrence Erlbaum.
- Gibbs, R. W. (1994). *The poetics of mind: Figurative thought, language, and understanding*. New York, NY: Cambridge University Press.
- Gibbs, R. W., & Matlock, T. (2002). Looking for metaphor in all the right ways. *Teoria et historia scientiarum: An interdisciplinary journal for interdisciplinary studies*, 1, 5–25.
- Gibbs, R. W., & Matlock, T. (2008). Metaphor, imagination, and simulation: Psycholinguistic evidence. In R. Gibbs (Ed.), *Cambridge Handbook of Metaphor and Thought* (pp. 161–176). New York, NY: Cambridge University Press.
- Golovchinsky, G., & Chignell, M. H. (1997). The newspaper as an information exploration metaphor. *Information Processing & Management*, 33(5), 663–683.
- Heine, B., Claudi, U., & Hünemeyer, F. (1991). *Grammaticalization: A conceptual framework*. Chicago, IL: The University of Chicago Press.
- Hopper, P. J., & Traugott, E. C. (2003). *Grammaticalization*. Cambridge, MA: Cambridge University Press.
- Hsu, Y. C. (2005). The long-term effects of integral versus composite metaphors on experts' and novices' search behaviors. *Interacting with Computers*, 17, 367–394.
- Hsu, Y. C. (2006). The effects of metaphors on novice and expert learners' performance and mental-model development. *Interacting with Computers*, 18, 770–792.
- Johnson, M. (1987). *The body in the mind: The bodily basis of meaning, imagination, and reason*. Chicago, IL: University of Chicago Press.
- Kuhn, W. (2007). Metaphor, spatial and map. In K. K. Kemp (Ed.), *Encyclopedia of Geographic Information Science*. Sage Publications (pp. 281–284).
- Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By*. Chicago, IL: University of Chicago Press.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. New York, NY: Basic Books.

- Lakoff, G., & Núñez, R. (2000). *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics Into Being*. New York, NY: Basic Books.
- Maglio, P. P., & Barret, R. (1997). On the trail of information searchers. In *Proceedings of the Nineteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum.
- Maglio, P. P., & Matlock, T. (1998). Metaphors we surf the web by. *Proceedings of Workshop on Personalized and Social Navigation in Information Space* (pp. 1–9). Stockholm, Sweden: Swedish Institute of Computer Science.
- Maglio, P. P., & Matlock, T. (1999). The conceptual structure of information space. In A. Munro, K. Höök, & D. Benyon (Eds.), *Social Navigation of Information Space* (pp. 155–173). Berlin: Springer-Verlag.
- Matlock, T. (2012). Framing political messages with grammar and metaphor. *American Scientist*, *100*, 478–483.
- Matlock, T. (2014). Motion metaphors in political races. In M. Borkent, B. Dancygier, & J. Hinnell (Eds.), *Language and the Creative Mind* (pp. 193–201). Stanford, CA: CSLI Publications.
- Matlock, T., Holmes, K. J., Srinivasan, M., & Ramscar, M. (2011). Even abstract motion influences the understanding of time. *Metaphor & Symbol*, *26*, 260–271.
- Matlock, T., & Maglio, P. P. (1996). Apparent motion on the World Wide Web. In *Proceedings of the Eighteenth Annual Conference of the Cognitive Science Society*. Mahwah, NJ: Lawrence Erlbaum.
- Matthews, J. L., & Matlock, T. (2011). Understanding the link between spatial distance and social distance. *Social Psychology*, *42*, 185–192.
- Meyer, I., Zaluski, V., & Mackintosh, K. (1997). Metaphorical internet terms in English, French, and Spanish. In P. Fernandez & J. M. Bravo (Eds.), *Pathways of Translation Studies* (pp. 69–184). Vallodolid, Spain: Universidad de Vallaloid.
- Miller, G. A., & Johnson-Laird, P. N. (1976). *Language and Perception*. Cambridge, MA: Harvard University Press.
- National Telecommunications and Information Administration (1999). *Falling through the net: Defining the digital divide*. Retrieved on April 9, 2014, from <http://www.ntia.doc.gov/report/1999/falling-through-net-defining-digital-divide>.
- Nelson, T. H. (1965). Complex information processing: A file structure for the complex, the changing and the indeterminate. *ACM/CSC-ER Proceedings of the 1965 20th National Conference*. New York, NY: ACM Press.
- Norman, D. A. (1999). Affordance, conventions, and design. *Interactions* *6*, 38–43.
- Núñez, R. (2011). On the science of embodied cognition in the 2010s: Research questions, appropriate reductionism, and testable explanations. *Journal of the Learning Sciences*, *21*(2), 324–336.

- Pulaczewska, H. (2011). *Aspects of Metaphor in Physics*. Boston, MA: De Gruyter.
- Reisfield, G. M., & Wilson, G. R. (2004). Use of metaphor in the discourse on cancer. *Journal of Clinical Oncology*, 22, 4024–4027.
- Ryan, J. (2010). *A History of the Internet and Digital Future*. London: Reaktion Books, Ltd.
- Smith, D., Kirby, C., Kimball, R., & Harslem, E. (1982). The Star User interface: An overview, *Proceedings of the AFIPS National Computer Conference* (pp. 515–528). Houston, TX: AFIPS.
- Sorrows, M. E., & Hirtle, S. C. (1999). The nature of landmarks in real and electronic spaces. In C. Freksa & D. M. Marks (Eds.), *Spatial Information Theory: A Theoretical Basis for GIS* (pp. 37–50). Berlin: Springer-Verlag.
- StatCounter (2014). *StatCounter Global Stats*. Retrieved from <http://gs.statcounter.com/#all-comparison-ww-monthly-201303-201403>.
- Sweetser, E. E. (1991). *From Etymology to Pragmatics: Metaphorical and Cultural Aspects of Semantic Structure*. Cambridge, England: Cambridge University Press.
- Talmy, L. (1975). Semantics and syntax of motion. In J. P. Kimball (Ed.), *Syntax and Semantics 4* (pp. 181–238). New York, NY: Academic Press.
- Traugott, E. C., & Heine, B. (Eds.) 1991. *Approaches to Grammaticalization*. Amsterdam: John Benjamins.
- Traugott, E. C. & König, E. (1991). The semantics-pragmatics of grammaticalization revisited, in E. C. Traugott & B. Heine (Eds.), *Approaches to Grammaticalization* (pp. 189–218). Amsterdam: Benjamins.
- Tversky, B. (1993). Cognitive maps, cognitive collages, and spatial mental models. In A. U. Frank & I. Campari (Eds.), *Spatial Information Theory: A Theoretical Basis for GIS*. (pp. 14–24). Berlin: Springer-Verlag.
- von Braun, W. (1970, May). TV broadcast satellite. *Popular Science*, 65–66.
- Winter, B., & Matlock, T. (2013). More is up... and right: Random number generation along two axes. In Knauff, M., Pauen, M., Sebanz, N., & Wachsmuth, I. (Eds.), *Proceedings of the 35th Annual Conference of the Cognitive Science Society* (pp. 3789–3974). Austin, TX: Cognitive Science Society.