

# “America Is Like Metamucil”: Fostering Critical and Creative Thinking about Metaphor in Political Blogs

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## ABSTRACT

Blogs are becoming an increasingly important medium—socially, academically, and politically. Much research has involved analyzing blogs, but less work has considered how such analytic techniques might be incorporated into tools for blog readers. A new tool, metaViz, analyzes political blogs for potential conceptual metaphors and presents them to blog readers. This paper presents a study exploring the types of critical and creative thinking fostered by metaViz as evidenced by user comments and discussion on the system. These results indicate the effectiveness of various system features at fostering critical thinking and creativity, specifically in terms of deep, structural reasoning about metaphors and creatively extending existing metaphors. Furthermore, the results carry broader implications beyond blogs and politics about exploring alternate configurations between computation and human thought.

## Author Keywords

Metaphor, political blogs, blog readers, computational metaphor identification, critical thinking, creativity.

## ACM Classification Keywords

H5.3. Group and Organization Interfaces; K.4.m Computers and Society: Miscellaneous.

## General Terms

Human Factors

## INTRODUCTION

Political blogs have become an increasingly influential and democratizing source of news and information [9,10,27], not only due to the increase in the number of people reading blogs [23], but also due to the relationship between bloggers and larger mainstream media [9]. Thus, it is important to understand how such blogs impact not only the content but also the framing of the news. Previous research on political blogs has focused on such areas as social network analysis [1], sentiment analysis [12], and political participation [10,27]. Most such computational approaches are adept at determining *what* is being said or by *whom*, but less good at

determining *how* it is being said, i.e., the conceptual framings underlying the discussion, or the relationships between what it being said and how.

The tool described here, metaViz, provides one means of addressing this gap by identifying potential conceptual metaphors in political blogs and presenting them via an interactive visualization. It uses computational metaphor identification (CMI) to find linguistic patterns that serve as evidence for conceptual metaphors [19,21,22]. For example, saying that “candidates *fight during* an election,” that one may have “*survived* a bitter primary” only to be “*defeated in* a run off,” invokes the metaphor ELECTION IS WAR<sup>1</sup>, that is, we often conceptualize an election as if it were a war. The goal of CMI is not to state definitively *the* metaphors in a given corpus, but rather to draw certain linguistic patterns, and the metaphors they might imply, to readers’ attention in an effort to foster critical and creative thinking. Given a particular metaphor, in what ways does it fit the situation, and what aspects does it highlight? How does it not fit the situation? Furthermore, what is an alternative metaphor that might reframe the situation differently? By supporting readers in thinking about such questions, metaViz can help foster critical and creative thinking about the conceptual framings underlying political issues. Furthermore, by employing collaborative visualization techniques based on previous research [15,16,31,33,34], this work extends our understanding of how information visualizations can be used to support social data analysis [15,33].

Results from a previous study suggested that metaViz was more effective than reading blogs alone at improving users’ critical thinking about conceptual metaphors [3]. This paper builds on that work, developing a deeper understanding of that critical thinking, and associated creativity, by examining comments left by users of metaViz about the computationally identified metaphors. The results demonstrate that certain features of metaViz, particularly some of those based on previous research [16,34], were effective at fostering critical and creative thinking, as well as point to other features that may not have been as effective. Furthermore, the results not only hold important implications for research on, and the design of, collaborative visualization systems, but they also draw attention to broader concerns

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<sup>1</sup>This paper uses SMALL CAPS for metaphors, *italics* for concepts, ALL CAPS for domains, and “quotes” for quotes.

pertaining to exploring alternate configurations of human thought and computational intelligence [32].

## RELATED WORK

### Conceptual Metaphor and Computational Linguistics

The tool described in this paper draws on Lakoff and colleagues' work [19,21,22], which views metaphors not as a poetic or rhetorical device, but rather as conceptual mappings that are a fundamental aspect of human cognition. For example, when discussing finance, one might say “he *poured* money into his savings account,” “they *froze* my assets,” or “capital freely *flowed* between investors.” Lakoff and Johnson [21] argue that such linguistic patterns evidence the conceptual metaphor MONEY IS A LIQUID, i.e., that we draw in part on our experiences with physical liquids to understand the abstract concept of money. The linguistic parallels arise because the conceptual mapping “sanctions the use of source domain language and inference patterns for the target domain” [19:208]. However, metaphors are not a primarily linguistic phenomenon; rather, the linguistic patterns serve as evidence for the cognitive phenomenon.

Conceptual metaphor plays a pivotal role in many areas of human experience, and political discussions are no exception. Howe [17] describes common political metaphors that draw on the source domains of war and sports; for example, a political party can be seen as a team, with individuals *joining* the team, *captaining* the team, being *team players*, etc. Sports and war metaphors emphasize conflict, but downplay the importance of negotiation and compromise. Lakoff [20] describes how parental metaphors for government differ along ideological lines. Conservatives, he argues, use a strict-father metaphor, wherein the primary role of government is disciplinary, while progressives use a nurturing-parent metaphor, wherein government exists to protect and care for its citizens. Such differences can play an important role in how various ideologies approach the same political issue.

Furthermore, the existence of such varied metaphors leads to a key aspect of conceptual metaphor theory: many different metaphors can be used to frame the same concept, a phenomenon referred to as metaphorical pluralism. For example, a wide variety of metaphors can be used to frame the concept of *love*, such as LOVE IS A JOURNEY: “this relationship is[n't] *going anywhere*”; LOVE IS MADNESS: “I'm just *wild* about Harry”; or LOVE IS MAGIC: “she is *bewitching*” [21:44,49]. Each metaphor highlights certain aspects of the concept or situation, while downplaying others. Lakoff and Johnson argue that “successful functioning in our daily lives seems to require a constant shifting of [many] metaphors ... that are inconsistent with one another ... to comprehend details of our daily existence” [21:221]. Moreover, suggestion of an alternative, novel metaphor can provide a different conceptualization that draws out different aspects of the situation, can “cause us to try to understand how [the novel metaphor] could be true, [and] makes possible a new understanding of our lives” [21:175].

However, Lakoff's is not the only account of conceptual metaphor. While, the various approaches are too numerous to review fully here (see [14] for such a review), one line of relevant research is structure mapping theory [13], which is a theoretical account of the process of analogical reasoning. Structure mapping makes a key distinction between surface similarity, which involves featural attributes of individual entities, and structural similarity, which involves relationships among multiple entities. For example, comparing an atom to the solar system, the orbital and electromagnetic relationships between the nucleus and electrons are structurally similar to the rotational and gravitational relationships between the sun and planets. On the other hand, the round shape of the nucleus is superficially similar to the round shape of the sun. While not wholly unproblematic [13], the distinction has proven useful in studies of metaphor comprehension; structural similarities are more important than surface similarities in making valid and informative analogical inferences [14]. This distinction between surface and structural comparisons is relevant to the present work in determining how critically subjects engage with conceptual metaphors.

### Computational Approaches to Metaphor

While a significant amount of research has been done on various computational approaches to metaphor [11,24,25], most such work treats metaphor as a hurdle to overcome during text processing. The goal is generally to differentiate literal text from figurative, and then to apply special processing to that figurative text to determine its literal meaning. One exception to that trend is CorMet [26], which uses domain-specific textual corpora to extract known conceptual metaphors, for example, extracting MONEY IS LIKE A LIQUID from corpora about scientific LABs and about FINANCE. In the LAB corpus, verbs such as “pour,” “flow,” “freeze,” and “evaporate” are all associated with words for *liquid* or *fluid*. In the FINANCE corpus, these same verbs are associated with words for *money*. The technique used in metaViz draws on CorMet but extends that work in two important ways. First, CorMet was designed to extract known conventional metaphors, whereas this work involves identifying potential metaphors in relatively arbitrary corpora. Second, little work has explored using such computationally identified metaphors to promote critical and creative thinking about metaphors.

### Political Blogs and Blog Readers

While there is a growing body of work on political blogs and bloggers [1,6,9,12,27], relatively little attention has been paid to readers of political blogs. An early qualitative study of blog reading found that readers “were conscious of *why* they read blogs, [but] few were reflective of *how* they read” [2:1119], arguing that an important area for future work involves developing tools that encourage critical reflection. In a large-scale analysis of quantitative data about blog readers, Farrell, Lawrence, and Sides [10] argue that reading political blogs often leads to greater participation—in terms

of voting, campaign contributions, and attempts to persuade others to vote in a particular way—but that it also leads to greater polarization, such that readers only read blogs with ideologies similar to their own.

Importantly, relatively little research has been done on tools designed specifically for blog readers. NusEye [8] is a tool for visualizing aspects of RSS feeds, and `feedme.csail.mit.edu` enables readers of RSS feeds to share content easily and rapidly. Existing sites such as `memeorandum.com` and `etalkinghead.com` aggregate blogs. Others, such as `wonkosphere.com`, `skewz.com`, and BLEWS [12], use techniques such as textual analysis or user voting to determine the political leanings of blog posts and other news. These and other similar projects serve as excellent services to keep blog readers informed as to *what* is being said by whom. However, such tools do not generally provide as clear a picture of *how* those things are being said, i.e., what underlying or implicit conceptual framings might be at work. Furthermore, none of these studies examine the use of such tools, especially not in terms of the critical and creative thinking they can foster.

#### Previous Work on CMI

A previous experimental study comparing metaViz to blog reading suggested that metaViz is more effective at fostering critical thinking than reading blogs alone [3]. That study did not analyze comments, and did not examine the *kinds* of critical or creative thinking exhibited by users of metaViz. In a separate study, CMI improved metaphorical creativity in science education by decreasing reliance on previously instructed metaphors [4].

#### Collaborative Online Visualization

Recent work on information visualization has explored ideas related to collaborative visualization and social data analysis [15,16,33,34]. Making sense of visualizations is not a solitary process but rather a social one, involving multiple persons, discussion, and consensus building [15]. By presenting computationally identified metaphors from political blogs, metaViz presents a unique sort of common ground to which users can bring their own unique perspectives [33]. Furthermore, due to the discussions involved in social data analysis, collaborative visualizations provide a means of enhancing the opportunities for debate and deliberation provided by current online social media [10]. The design of metaViz also draws on previous research to include a number of social cues for social navigation and data analysis [16,34], as described in detail in the implementation section below.

#### IMPLEMENTATION

The metaViz implementation consists of two main components: the CMI algorithms that run offline, and the online metaViz web application.

#### Computational Metaphor Identification

This section provides a conceptual overview of computational metaphor identification (CMI), which extends on previous work [26]. For more details, see [3,4].

The crux of CMI is selectional preference learning [29], which quantifies the degree to which certain classes of nouns tend to be associated with specific verbs. For example, words for the concept of *food* are often the direct object of the verb “eat.” To identify metaphors, CMI looks for correspondences in selectional preferences between the source and target corpora. For example, in the MILITARY corpus, terms for *war* would select to be the direct object of “win,” the object of the preposition “during” with the verb “fight,” the object of the preposition “in” with the verb “defeated,” and so on. In some blog corpora, words for *election* also select for those same verbs in the same grammatical relationships. Based on the similarity of these selectional preferences, each mapping is given a confidence score to indicate how likely the linguistic patterns are to evidence a conceptual metaphor. One of CMI’s strengths is that it works in the aggregate. While individual instances of phrases such as “fought during the election” or “defeated in the primary” may not at first glance appear metaphorical, it is the systematicity of these patterns that becomes compelling evidence for the existence of a metaphor.

#### metaViz

MetaViz presents the results of the above algorithm in a readily accessible, visual, interactive fashion to foster critical and creative thinking about those potential metaphors. This section describes the design process behind the interface, and illustrates the features of metaViz through a usage scenario. It also notes how the interface design incorporates results and principles from previous research. For more technical implementation details, see [3].

#### Design Process

The project team initially intended to use existing visualization tools, such as ManyEyes or Prefuse. However, the traditional visualization methods provided by most toolkits proved not particularly apt for the data at hand. Using pencil-and-paper sketches, Flash mock-ups, and early prototypes, and less traditional designs were demonstrated to members of the authors’ research group, researchers from other groups, various administrative staff, press relations, a pilot study group of political blog readers, and other individuals to ensure that the design was comprehensible by a wide range of people, as well as afforded a user experience amenable to critical and creative thinking.

#### Usage Scenario

Suppose Devon, an avid reader of political blogs, is interested in digging a little deeper into the content on some of those blogs. When she first opens metaViz, she sees a list of analyzed blogs (Figure 1, left side). Devon is directed to choose one or more corpora, as well as a source domain for each from which to see potential metaphors. Some domains available in metaViz, such as MILITARY and SPORTS, were informed by previous work on political metaphors [17], while others, such as SCIENCE and FOOD & DRINK, were suggested by pilot study users.

Devon selects three corpora and chooses a source domain from which to see metaphors for each: MILITARY metaphors in Power Line, SPORTS metaphors in Donklephant, and SCIENCE metaphors in the aggregated Republican blogs. Potential metaphors for each corpus-domain pair are displayed in a separate column (Figure 1, colored central columns). As per the “overview first, zoom and filter, then details on demand” mantra [31], Devon first sees all metaphors in each corpus-domain pair. Metaphors are depicted as data clouds, grouped by the target concept they frame. Target concepts are listed in order of their strongest metaphor. For example, in the green (middle-left) column in Figure 1, Devon sees that the metaphor AN ELECTION IS LIKE A BATTLE is the single strongest metaphor from the MILITARY domain in the blog Power Line, so metaphors for *election* are listed first. The wording “is like” is used rather than “is” to aid in the comprehension of these potentially novel metaphors [5]. The metaphor cloud design also aligns with the notion of metaphorical pluralism [21], encouraging Devon to consider how each metaphor might variously fit or not fit the concept it frames.

Looking at the SCIENCE metaphors in the Republican blogs, she can see *that* A CANDIDATE IS LIKE A THEORY. Interested in *why* a candidate might be like a theory, Devon clicks on the source term (i.e., “theory”). In the bottom pane (in Figure 1), she then sees parallel example phrases from the target and source corpora, paired up based on the verb-case slots mediating the mapping. For example, she sees that the aggregated Republican blogs talk about how “Obama is tested” similar to how, in science, a “theory is tested.” Initially, she is skeptical; only the single most relevant fragment for each verb-case slot is displayed. When she clicks the nearby arrow, the list expands to show many more examples. Each example links back to the corpus from which it came, thereby allowing the her to see the metaphor in context. Devon now sees that these fragments do form a pattern, that these blogs really are, in some ways, talking about the candidates as if each is a scientific theory; they are each variously supported, argued for or against, and eventually proven in an election.

Wanting to share her newfound insight, Devon notices the comments section (Figure 1, right column). Following the results of Danis et al. [7], the initial design of metaViz did

not include a comment feature, instead providing the ability to link directly to the current state of the visualization. However, such an approach dissociated metaViz from the “online social environment” [33:549] of which it is a part. Our pilot study made it clear that some sort of social scaffolding was necessary to facilitate critical and creative thinking; as one pilot study participant put it, “Sure, I see this metaphor here and it kind of makes sense. Now what?”

To address this gap, a discussion feature was added, allowing users to leave comments. The number of comments made about a given corpus is shown in a speech bubble next to the corpus name (Figure 1, left column), and the number of comments about each domain is shown in the domain selection drop down. These comment counts “embed social navigation cues in the visualization” itself [16:1037] and, in information foraging terms, provide a “social information scent” [34] indicating areas that were of interest to others.

In the comments, Devon sees not only thoughts and insights about the specific metaphor she is currently viewing, but rather comments about all metaphors from these corpus-domain pairs. This scoping follows Heer et al.’s suggestion to “show commentary related, though not directly attached to, the current view,” thereby alleviating the need “to navigate to a precise location to see related comments” [16:1037]. Thus, Devon can notice comments about the metaphor A VOTE IS LIKE A GAME in Donklephant. She makes a mental note to look at that metaphor later and continues to read comments about A CANDIDATE IS LIKE A THEORY. One points out that the metaphor “really highlights that you don’t know what you’re getting.”<sup>2</sup> Believing that this previous comment has missed some of the metaphor’s nuance, Devon suggests, “doesn’t it mean that you think you know what you are getting but won’t actually know for a fact until the candidate is in office?” Not only can the computationally identified metaphors help provide novel perspectives on familiar concepts, but the processes of commenting, collaborative sensemaking [15], and social data analysis [33] can help encourage and support critical and creative thinking.

**EVALUATION**

In general, we seek to understand how computational techniques such as CMI can be leveraged to foster critical thinking and creativity. In a previous study comparing metaViz to regular blog reading, users of metaViz demonstrated improved critical thinking over those subjects who only read blogs [3]. This paper examines comments left on metaViz to understand better the *types* of critical and creative thinking fostered. Specifically, we focus on critical thinking—evidenced by critical, structural [cf. 13] engagement with metaphors—and creativity—the ways in which comments extend on, and create new, metaphors—as well as the ways in which specific features of metaViz did or did not effectively foster critical and creative thinking.

<sup>2</sup>While the specifics of the usage scenario are fabricated, these quotes are from actual user comments on metaViz.

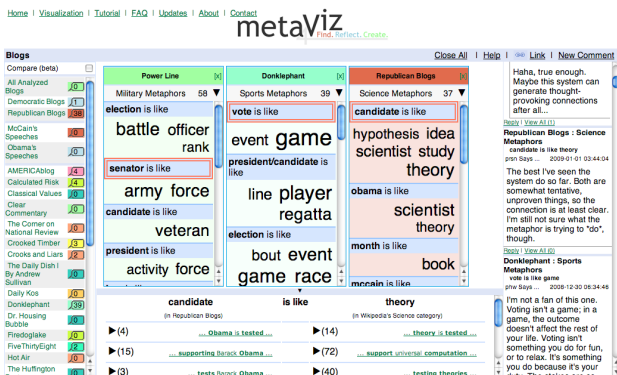


Figure 1: metaViz interface; see Usage Scenario for details.

**Methods**

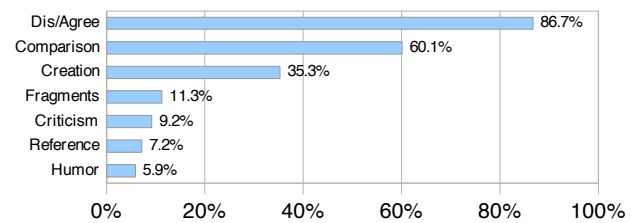
The comments analyzed here were collected by enrolling study participants through Amazon’s Mechanical Turk service [cf. 18]. Participants were paid \$0.50 to leave two comments on metaViz, one that either agreed or disagreed with some identified metaphor, and one that either agreed or disagreed with another comment. While some chose to leave more comments, all participants received the same compensation. Participants were also asked how often they read political blogs and which blogs they read. There were two distinct comment collection periods. The first was a week and a half long period during December 2008; these comments were collected as part of a previous study [3]. The second was during a five week period from July through August 2009; during this time, the CMI algorithm was run once a week to update the system with new metaphors, and at the same time a new task was launched on Mechanical Turk. As in [16], there was little variation in comments collected during the two collection periods, so this analysis aggregates data from all comments collected.

In order to understand better the critical and creative thinking fostered by metaViz, we conducted a content analysis of the comments. A coding schema was developed based on previous literature, on specific research questions about impacts of system features, and on iterative readings and discussion of the data among the authors. *Agreement*: whether the comment agrees with a particular metaphor, disagrees, or both agrees and disagrees. *Comparisons*: if the comment compares the source and target, whether it focuses on surface featural aspects, underlying structural relations, or some other comparison [cf. 13]; e.g., for ELECTION IS LIKE BATTLE, a comment noting a similar “conflict between differing views or differing forces” shows a structural comparison, whereas for OBAMA IS LIKE BASEBALL, a comment stating that “Obama is just as popular in the US as baseball” shows a surface comparison. *Creation*: if the comment makes new metaphorical mappings, whether it elaborates an identified metaphor, extends an identified metaphor, or generates a new metaphor (described further below [cf. 22]); this code helps assess metaphorical creativity. *Fragments*: the comment mentions the example fragments in the bottom pane (see Figure 1); this code helps determine the importance of example sentence fragments. *Reference*: if the comment refers to linked content, whether it refers to a blog, to Wikipedia, or to some content without being specific (e.g., “the article” could be a blog post or a Wikipedia article); this code helps determine the impact of the links from example sentence fragments. *Criticism*: the comment provides a criticism of metaViz (not of a specific metaphor, but of the system in general); this code is based on patterns evident in iterative readings of the data. *Reply*: whether the comment initiates a new thread, agrees with a previous comment, disagrees with a previous comment, or both agrees and disagrees. *Humor*: comment makes a joke or humorous remark; this code was informed partly by the data and partly by previous work [16]. Inter-rater reliability was established on all codes using Cohen’s  $\kappa \geq 0.75$ .

**Results**

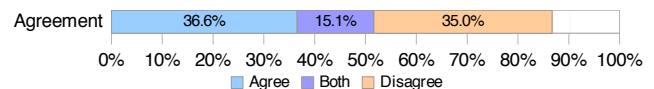
This evaluation demonstrates the ways in which metaViz fostered critical and creative thinking about metaphors. After providing an overview of the data, this section examines patterns of critical thinking about metaphors and of metaphorical creativity in order to understand both how various features impacted critical and creative thinking as well as their relationships to other aspects of the data.

After removing duplicate, empty, and nonsensical comments, there were 391 comments in 264 threads from 168 distinct users. Average time-on-task was 13 minutes (median 10.6, std. dev. 9.8), suggesting that most users completed the task as requested. Of our participants, 82.3% regularly read at least one political blog. Thus, while not all were avid blog readers, most participants were among metaViz’s intended user base. Figure 2 provides an overview of the comment content analysis. For those codes with multiple values, this figure shows how many received any value of the code; e.g., 86.7% responses explicitly stated agreement or disagreement with a given metaphor. This overview suggests at least two important insights that are explored further below: the majority (60.1%) of comments engage with the metaphor by comparing the source and target, and over one-third (35.3%) involve metaphorical creativity.



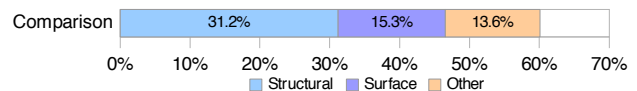
**Figure 2: Overview of codes applied to comments.**

Figure 3 depicts a breakdown of the agreement with identified metaphors in the comments, showing a nearly even split between agreement and disagreement.



**Figure 3: Agreement rates; nearly the same number of comments agreed with the metaphors as disagreed with them.**

Figure 4 shows the types of comparisons used. Over half those comments explicitly compare the target and source concepts used structural reasoning [cf. 13], demonstrating a deep engagement with the metaphors.



**Figure 4: Comparison types; most comments used structural reasoning to compare target and source concepts.**

*Critical Thinking about Metaphors*

As described above, critical thinking about a metaphor hinges on engaging with its structural, relational aspects

rather than the surface, featural aspects [13]. Thus, our analysis here focuses on this structural reasoning in the comments on metaViz. Specifically, we examine how example fragments with their linked content and threaded commenting supported structural reasoning, as well as its relationship with agreement.

Table 1 shows results from a series of  $\chi^2$  or Fisher’s tests examining the interaction of example fragments, references to linked content, or occurrence of either, with type of comparison. There was a significant interaction between mention of example fragments and type of comparison used.

	Fragments	Reference	Frag/Ref
Comparison	0.032 *	0.360	0.024 *

**Table 1: Interactions with comparison type; p-values from  $\chi^2$  tests or, for small counts, Fisher's exact test. Either citing example fragments or referring to linked content was significantly related to type of comparison.**

Table 2 shows the nature of this interaction. We see that these features, which were intended to help foster critical (here, structural) thinking, were associated to some extent with structural comparisons, but also with an increase in other types of comparisons. Anecdotally, many such instances involved comparing the words in the example fragments; e.g., one comment on MARRIAGE IS LIKE BELIEF said, “I don’t think this is the way that the author is talking about ‘practising’ - they mean it as... to get better and better, rather than to practise as in the way you practise your faith.” Although such comments might demonstrate a type of critical thinking about language or technology, it is not the critical thinking about metaphors metaViz is designed to foster.

	Structural	Surface	Other
Frag/Ref	10 (40%)	4 (16%)	11 (44%)
None	112 (53.3%)	56 (26.7%)	42 (20%)

**Table 2: Comments citing example fragments or referring to linked content more often used "other" comparisons.**

If the fragments and linked content did not help foster critical thinking, were they effective at convincing participants of the metaphor’s existence or accuracy? Indeed there was again a highly significant interaction between agreement and fragments or references ( $\chi^2$ ,  $p < 0.001$ ), depicted in Table 3. We see that those comments citing example fragments or referring to linked content were far more likely to disagree with the metaphor, again, not the intended effect of these features. The possible causes and potential implications of these results are considered in the discussion section below.

	Agree	Disagree	Both
Frag/Ref	9 (14.8%)	41 (67.2%)	11 (18.0%)
None	134 (48.2%)	96 (34.5%)	48 (17.3%)

**Table 3: Comments citing example fragments or referring to linked content more often disagreed with the metaphors.**

The other main feature of metaViz intended to help foster critical thinking was commenting. Specifically, we wanted to understand how aspects of initial comments impacted critical thinking in replies to that comment. A  $\chi^2$  test shows that whether an initial comment agrees with a metaphor impacts whether replies agree, and similarly with the type of comparison made (both  $p < 0.001$ ). In Table 4, we see that the initial comment’s agreement with the metaphor is predictive of the replies’ agreement, except that when the initial comment both agrees and disagrees, the replies are more evenly split, with a slightly larger portion disagreeing.

	Agree	Disagree	Both
Agree	31 (72.1%)	4 (10.0%)	6 (27.3%)
Disagree	7 (16.3%)	26 (65.0%)	9 (41.0%)
Both	5 (11.6%)	10 (16.7%)	7 (31.8%)

**Table 4: An initial comment’s agreement (top) is highly predictive of replies’ agreement (side).**

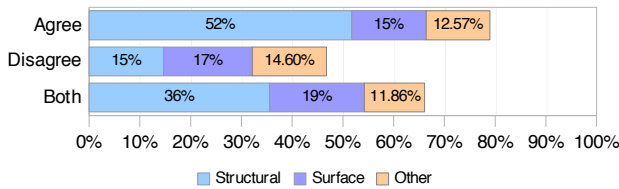
Similarly, Table 5 shows that the comparison used in an initial comment is highly predictive of replies’ comparisons, except that initial comments focusing on surface features had replies split between surface features and structural relations. For example, one comment on AN ELECTION IS LIKE A BATTLE noted that both cost large amounts of money, a surface feature. Two replies then mentioned that both involve opposing forces and “a figurehead at the top directing [the] troops,” which are structural similarities.

	Structural	Surface	Other
Structural	21 (70.0%)	10 (43.5%)	1 (16.7%)
Surface	6 (10.0%)	11 (47.8%)	0 (0.0%)
Other	3 (5.0%)	2 (8.7%)	5 (83.3%)

**Table 5: Type of comparison in an initial comment (top) is predictive of replies’ type of comparison (side).**

In other instances, comments helped make clear metaphors that might have otherwise been confusing. One comment on a candidate is like a theory pointed out that “we don’t know the realities of a candidate before they take office, only their theoretical actions,” to which another comment replied, “I hadn’t thought about the metaphor this way until I read your comment. I like [your thoughts] on... how the metaphor could fit if it was applied this way.” These results speak to the commenting feature’s support for social data analysis [15,33] and critical thinking about metaphors.

Figure 5 shows the significant interaction ( $\chi^2$ ,  $p < 0.001$ ) between agreement and comparison type. We see that those comments either agreeing or both agreeing and disagreeing were more likely to use structural reasoning, and that those only disagreeing more likely used surface reasoning.



**Figure 5: Agreement vs. comparison; comments agreeing with the metaphor more often used structural comparison.**

This result carries interesting implications for what counts as critical thinking. We might naively assume that disagreement with a metaphor likely evidences more critical thinking about that metaphor. However, these results suggest that, for the computationally identified metaphors, those subjects who agreed evidenced more critical thinking.

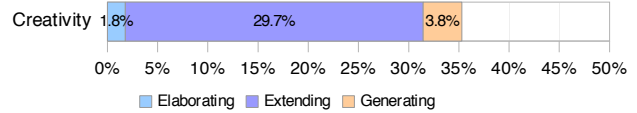
In summary, two main features of metaViz were designed specifically around fostering critical thinking: the example fragments and the threaded comments. These results suggest that, while the example fragments were not strongly associated with critical thinking, the comment feature was effective at supporting critical thinking. Possible causes and implications are considered below in the discussion section.

*Metaphorical Creativity*

The goal of metaViz is not only to encourage users to consider what any given metaphor both highlights and hides, but also to generate new metaphors that might frame the situation differently. Drawing on [22], we analyze three primary categories of metaphorical creation: elaborating, extending, and generating. First, elaborating involves supplying more detail by filling in a general concept in a metaphor with a specific instance. For example, one comment on VOTING IS LIKE A GAME suggested that “with all of the ‘extra’ voting going on these days, voting is like a game of chance,” elaborating the metaphor by supplying details from a specific type of game. Second, extending invokes other aspects implied by, but not directly stated in, the metaphor. For example, agreeing with A CANDIDATE IS LIKE A THEORY, one user pointed out that “A candidate is a proposition, something that is not yet for certain, something you still need to test, something that some people support, and something that one day might become a reality.” Third, generating involves suggesting an alternate metaphor entirely. For example, one comment disagreed with A SENATOR IS LIKE AN ARMY, suggesting instead that a senator “is a General [who] DIRECTS [sic] an ‘army’ of campaign workers.” While not all of these categories involve the creation of entirely new metaphors, they all involve creating new metaphorical mappings in some way. This

section explores the relationships of metaphorical creativity to features of metaViz and to critical thinking.

Figure 6 shows a breakdown of the types of metaphorical creativity, showing that the large majority of creative responses extended the metaphor. We also want to understand the interactions between creativity and other aspects of the comments. Since there were only seven instances of elaborating, the following analyses focus on extending and generating so as to avoid small count data.



**Figure 6: Types of metaphorical creativity; extending the metaphor was most common.**

Table 6 shows the significant interaction between comparison type and metaphorical creativity (Fisher’s,  $p < 0.001$ ). Specifically, those comments using structural comparisons (i.e., critical thinking) were far more likely to be extending the metaphor. For example, one comment used structural reasoning to extend OBAMA IS LIKE A SCIENTIST: “he has a theory on how things should be run, he’s done is [sic] outside research, and now its [sic] time to test his experiment.” This result shows a strong connection between critical and creative thinking about metaphors.

	Structural	Surface	Other
None	35 (28.7%)	32 (57.1%)	42 (82.4%)
Extending	82 (67.2%)	21 (37.5%)	7 (13.7%)
Generating	5 (4.1%)	3 (5.4%)	2 (3.9%)

**Table 6: Interaction of comparison and creativity; structural comparisons were associated with extending metaphors.**

The results in Table 2 above showed that example sentence fragments and linked content did not effectively support critical thinking. Similarly, Table 7 shows that those comments that did *not* cite example fragments or refer to linked content were more likely to extend the metaphor or generate novel metaphors. Again, possible explanations and implications are taken up in the discussion section below.

	Frag/Ref	None
None	60 (92.3%)	193 (60.5%)
Extending	4 (6.2%)	112 (35.1%)
Generating	1 (1.5%)	14 (4.4%)

**Table 7: Citing example fragments or linked content was associated with decreased creativity.**

We now examine how the commenting feature helped support metaphorical creativity by considering relationships between initial comments and replies. Table 8 shows that the type of creativity in the initial comment is predictive of creativity in the replies (Fisher’s,  $p < 0.001$ ).

	None	Extending	Generating
None	63 (79.7%)	23 (50%)	3 (37.5%)
Extending	13 (16.5%)	22 (47.8%)	2 (25%)
Generating	3 (3.8%)	1 (2.2%)	3 (37.5%)

**Table 8: Metaphorical creativity in an initial comment (top) is predictive of creativity in replies (side).**

Further supporting the relationship between critical and creative thinking, Table 9 shows that initial comments using structural comparisons were more associated with extending the metaphor (Fisher’s,  $p=0.0068$ ). This resonates with the result that structural comparisons were generally associated with extending the metaphor (Table 7).

	Structural	Surface	Other
None	20 (44.4%)	26 (72.2%)	13 (86.7%)
Extending	22 (48.9%)	9 (25%)	1 (6.7%)
Generating	3 (6.7%)	1 (2.8%)	1 (6.7%)

**Table 9: Structural comparisons in initial comments were associated with replies extending the metaphor.**

These results suggest that attributes of the initial comment strongly influence those of replies. In one example, a comment disagreed with AMERICA IS LIKE MILK, saying that “I do not think that America is very much like milk at all. Milk is thick, smooth, and sweet, while America is rather...gritty. America is like Metamucil.” Metamucil is a fiber supplement that, when dissolved in water, makes a somewhat gritty concoction. Replies picked up on this theme, including one noting that “America very rarely gives you your daily recommended fiber, so, perhaps America is just muddy water?” Another reply agreed with the original metaphor, that “America is like milk in the sense that new immigrants tend to get homogenized.” Each reply considered different aspects of the new metaphor and exhibited slightly different forms of creativity.

In conclusion, these results show that the threaded commenting feature of metaViz effectively supported critical thinking and creativity, that the example sentence fragments and linked content were not as effective, and that critical thinking about metaphors and metaphorical creativity were related.

**DISCUSSION AND IMPLICATIONS**

This section compares these results with previous work, discusses both potential causes of and some limitations of the results, and considers broader implications.

Previous work on collaborative visualization found that commenting and discussion was an important component of social data analysis [7,16] and suggested that a “social information scent” [34] could help facilitate such discussion. MetaViz follows up on implications from this

previous work, and the results show that such features can facilitate critical and creative thinking about metaphors.

However, while clearly important, it is not entirely obvious the exact role that comments played. Wattenberg and Kriss suggest that “an information visualization tool may be fruitfully viewed... as part of an online social environment” [33:549]. Is it crucial that a user interact with or even read others’ comments, or is the mere presence of comments enough to encourage the sense of a social environment?

The example fragments and linked content were also meant to facilitate critical and creative thinking, by connecting the computationally identified metaphors to their context of use. However, comments mentioning fragments or linked content rarely exhibited structural engagement with the metaphors or metaphorical creativity, and more often disagreed with the metaphors. It may be that those people who agreed with the metaphor did not dwell on the example fragments but rather focused on the metaphor itself and its implications. Alternatively, it may be that the automatically identified sentence fragments are not always convincing evidence for the potential metaphor. Such a conclusion might imply that, for the goal of supporting critical and creativity thinking, showing a user constituent portions of the data behind the computational analysis may not be as effective as showing her the results of the analysis alone.

Using Mechanical Turk workers as subjects also limited the types of uses evaluated. This method prevents studying commenting patterns of repeat or long-term users, as well as how collaborative features would be used in natural settings. As described below, future work should explore use of metaViz and similar systems “in the wild.”

These results also lead to questions of whether or not metaViz “works” and what such a claim might mean. The number of comments critiquing the system, as well as the number disagreeing with metaphors and the associated between disagreement and the example fragments, suggest that the system might not be terribly effective at identifying metaphors, or at least at filtering spurious results. Given the novelty of CMI, this is entirely possible; a number of technical improvements are possible. However, even seemingly spurious results were at times able to encourage critical and creative thinking. For example, the discussion excerpted above about AMERICA IS LIKE MILK led to some quite novel metaphor generation. Such concerns could apply equally to any sort of tool that includes computational analysis in support of human activity. Here, we claim that, while there are areas for potential improvement, metaViz does effectively foster critical and creative thinking. We are not suggesting that the quality of the computational analysis is unimportant. Rather, we suggest that such analyses may also be fruitfully evaluated in terms of their capacity as a resource for interpretation [cf. 30].



## FUTURE WORK

The results presented above demonstrate that metaViz was effective at fostering critical and creative thinking about metaphors, but they cannot indicate exactly which features were most effective toward that end. Future studies should be done, both with metaViz and with similar systems, to ascertain which features are associated with which results for what populations. For example, removing the example fragments would enable determining their impact on various aspects of critical and creative thinking. Similarly, preventing comments from being shown to other users could help determining the importance of being able to read others' comments. Future studies should also compare results from readers and non-readers of political blogs. In terms of examining CMI itself, one could conduct a similar study using metaphors identified by trained linguists or generated by random to determine if the computational technique is more or less effective than alternative methods.

MetaViz and similar tools should also be evaluated through long-term, *in situ* studies with established communities of blog readers. How does metaViz usage impact, interact with, influence, get influenced by previous blog reading behavior? Does metaViz integrate with existing blog reading practices or is it seen as a separate activity? How might metaViz or similar computational tools enable new types of reading across multiple blogs? Such studies could address limitations of using subjects from Mechanical Turk.

Future work should also explore how these results and implications can be applied to foster critical and creative thinking in a variety of other contexts, e.g., education [4].

## CONCLUSION

This paper describes a study of metaViz, a tool that identifies potential metaphors in political blogs. The evaluation presented here examines user comments left on metaViz, demonstrating the system's effectiveness at fostering critical and creative thinking about conceptual metaphors. In addition to specific implications for design and future work, this research represents a new direction in two important ways.

First, this is one of the first studies in the emerging field of blog readers [2] to study a tool for readers of blogs. Many novel computational techniques have been applied to online social media [1,8,12], but few have been incorporated into tools for users, especially readers, of these media. Not only are blog readers an important research area, but similar studies should also be conducted to explore readership in other social media, such as Flickr, YouTube, or Twitter.

Second, while metaViz incorporates techniques from machine learning, computational linguistics, and other branches of artificial intelligence, this work represents an inversion of such approaches. Traditionally, AI research considers the question, "Can people make computers think?" That is, can a computer be made to do something

that, if done by a human, we might call intelligent [28,32]. The work described here turns that question on its head, asking instead, "Can computers make people think?" That is, can we develop computational systems or devices that encourage people to approach familiar concepts or situations from different, novel perspectives? In this way, metaViz aligns with a broader interest in understanding the relationship between human and machine intelligence [32]. This paper focuses specifically on metaphor, i.e., using computational metaphor identification to foster critical and creative thinking about conceptual metaphors in political blogs. However, we argue that this sensibility could be beneficially applied in a number of other contexts, enabling us to explore alternative configurations of the relationship between computation and human thought.

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