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RESEARCH ARTICLE

SOCIAL MEDIA AFFORDANCES FOR CONNECTIVE ACTION: AN EXAMINATION OF MICROBLOGGING USE DURING THE GULF OF MEXICO OIL SPILL[1]

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This research questions how social media use affords new forms of organizing and collective engagement. The concept of connective action has been introduced to characterize such new forms of collective engagement in which actors coproduce and circulate content based upon an issue of mutual interest. Yet, how the use of social media actually affords connective action still needed to be investigated.

Mixed methods analyses of microblogging use during the Gulf of Mexico oil spill bring insights onto this question and reveal in particular how multiple actors enacted emerging and interdependent roles with their distinct patterns of feature use. The findings allow us to elaborate upon the concept of connective affordances as collective level affordances actualized by actors in team interdependent roles. Connective affordances extend research on affordances as a relational concept by considering not only the relationships between technology and users but also the interdependence type among users and the effects of this interdependence onto what users can do with the technology. This study contributes to research on social media use by paying close attention to how distinct patterns of feature use enact emerging roles. Adding to IS scholarship on the collective use of technology, it considers how the patterns of feature use for emerging groups of actors are intricately and mutually related to each other.

Keywords: Connective affordances, microblogging, interdependence, roles, mixed methods, sustainability, collective use, new forms of collective engagement

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Introduction

Deepwater Horizon, an oil and gas prospect that exploded in April 2010 in the Gulf of Mexico, caused fatalities and extensive environmental damage. The crisis made headlines, stayed in the general consciousness for months and triggered multiple efforts to repair the harm and prevent future such accidents (Casey 2011; Hoffman and Jennings 2011). Notably, the oil spill was, according to statistics released by the microblogging platform Twitter,[2] the most microblogged topic of 2010. Through microblogging, anyone could publicly post short elements of content at low technical or financial cost (Grace et al. 2010; Jansen et al. 2009). Any user of the platform could use microblogging to take a public stance on the oil spill or organize responses to it, among other things (Merry 2013). Such intense use of microblogging at the occasion of the oil spill intriguingly calls into question how the use of microblogging and, generally, of social media facilitates the emergence of new forms of collective endeavors and processes.

Social media are technologies that allow for user-generated content, making it possible for users to develop, circulate, share, and comment upon various types of content (Kietzmann et al. 2011; O'Reilly 2007). Information Systems (IS) research has started to examine what happens in new, social media-enabled, processes (e.g., Nan and Lu 2014; Oh et al. 2013). In these new phenomena, actors take on informal roles, build emergent and organic relationships, and rely heavily upon electronically mediated communications (Ghobadi and Clegg 2015; Harlow and Guo 2014). These new forms of organizing and collective engagement enabled by social media use thus bear some kinship with but are not identical to traditional forms of collective action (Olson 1965). To characterize them, the concept of connective action has been proposed (Bennett and Segerberg 2012, 2013; Lim 2013). Connective action refers to new forms of collective engagement whereby multiple actors come together spontaneously and informally, even if they do not all equally identify with a common cause, and engage in coparticipation and coproduction of content with the use of social media (Bennett and Segerberg, 2012, 2013).

However, we still know precious little about how the use of social media affords these new forms of collective engagement that have been encapsulated under the label of connective action. This is an important issue for IS research because it requires us to extend existing theory and contexts of investigations and, doing so, to address critical gaps in the discipline. With regard to extending theory, the affordance perspective, which accounts for the action potentials of technology by taking into consideration its features in relation to users' perceptions and needs (Faraj and Azad 2012; Leonardi 2011), is particularly relevant. However, it has so far tended to focus on the individual or intra-organizational levels (Fayard and Weeks 2007; Strong et al. 2014) but not yet on broader levels. Examining the affordances of technologies such as social media, characterized by their openness and user-friendliness (boyd and Ellison 2008; Vaast et al. 2013), and their potential impacts onto connective action thus requires researchers to deal with calls for theorizing the affordances of technologies at meso levels (see Leonardi 2013; Volkoff and Strong 2013).

With regard to extending the contexts of investigations, social media allow for actors' interdependence to take place beyond established organizational and hierarchical role structures (Lim 2013; Stohl 2014; Zimbra et al. 2010). Examining how this happens thus involves responding to calls for IS research to engage with a greater variety of collective phenomena than traditional organization-based ones (see Kane et al. 2014; Majchrzak et al. 2016; Wattal et al. 2010). Such investigations are particularly needed to help understand and conceptualize how social media use affords emerging roles and interdependence of actors in situations triggered by crises such as the Gulf of Mexico oil spill.

All in all, then, there is need for a consideration of how social media use is associated with connective action. The aim of this paper is to examine this issue by focusing on the following research question: How does social media use afford connective action?

Tackling this question, this study contributes to IS research first by introducing and elaborating upon the concept of connective affordances as collective level affordances actualized by actors in interdependent emerging roles. The conceptualization of connective affordances extends the perspective on affordances as a relational concept (see Faraj and Azad, 2012; Orlikowski and Scott 2008). It allows us to pay attention not only to the relationships between technology features and users but also to the interdependence type (Thompson 1967; Van de Ven et al. 1976) among these users and the potential effects of this interdependence onto what users can (or cannot) do with the technology. Moreover, this study adds to IS research on social media a consideration of their use for new forms of organizing and collective engagement and a precise examination of how differentiated patterns of feature use reveal distinct roles. This research elaborates upon IS scholarship on collective use (Burton Jones and Gallivan 2007; Lapointe and Rivard 2005) by considering the interdependent effects of the use of technology whereby the pattern of feature use for one group of actors is intricately and mutually related

[2]http://blog.Twitter.com/2010/12/hindsight2010-top-trends-on-Twitter.html

to the patterns of feature use for other groups. This study finally adds an IS perspective to recent scholarship on connective action by providing a theoretically elaborated and empirically grounded approach of how the use of social media affords such new forms of collective engagement.

In what follows, we present the theoretical underpinnings of this work based on social media, affordances, as well as emerging roles and interdependence in connective action. We then detail the empirical context of this research, the use of the microblogging application Twitter at the height of the Gulf of Mexico oil spill, and the mixed-methods grounded analyses that we carried out. The findings elaborate upon the emerging roles of actors engaged in connective action episodes and characterize the interdependence among these roles. We discuss the meaning of these findings, introduce the concept of connective affordances to clarify how social media use affords connective action, and draw implications of this study for research and practice.

Affordances of Social Media and Connective Action

This section presents the theoretical underpinnings of this research on social media and their affordances, interdependence, and connective action. Existing scholarship allows us to lay out an initial theorizing of how actors engage in new forms of collective engagement as social media afford them to interdependently enact emerging roles in connective action.

Social Media

Social media are web-based technologies that make it possible for all users to create, circulate, and share multiple types of content (Kaplan and Haenlein 2010; Kietzmann et al. 2011). There have been various kinds of social media technologies (e.g., video-sharing sites, social networking sites, blogs, and microblogs; Kietzmann et al. 2011; Koch et al. 2013; Vaast et al. 2013).

Much social media scholarship in IS has focused upon how social media is used within organizations, especially by individual employees or work groups (Treem and Leonardi 2012; Vaast and Kaganer 2013). This scholarship has examined at length the implications of social media use within organizations for knowledge sharing (Leonardi 2014), communication (Huang et al. 2015), and collaboration (Gibbs et al. 2014), in particular. It has started to investigate how organizational processes and functions may get transformed with the use of social media (Ali-Hassan et al. 2015; Aral et al. 2013; Schmidt et al. 2016). Of note, however, in much of this scholarship, the users of social media applications are employees who use social media as part of their formal roles in the organization (Leonardi and Vaast 2017).

There has so far been comparably less research on the use of social media and the emergence of new ways of organizing or new phenomena associated with social media use. Yet, seminal research has started to investigate how the relationships among different types of actors may be transformed (Orlikowski and Scott 2014), how new actor categories or roles may emerge (Vaast et al. 2013), or how existing or new collective processes may be enabled (Kallinikos and Tempini 2014; Oh et al. 2013) by the availability and use of social media. More research on how social media use is associated with processes of collective engagement and organizing that do not primarily involve formal organizations as focal coordination mechanisms is thus welcome.

Such research could in particular pay close attention to how different users of social media applications precisely rely upon their features. A close examination of feature use would be useful because it would help address gaps in IS research on technology use (as noted in Burton-Jones and Straub 2006; Markus and Silver 2008) in general and on social media use in particular (Treem and Leonardi 2012). It would also be particularly helpful to unearth how different users may take on emerging roles in connective action when using social media.

This research empirically deals specifically with microblogging. Microblogging "allow[s] users to exchange small elements of content such as short sentences, individual images, or video links" (Kaplan and Haenlein 2011, p. 106). Twitter (www.Twitter.com) has been a popular microblogging platform in the Western world with about 310 million active users as of May 2016.[3] Twitter allows its users to broadcast freely news, create and circulate content, as well as share opinions and links to other webpages. Among the defining features of microblogging is that it only allows for the exchange of extremely short messages or posts (the "tweets"). In Twitter, for instance, posts are limited to 140 characters in length. Users can follow one another on the basis of shared interests by using built-in search and follow functionality. Furthermore, content produced through microblogging can be organized as microbloggers (in Twitter, the "tweeters") assign tags to their posts. In the case of Twitter, in particular, tweeters can attach various "hashtags" ("#") that can help

[3]http://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/

users search for microblog posts on specific topics. Moreover, posts can be directed as their authors can specify targets for their posts. In Twitter, directed communications are indicated by the symbol "@." Microblogging also includes features that allow people to relay others' posts, either verbatim or with additional content and perspective (e.g., on Twitter, the "retweet" feature).

Affordances of Social Media

Features of social media applications provide the foundations for affordances. Affordances correspond to "action possibilities and opportunities that emerge from actors engaging with a focal technology" (Faraj and Azad 2012, p. 238). The concept of affordances originated in Gibson's (1977) work in ecological psychology and has long been influential in the Human Computer Interaction and technology design fields (see Gaver 1991; Norman 1999). IS researchers have embraced the concept of affordances to theorize technology in a way that pays serious consideration to the materiality of technology without reverting to technological determinism (Fayard and Weeks 2007; Leonardi 2011; Strong et al. 2014; Zammuto et al. 2007).

The concept of affordances is relational in that it is defined in the relationships between the users (characterized by their specific intentions and situated within a particular social context) and the material features of the technology (Faraj and Azad 2012; Markus and Silver 2008; Orlikowski and Scott 2008). Because of this relational property of affordances, the same technology, even the same features of a technology, may support different affordances (Leonardi 2013).

What this implies for the affordances of social media is that specific social media applications (e.g., microblogging) may offer some affordances for some actors, but that they may also offer other affordances for different actors or even different affordances for the same actors experiencing different needs. Affordances of social media for action (e.g., for playing, for socializing, or for engaging in connective action) may or may not be actualized in use.

Much IS research on technology affordances has so far examined them at the relatively micro level of individuals and small groups (Fayard and Weeks 2007; Vaast and Kaganer 2013). Seminal IS research has started to consider affordances at the less micro level of departments and organizations (Strong et al. 2014; Volkoff and Strong 2013). Leonardi (2013) in particular distinguished between individualized affordances, shared affordances, and collective affordances. Leonardi (2013, p. 752) defined individualized affordances as affordances that are realized by individual actors to fit their own specific needs that others may not share. They are intrinsically individual-level constructs. Going beyond the individual to a higher level of analysis, multiple actors may use technology in a way that actualizes shared or collective affordances. Shared affordances correspond to affordances that are actualized by actors who share similar needs and uses of the technology. Collective affordances are actualized as various actors use a technology in a way that reflects their own needs and that, in the aggregate, generates a collective outcome, as in Oborn et al. (2011).

Affordances of Social Media and Interdependence

Various users may thus rely distinctly upon different features of social media and, in particular in this research, microblogging. We argue that, at the collective level, variations among users of microblogging and of its features reflect various types of interdependence. Interdependence corresponds to the intensity and types of interactions and behaviors among actors and relates to how various actors depend upon each other for their own actions as they accomplish tasks (Puranam et al. 2012). In his 1967 seminal work, Thompson, studying mostly intra-organizational contexts, characterized three key types of interdependence: pooled, sequential, and reciprocal.

Under pooled interdependence, each actor makes a discrete contribution to the completion of a task without expressly requiring input or participation from others. This situation corresponds to "one in which each part renders a discrete contribution to the whole" (Thompson 1967, p. 54) with "relative independence from the other members of team" (Bell and Kozlowski 2002, p. 25). With microblogging, various actors' autonomous use of features such as original tweets brought together with microblogging use would be representative of pooled interdependence.

In sequential interdependence, the input from one's contribution to the overall process is dependent upon the output of somebody else's completion of his or her deliverable. "Work and activities flow uni-directionally from one member to another" (Bell and Kozlowski 2002, p. 9) and there is a direct interdependence between actors who are functionally adjacent within the overall workflow. With microblogging, the single use of the retweet feature is representative of sequential interdependence. The use of this feature requires the preceding use of a microblogging feature that generates the content to be retweeted. The direction of the interdependence is unidirectional since the content needs to be created before being further circulated.

Reciprocal interdependence corresponds to "the situation in which the outputs of each become inputs for the others" (Thompson 1967, p. 55). The dependence within the overall flow of actions is bidirectional in that actions flow back and forth among actors over time (Bell and Kozlowski 2002). With microblogging, for instance, users who post content by making use of the directed feature (i.e., the "@" feature), could get a response and from this response decide to further post directed content, which could be considered as engaging in reciprocal interdependence. Such use of the "@" feature establishes reciprocal links among users and emerging bi-directional communications among them. However, we note that Thompson conceptualized reciprocal interdependence as associated with formal, established (intra-)organizational roles, rather than with more informal contexts such as the ones enabled by social media use. Moreover, actors in reciprocal interdependence, according to Thompson, are only engaged in 2 × 2 relationships (A and B depend upon each other, as well as B and C, but not A and C), which is an assumption that does not fit well with the openness of social media (Kane et al. 2014).

Affordances of Social Media and Interdependence in Connective Action

Investigating the use of a simulation technology within an organization, Leonardi (2013) considered that the actualization of shared affordances corresponded to instances of reciprocal interdependence among users and that the actualization of collective affordances corresponded to instances of pooled interdependence. Actors who share similar needs and uses of the technology actualize shared affordances. As such, Leonardi argued, reciprocal interdependence in technology use creates the conditions for shared affordances, and pooled interdependence is related to collective affordances.

Building further upon these insights, we consider that the use of social media (and, in particular for this paper, microblogging) enables a distinct interdependence type among the emerging roles of actors engaging in connective action. Connective action corresponds to new forms of collective engagement enabled by digital technologies (and, in particular, social media) that are both related to, and yet different from, the traditional conceptualization of collective action (Bennett and Segerberg 2012). As contrasted with traditional forms of collective action, the organization and coordination of connective action relies less on the engagement of formal organizational actors (such as SMOs or government) and social identification and more upon personalized expression of identity and communication as well as upon sharing with social media (Stohl 2014). Social media enable the engagement of multiple actors in connective action with "co-production and co-distribution, revealing … peer production and sharing based on personalized expression" (Bennett and Segerberg 2013, p. 35). Connective action hence depicts new forms of collective engagement that build upon "loose networks facilitated through technology platforms and applications" (Loader and Dutton 2012, p. 613).

Through their use of social media and of their various features, actors may actualize similar or different affordances. Some of these affordances may be related to engaging in connective action, while other aspects of their social media use may not. For instance, a microblogging user independently posting a picture of their latest meal would not be engaging in connective action, whereas the same user publishing a post expressing their assessment of a certain cause and/or retweeting others' content about a cause might be. Doing so, the user would be personally expressing their perspective on this cause by tweeting and sharing their or others' perspective with the use of the various features of microblogging.

With social media use in connective action, as compared to more traditional IS use within organizations (e.g., Leonardi 2013; Strong et al. 2014), actors' roles are not clearly and *a priori* defined (Bennett and Segerberg 2012; Lim 2013; Walgrave et al. 2011). In analogy with online communities and open-source software development, in social media-afforded connective action, there may be emergent leadership (Johnson et al. 2015) and self-organization (Fuchs 2006; Nan and Lu 2014; O'Mahony and Ferraro 2007), but roles and organizing principles are not predefined. Roles and their enactment by multiple actors can be fluid and changing with social media use (Loader and Dutton 2012). This claim contrasts with Strong et al.'s (2014) research that focused on intra-organizational formal role-based affordances. Instead, with social media use, various actors may organically take on interdependent roles in connective action (Bennett and Segerberg 2012; Carty 2010; McCaughey and Ayers 2013). Who enacts these roles and what these roles involve is not predetermined and can thus be fluid and emerging as is the interdependence among them (Loader and Dutton 2012; Stohl 2014). Interdependence among emerging roles in connective action may also neither be characterized simply as pooled (since in connective action there is joint engagement in a collective process; see McCaughey and Ayers 2013), nor sequential (since relationships are not unilaterally temporally dependent; see Stohl 2014), or reciprocal (since connective action relies upon roles that are emergent rather than *a priori* defined as in a traditional organizational context; see Walgrave et al. 2011).

Affordances of social media for connective action may thus be actualized by emerging and fluid groups of actors who are

involved in different ways and to different degrees in connective action. Some actors may use social media in similar ways and take on similar emerging roles while collectively actors may take on complementary, interdependent roles that make up the connective action. What these affordances of social media are that enable connective action, and how to characterize them and the interdependence among emerging roles, still deserve to be investigated empirically and then theoretically elaborated, which leads us to our methods and analyses.

Methods

Research Context

This research adopted a mixed methods design focused on the use of microblogging during the Gulf of Mexico oil spill of 2010. The oil spill originated from the explosion of Deepwater Horizon, which drilled into the BP-operated Macondo oil and gas prospect in the Gulf of Mexico, on April 20, 2010. The explosion killed 11 people and injured 17 others. The oil spill has been destructive, spoiling marine and wildlife habitats as well as hurting the Gulf of Mexico's fishing and tourism industries. While the oil spill originated from a leak that started in April 2010, the crisis unfolded over a period of several months and its economic, ecological, and political repercussions have been ongoing, prompting many to express dismay over the events, to organize protests, and to call for sustainable changes (Casey 2011; Hoffman and Jennings 2011). The oil spill became the most microblogged issue of 2010 and many microblogging users engaged in connective action related to the oil spill. Information and opinions about the oil spill were expressed and (re-)circulated via Twitter. Some tweets also incited concrete actions to respond to the oil spill. For example, some tweets aimed at organizing donations and fundraising efforts. Other tweets took the form of references to online and offline demonstrations or encouraged volunteering to clean up the Gulf and rescue animals.

Our investigations focused on the use of the microblogging application Twitter at the occasion of the oil spill. Table 1 summarizes the key features of microblogging available in 2010 (i.e., at the time of the oil spill).

Data Collection

We collected microblog posts (i.e., tweets) through the Twitter platform from April 20, 2010 (when the leak started) until July 19, 2010, for a three-month period that constituted the apex of the spill. Twitter has been the prevalent microblogging platform in the United States since its launch in 2006. To access Twitter's archives we relied upon Topsy (http://topsy.com), a real time search engine for the social web. Topsy archives tweets and provides access to a retrospective archive of tweets dating since 2006. Users of the service are allowed to search for tweets within a defined time period. By way of a Python script, we used Topsy's Otter API, a RESTful HTTP web service that provides access to Topsy's search results, to retrieve in bulk the Twitter account name, the timestamp, and the text of the various posts. To collect these tweets, we used hashtags such as #oilspill and #bpoilspill and made daily queries. This search resulted in more than 23,000 tweets. While this dataset most probably did not correspond to *all* microblog posts about the oil spill during the investigated period, we were confident that it represented a fairly extensive and representative collection of such microblog posts as we undertook several alternative searches with other hashtags and search engines.

Within this broad database of posts, each author, on their own, read the entire dataset of tweets sorted chronologically. In particular, we sought to identify instances of what we called connective action episodes (CAEs). The rationale for a focus on CAEs rather than on attempting to analyze the entire set of tweets was the following: because the oil spill was much microblogged about in 2010, it was likely that not all tweets about the oil spill were associated with connective action. Therefore, trying to make sense of the entire corpus of tweets would have led us, erroneously, to put together tweets that did not reflect engagement in connective action and would have increased the risk of missing key instances of engagement in actual connective actions. We thus aimed at refining our data collection process to be able to examine specifically instances and processes of connective action.

Building on scholarship on connective action (Bennett and Segerberg 2012, 2013; Stohl 2014), therefore, we identified CAEs in our data set when they met the following four criteria: (1) they involved multiple actors interacting through their microblogging use; (2) they were characterized by an identifiable, but not necessarily very precise, common cause or theme; (3) they unfolded over time; and (4) they involved on-the-ground or virtual actions (e.g., virtual protest letters). We discussed multiple times our exploratory readings of the data and discussed various focal CAEs. Upon further examination of the tweets and in light of the selection criteria detailed above, we reached a consensus on three CAEs that emerged from our data as particularly revealing, namely: the "Boycott BP," the "Stop the drill," and the "Hair and Fur" initiatives that we analyze below in the findings sections (see Table 2 for a summary).

Once we had identified qualitatively these three CAEs, we engaged in a new systematic data collection process to access

Table 1. Key Microblogging Features in 2010

Microblogging Features	Description
Short published content	Defining limited length of online posts. In Twitter for instance, microblog posts, or "tweets" are limited to 140 characters.
Directed tweets ("@")	Ability to publish content that is either directed at certain users of the platforms or undirected. Directed posts are public, just as non-directed ones (as opposed to messages that are private).
Hashtags ("#")	Ability to tag microblog posts, leading ways to a social tagging categorization system.
Links	Ability to embed URLs within microblog posts, hence connecting microblog posts to other web-based content.
Retweets (RT)	Ability to repost and further circulate content already posted in the networks.

Table 2. Summary Information on the Three CAEs

Episodes	Stop the drill	Boycott BP	Hair and Fur
Main theme or cause of the connective action	Encouraging efforts to stop offshore drilling, often via the signature of online petitions.	Encouraging people not to remain customers of the company widely perceived as at the origin of the oil spill.	Encouraging the collection of hair and fur to create boons that absorb oil spreading in the sea.
Period covered in episode	Mostly May – Beginning of July 2010	Throughout investigation period	Mostly May – Mid-June 2010.
Number of collected tweets	701	897	284
Number of tweeters	500	602	258
Examples of tweets	"#oilspill knows no mercy for anyone or anything - national parks threatened by #oil http://bit.ly/bLijyf #stopthedrill" "Yes! to a permanent FL drilling ban - Video: http://youtu.be/8L9ML1Q_wvs #oilspill #sayfie"	"Declare your Oil Independence on Independence Day Weekend. Boycott #BP. Oil Spill #boycottbp #oilspill" "If only the seafood in the Gulf/Keys were basting in olive & not crude oil. But nooooo. #oilspill #FAIL #BoycottBP"	"Fight the #oilspill: cut your hair http://bit.ly/bWCqhi RT" "GREAT to SEE! People R clicking the link to donate hair or fur to save Gulf Coast wetlands http://bit.ly/oilboomhair #oilspill"

as many tweets on each episode as possible. To do so, we collected threads of tweets related to the CAEs through trackbacks of originally identified tweets. Our mixed methods analyses then focused on this set of tweets collected from these three CAEs.

Mixed Methods Analyses

Researchers have increasingly relied upon social media as sources of data for their investigations (e.g., Agarwal et al. 2012; Chau and Xu 2012; Vaast et al. 2013). The importance of data-driven inductive research in enriching the theoretical repertoire has recently been highlighted (Grover and Lyytinen 2015). Social media and other forms of trace data have necessitated original modes of inquiries. The IS discipline has promoted such novel methodologies (Abbasi et al. 2016; Levina and Vaast 2015; Walsh 2014). Emerging research on microblogging has insisted on the importance of considering a collective corpus of microblog posts to make sense of them and of the events they characterize (boyd and Crawford 2012).

Our methodology relies on three foundations. First, it builds on established literature on grounded theorizing that highlights the role of induction and abduction in building rigorous theory (Glaser and Strauss 1967; Strauss and Corbin 1998), including novel adaptations of grounded theorizing to social media and electronically mediated social contexts (Levina and Vaast 2015; Vaast and Walsham 2013). Second, our methodology benefits from scholarship in computational social

science and the adaptation of various computational techniques to analyze social media data (Gaskin et al. 2014; Watts 2013). Computational scholarship, in particular, inspired our motifs analysis (see below) that proved instrumental in characterizing the interdependence type in the CAEs. Third, our methodology draws from the mixed-methods literature to analyze our data and understand a focal phenomenon of interest, that is, how microblogging use afforded the connective action during the oil spill (see Levina and Vaast 2015; Zachariadis et al. 2013).

We started this study with a theoretical sample that evolved over the course of the study. In exploring and analyzing the sample, we alternated between qualitative and quantitative analysis in accordance with the recent guidelines on mixed-methods research (Urquhart and Vaast 2012; Walsh 2014; Zachariadis et al. 2013). We outline the purposes of the mixed-methods used in this research in Table 3. Figure 1 presents a visual summary of the data collection and analysis process followed in this research.

We carefully read each episode and took note of the patterns of Twitter activity over time (who participated, when, how Twitter threads unfolded, and how these threads related to the broader context of the oil spill). Our first readings of the episodes aimed at gaining a holistic understanding of what was happening. As the analyses deepened, we paid careful attention to the similarities and differences among episodes. We noticed, for instance, differences between the "Hair and Fur" episode and the other two ("Boycott BP" and "Stop the drill"). We discussed repeatedly among one another to contradict and deepen our emerging interpretations of the episodes separately and jointly. As the qualitative analyses proceeded, we considered how the tweets and corpuses of tweets led us to an understanding of what actors (tweeters) did in the episodes, what this meant for connective action, and how this related to roles and affordances.

Quantitatively, we engaged in cluster, temporal, and network motifs analyses of tweeting behavior. First, the cluster analysis helped us examine if there were consistent shared patterns of feature use among various participants in the CAEs. The cluster analyses focused on tweets, retweets, hashtags ("#"), mentions ("@"), and hyperlinks. We used density-based spatial clustering of applications with noise (DBSCAN) as a clustering algorithm (Ester et al. 1996). With social media data, DBSCAN was useful to us because it allows the discovery of nonlinear clusters of uneven sizes. DBSCAN is also robust to noise and outliers, and does not require the specification of the desired number of clusters *a priori*. The only parameter required is the minimum distance between two data points to be part of the same cluster. To ensure robustness, we varied the distance parameter and found three stable configurations of 18, 3, and 2 clusters (see Figure 2). Given these results, the configuration of three clusters seemed the most appropriate for further analyses.

Clustering enabled us to group tweeters participating in the CAEs on the basis of similarity in feature use. Tweeters who were more similar in their feature use were grouped together, while tweeters who were dissimilar in their feature use were put in different clusters. Once we had identified the clusters, we looked at whether members of these clusters had participated similarly or differently in the three CAEs in order to deepen the contrast among episodes. Moreover, we mixed findings from the cluster analyses and from the qualitative analyses to understand better the different clusters and to examine if meaningful similarities or differences emerged.

Second, with the temporal analyses we looked at the volume of tweeting behavior per cluster and per CAE over time. These temporal analyses were helpful to see how the different clusters participated in each CAE over time.

Third, in order to analyze more systematically the patterns of interdependence among roles for the three CAEs, we extracted network motifs for each episode. Network motifs correspond to recurrent and statistically significant subgraphs or patterns of relationships among nodes in a network (Milo et al. 2002; Wernicke and Rasche 2006). Motifs have been shown to correspond with functional attributes in various networks such as ecological food webs, genetics networks, and the World Wide Web (Benson et al. 2016). In the CAEs, the nodes represented the identified clusters and the edges represented interconnections among clusters. These interconnections came from the use of specific features of microblogging that can best capture the ways in which the tweeting activity of different actors is interdependent with that of other actors: the "@" feature of the directed tweet, and the retweet feature.

We identified size-four motifs in the three CAEs networks using FANMOD (Wernicke and Rasche 2006). While larger motifs give a richer description of topology, the size of motifs is usually limited to five for practical considerations (Janjić and Pržulj 2012). Four was the largest feasible motif size given the size of the networks at hand. The found motifs were then ranked by their Z-score. The Z-scores are calculated by comparing motif frequencies in the studied network with their frequencies in randomly generated networks of similar size (Wernicke and Rasche 2006). Motifs of high Z-scores represent unique motifs that occur much more frequently in the studied network than what we would expect by chance (Kashtan et al. 2004). Z-score values of 4 to 5 are suggested as cut-offs for analysis (Milo et al. 2002, p. 826). (Figure 8 presents all of the network motifs with $Z > 5$.) All of these motifs were statistically significant ($p < .0001$).

Table 3. Purposes of Mixed-Methods for this Study (Adapted from Zachariadis et al. 2013, p. 865)

Purposes of Mixing Methods in Critical Realist Research	Application in this Research
Complementarity and diversity: Mixed methods provide complementarity of a phenomenon in a multi-layered world with multiple levels of abstraction	Quantitative cluster analysis to uncover different clusters of feature use; qualitative analysis to understand the roles these clusters played in connective action.
Expansion: Using mixed-methods to expand upon previous research and uncover generative mechanisms	Mixed methods to apprehend the nature of interdependence among roles in CAEs and to infer and qualify the nature of affordances of microblogging associated with this interdependence.
Compensation: Weaknesses of different methods compensate each other	Quantitative analyses to apprehend systematically all collected data regarding the CAEs; qualitative analyses to bring meaning holistically to this systematic apprehension of the CAEs.

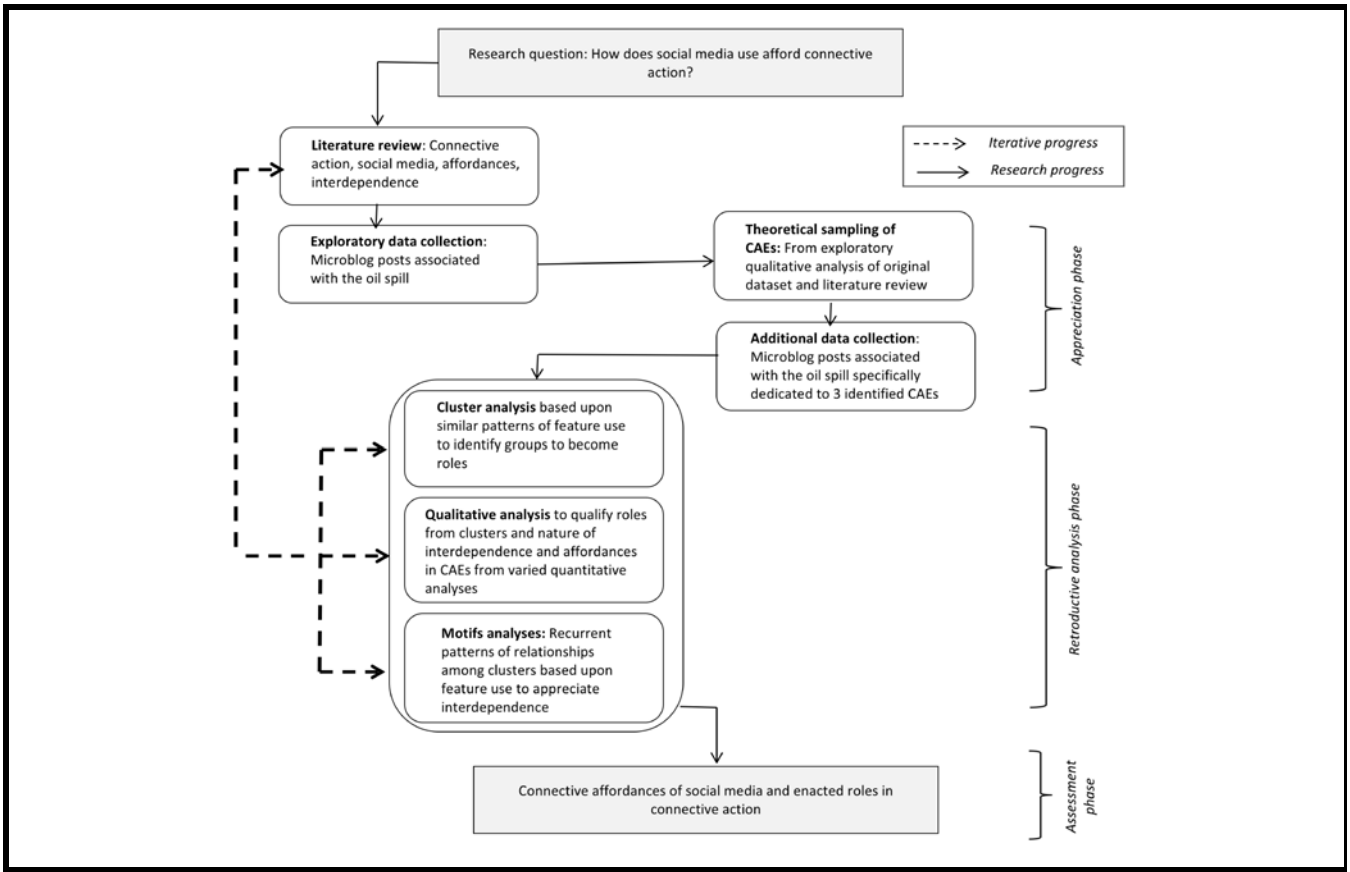


Figure 1. Visual Summary of the Data Collection and Analysis Process (Adapted from Zachariadis et al. 2013, p. 867)

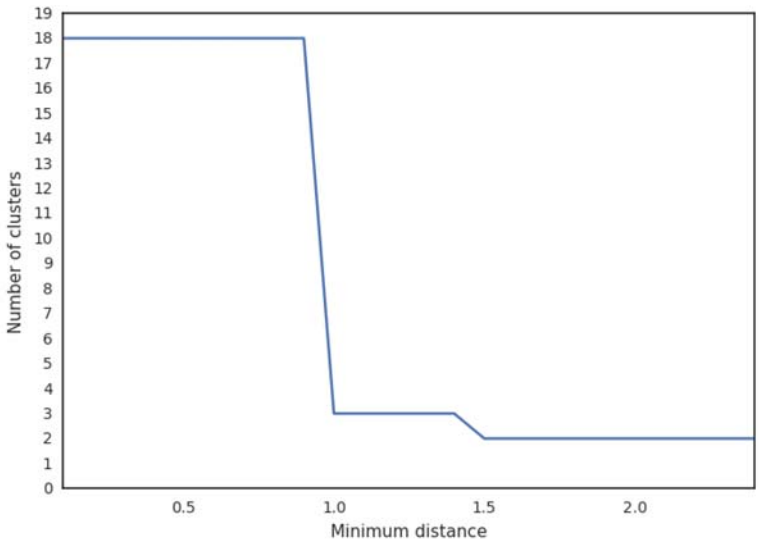


Figure 2. Cluster Analysis

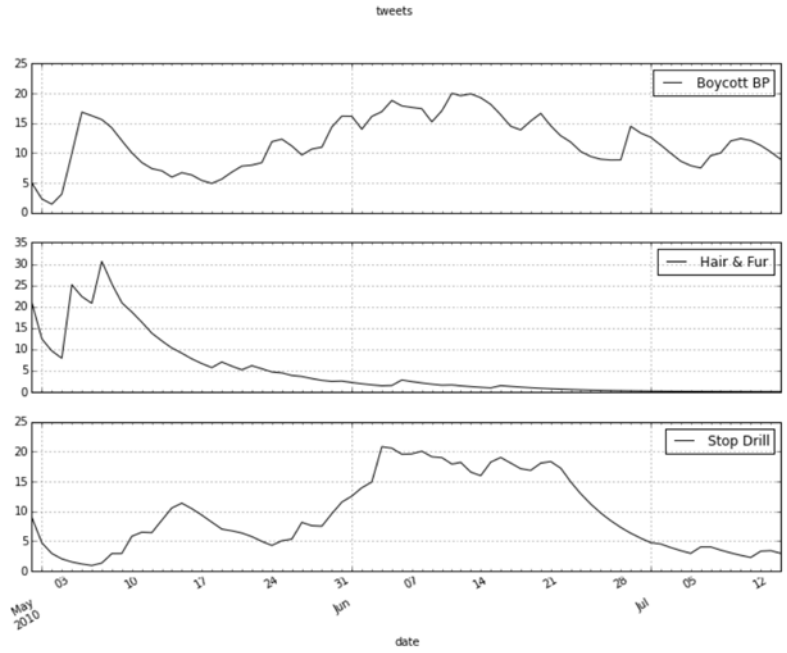
Overall, these mixed analyses combined to help us assess how users used microblogging and enacted different but mutually dependent roles. They led us to understand how the interdependence among these roles revealed affordances enabling connective action. The following sections detail the findings that emerged from the analyses. We first present the CAEs in a holistic manner. We then identify three emerging roles characterized by distinct patterns of feature use and engaged in the unfolding of the connective action, before examining systematically the interdependence among these roles in the three CAEs.

Three Connective Action Episodes During the Oil Spill

We begin by depicting the connective action episodes (CAEs). Table 2 provides information on the CAEs and Figure 3 shows the evolution over time of tweets per episode.

The "Stop the drill" episode included calls to stop drilling offshore and limit the dependence on oil. Some of these calls included precise instructions to contact official representatives ("*NOT GOOD ENOUGH: Call the @WhiteHouse: Don't just delay offshore oil drilling, end it! (202-456-1111) #OilSpill #bpFAIL*") or to provide support for an online petition (e.g., "*Have you voiced your support for an amdmt banning drilling near FL's beaches? Help us reach 10k names! http://bit.ly/aKG27h #flgov #oilspill*"). Others of these calls remained very broad and did not include actionable directions *("#oilspill knows no mercy for anyone or anything - national parks threatened by #oil http://bit.ly/bLijyf #stopthedrill*"). The episode was very active during the middle of our investigation period. By the beginning of July 2010, activity had not died down on this connective action, but had been much reduced.

The "Boycott BP" episode corresponded to actors who came together on Twitter in order to encourage people to stop using the services and products of BP, the company widely perceived to be at the origin of the oil spill. Many tweets included actual calls to sign online petitions (e.g., "*Let @BP_America know that you'll be Boycotting BP Gas Stations http://act.ly/1yo RT to sign #actly #eco #oilspill*" 05/16/2010), links to petitions, and were at times heavily retweeted. Some tweets associated with this episode illustrated the elusive nature of the common cause of this connective action. This was illustrated in a tweet asking: "*What hurts BP more: boycotts, or hilarious cat videos? http://bit.ly/bGOaNj #oilspill*." (06/16/2010). Other tweets called for a boycott of BP in a strong manner and seemed to indicate catharsis through electronically mediated communication (similar to Da Cunha and Orlikowski (2008) or Vaast and Levina (2015)) (see, e.g., "*If You're Not Outraged, You're Not Paying Attention! ===BOYCOTT BP NOW=== @Greenpeace @greenpeaceuk @greenpeaceusa #oilspill*," 05/20/2010). The "Boycott BP" episode remained active throughout our observation period.



Note: The y axis represents the number of tweets. The series are smoothed with an exponential moving average kernel.

Figure 3. Tweets Over Time per Period

In the "Hair and Fur" episode, what brought actors together was the organization of collection of hair and fur to create booms that would then be used to absorb oil in the water (e.g., "*Cool way to help #oilspill cleanup: donate hair/fur clippings & nylons for oil booms!*" (05/05/2010); *"@SOMEONE do you have information on where to send fur? i have oodles of cat fur, i can soak up MILES*" (05/04/2010)). This cause was precise and seemed to have straightforward on-the-ground potential implications. Yet, at some point during the investigated period, it became clear that the collected hair and fur would not be used, contrary to prior expectations. This information circulated (e.g., "*Engineers will not use hair to soak Gulf oil spill: Engineers will not use booms made out of hair to soak... http://bit.ly/afpXfC #oilspill*"; "*That thing where you were supposed to donate your hair to help clean up #oilspill? We were wrong. Forgeddaboutit http://bit.ly/a3YOuD*" 05/22/2010). Mere days later, however, new tweets calling for hair and fur resurfaced and circulated (e.g., "*Donate your hair or your pet's fur to help clean oil spills http://bit.ly/aUeFz5 by @SOMEONE #oilspill / RT @SOMEONEELSE*," 06/06/2010). Activity in this episode continued for two to three more weeks before dying down.

In terms of progression of these episodes over time, the "Hair and Fur" episode, at the beginning, showed the highest tweeting activity in absolute terms when compared to the "Boycott BP" and "Stop the drill" episodes. However, it did not maintain as much momentum over time as the "Boycott BP" and the "Stop the drill" episodes. The "Stop the drill" episode had become much less active at the end of our observation period but the "Boycott BP" continued to be active.

Beyond these differences in terms of unfolding, these three episodes illustrated how, in connective action, actors came together on the basis of a common cause or theme that they may not have all equally identified with, and engaged in co-production and circulation of content via social media (in this instance, Twitter). These episodes showed how, for connective action, whether a common cause translated into concrete efforts for social change and/or on-the-ground or online mobilization was not essential to the tweets being produced and circulated.

Patterns of Feature Use and Emerging Roles in the CAES

Having apprehended how the CAEs unfolded, we then looked more precisely at how users engaged in them through their feature use and how they enacted different roles in connective

action. To do so, we started by examining the most notable qualitative differences in the ways in which actors used Twitter in the episodes. For instance, very often the CAEs involved multiple spikes in tweets on the basis of one or several original tweets that were then circulated further through retweets and often also directed tweets (see Vignettes 1 and 2).

Actors also displayed differentiated engagement in the episodes. Some tweeters produced a lot of original content. Sometimes momentum around the original content happened, sometimes it did not. Many other tweeters simply circulated others' tweets. At times some tweeters generated broader interest once they started tweeting, or retweeting, about an issue. Some tweeters therefore generated more activity from others as they tweeted or retweeted. This activity manifested in some new tweets and particularly in more retweets.

This qualitative investigation therefore suggested that there were indeed different roles enacted in connective action. In order to examine systematically these differences in how tweeters used various features of microblogging and how these differences enabled the enactment of different roles, we then turned to the cluster analysis.

Cluster Analysis

The cluster analyses resulted in three key clusters (provisionally named clusters 1, 2, and 3) characterized by marked differences in feature use (see Table 4).

Cluster 1 was the smallest cluster (49 tweeters). It was marked by its high original posting activity (highest average number of tweets) and heavy use of all key features of Twitter (mentions, links, retweets, hashtags). Cluster 2 was a larger cluster (243 tweeters). It was marked by some original posting activity (moderate average number of tweets) and a limited use of all key features of Twitter. At first glance, cluster 1 and cluster 2 may have seemed to differ mostly in their intensity of use. Yet, there were some further distinctions in their patterns of feature use. Compared with cluster 1, cluster 2 generated many fewer original tweets (22% less than cluster 1), mentioned fewer specific users (31.9% less use of the "@" feature than cluster 1), and made reference to fewer external sources of information (16.5% fewer links). However, they engaged in the labeling of tweets through hashtags to a large extent (only 7.7% less than cluster 1), as well as in retweets (only 8.9% less than cluster 1).

Cluster 3 presented a strikingly different pattern of feature use from clusters 1 and 2. It was also the largest cluster by far (975 tweeters). This cluster was marked by the absence of original posting activity (no original tweet) and by its exclusive use of a single feature of Twitter, that of the retweet. Of all participants in the CAEs, 75% thus belonged to cluster 3 and only participated through circulating others' content. Moreover, given that these users constituted the largest group, they generated the most volume of tweeting activity in the CAEs (see Figure 4).

Emerging Roles in CAEs

We noted earlier that the CAEs unfolded with spikes of activity initiated by original tweets that then garnered more or less momentum through retweets or other original tweets. We went back to the episodes and saw that the actors who initiated these spikes of activities belonged to cluster 1 (i.e., to the cluster of frequent and heavy users of key features of Twitter). We also had noted that, sometimes, issues related to the connective action (e.g., offshore drilling, hair and fur donation) seemed to garner momentum not right after an initial tweet was posted, but after another actor retweeted it. We looked at the users who retweeted the original posts and were able to build momentum on others' tweets. These users, who can be characterized as having brought others' interest onto the issue at hand, also usually belonged to cluster 1. Moreover, we went back into the mass of retweets and saw that they originated from users from the three clusters but mostly from users from cluster 3 (characterized by its use of Twitter through a sole feature, that of retweeting).

Based on this empirical evidence, we identified three emerging roles in the CAEs. We inductively named the role that participants from cluster 1 enacted that of "advocates" of the connective action, the role that participants from cluster 2 enacted its "supporters," and the role that participants from cluster 3 enacted that of "amplifiers." See Table 5 for an overview.

The role of advocate was enacted as some users engaged in the CAEs by initiating activity and providing content that pertained to the topic being addressed. Advocates engaged in connective action with personalized expression of their perspective (e.g., by referring often to the "I" pronoun) and shared content that they and others had created. The enactment of this role involved shaping what the cause of the connective action was about as well as prominently contributing and thus bringing broader interest to the cause through the use of multiple features. Advocates (re-)initiated activity related to the connective action.

Other users who used microblogging features more moderately enacted the role of supporters. A less prominent or intense use of microblogging and of some of its key features characterized the role of supporter of connective action. Supporters, like advocates, engaged in personalized expres-

Vignette 1. Illustrative Thread, Boycott BP CAE

Tweeter	Tweet	Date
neoisone	BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/23/2010
wesunruh	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/24/2010
mason_mem	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/24/2010
thomasnordwest	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/25/2010
typingmonkey	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/25/2010
paullomaxphoto	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/25/2010
julieanne003	RT @NeoIsOne: BP owns Arco and AM/PM, so boycott them also. Time to break them. #oil #spill #BP #BPboycott #gulf #oil #oilspill #BPsucks	05/25/2010

Vignette 2. Illustrative Thread, Stop the Drill CAE

Tweeter	Tweet	Date
oceana	Boy, did #BP ever deliver - 1999 slogan a bit ironic now http://bit.ly/b8Y2sB #oilspill #stopthedrill	06/04/2010
yadis_1436	RT @Oceana: Boy, did #BP ever deliver - 1999 slogan a bit ironic now http://bit.ly/b8Y2sB #oilspill #stopthedrill	06/04/2010
seachele420	RT @Oceana: Boy, did #BP ever deliver - 1999 slogan a bit ironic now http://bit.ly/b8Y2sB #oilspill #stopthedrill	06/04/2010
einheitsschuelr	RT @Oceana: Boy, did #BP ever deliver - 1999 slogan a bit ironic now http://bit.ly/b8Y2sB #oilspill #stopthedrill	06/04/2010
wwjd50	RT @Oceana: Boy, did #BP ever deliver - 1999 slogan a bit ironic now http://bit.ly/b8Y2sB #oilspill #stopthedrill	06/04/2010

Table 4. Average Feature Use per Cluster

	Number of Tweeters	Original Tweets	Retweets	Hashtags	Mentions	Links
Cluster 1	49	4.694	2.265	17.061	2.143	3.388
Cluster 2	243	1.058	0.202	1.313	0.683	0.560
Cluster 3	975	0.000	1.269	0.000	0.000	0.000

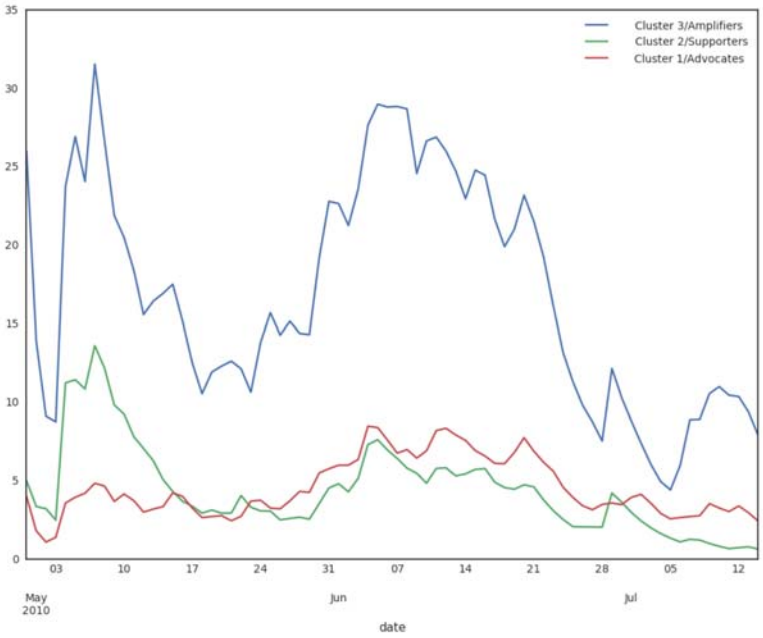


Figure 4. Clusters' Activity Over Time (All CAEs Combined)

Table 5. Enacted Roles in Investigated CAEs

Enacted Role	Advocates	Supporters	Amplifiers
Roles in connective action	Initiate activity on the connective action. Catalyze others' interest. Rekindle interest in the connective action.	Follow in time and support advocates' activity in the connective action.	Scale up and maintain over time the momentum of the connective action.
Frequency and intensity of microblogging use in the CAEs	Heavy users	Moderate users	Moderate users
Patterns of feature use	All key features used	All key features used, especially retweet and tagging features	Only retweet feature
Illustrative tweets	"To this day I'm still boycotting Exxon (deservedly so!) Now I will no longer buy BP as well. We have a VOICE w/how we spend our $! #oilspill"	"@Alyssa_Milano my 6 year old daughter just sent her 8 inches of hair to help make the mats to help clean. she is so proud."	"RT@FairDealDaveNH: RT @jgrindal: Make no mistake, #BP 's #oilspill is the oil & gas industry's Chernobyl. No one will ever look at off"
Actions in CAEs	Initiating activity by advocating for the cause of the connective action and encouraging others' to participate. Engaging in personalized expression of opinion and identity as well as sharing of content.	Supporting the cause of the connective action by qualifying its cause. Engaging in personalized expression of opinion and identity as well as sharing of content.	Scaling the cause of the connective action by broadcasting and further circulating others' content. Exclusively sharing of others' content.
Reciprocal interdependence among enacted roles	Advocates initiate, guide, and rekindle the connective action; supporters qualify the connective action; amplifiers scale the connective action by further circulating others' content and sustaining the momentum.		

sions of their perspective on the connective action as well as in sharing of their and others' content. Their use of microblogging followed in time advocates' use of microblogging in the CAEs. Supporters' activity helped garner and maintain momentum for the connective action and contributed to perpetuate activity by adding content and by qualifying the connective action (e.g., via the use of the hashtag feature). Supporters qualified the connective action.

Users who used microblogging and enacted the role of amplifiers engaged in the connective action by sharing and further circulating advocates' and supporters' content via retweets. Compared to advocates and supporters, amplifiers were not engaged in personally expressing their perspective on the cause of the connective action. Instead, they were highly involved in sharing others' content. Their exclusive use of one feature, retweet, contributed to scale up the connective action and to maintain its momentum over time. Amplifiers thus scaled up and maintained the connective action.

Interdependence in the CAES

Having identified and characterized three emerging roles in the CAEs that were associated with different patterns of microblogging feature use, we then turned our attention to the type of interdependence among these roles in the CAEs. To do so, we looked at the unfolding of the three CAEs over time and at the relative involvement of advocates, supporters, and amplifiers. We then examined closely network motifs of the relationships among the three roles to characterize more precisely the interdependencies at play for the three CAEs.

Differentiated Involvements in the CAEs

We examined how similarly and differently the three CAEs unfolded and, to do so, we first delved into the relative participation of the various roles in each of the CAEs (see Table 6).

Table 6 shows that two episodes, "Stop the drill" and "Boycott BP," were relatively similar in the participation of the three roles. Advocates participated four to five times more than the other roles in terms of average number of original tweets per episode. The "Hair and Fur" episode differed from the other two CAEs in this key aspect. Advocates were much less present and active in this episode than in the other two. In particular, as seen in the tweets/episode column, advocates (cluster 1) were much less active in the "Hair and Fur" episode than in "Boycott BP" and "Stop the drill." In the "Hair and Fur" episode, there was thus relatively less tweeting activity from the most frequent and heavy users of all key features of microblogging. Lacking some of the activity from advocates, supporters and amplifiers did not compensate to generate or maintain the momentum in this CAE. The "Hair and Fur" episode failed to maintain as much momentum on Twitter as the other two episodes, as seen in Figure 3.

Building further upon these findings, we delved into the evolution over time of the different episodes and of the roles' participation in them (see Figures 5, 6, and 7).

For all three episodes, amplifiers' participation amounted to the majority of the tweeting activity. Amplifiers' activity came entirely from retweets. It dominated in volume the participation from advocates and supporters because of the greater number of amplifiers than of advocates and supporters.

However, again we noted here similarities between the "Boycott BP" and the "Stop the drill" episodes and a key difference with the "Hair and Fur" episode. In the "Hair and Fur" episode, as contrasted with the other two CAEs, advocates (i.e., the actors who usually participated heavily and used key Twitter features intensely) generated less activity than supporters (i.e., actors who exhibited moderate patterns of feature use). This notable difference between the "Hair and Fur" episode and the other two episodes confirmed our earlier observation that, in the "Hair and Fur" episode, compared with the other two CAEs, there was relatively less activity from advocates. This relative lack of advocates' activity in the "Hair and Fur" episode compared to the other two episodes affected the mutual relationships among the three emerging roles.

Motifs Analysis

In order to assess further the interdependencies among roles, we analyzed and contrasted the network motifs with the highest Z scores for the three CAEs. We noticed intriguing differences between, on the one hand, the "Boycott BP" and "Stop the drill" episodes, and, on the other hand, the "Hair and Fur" episode (see Figure 8 and Vignette 3).

With the "Boycott BP" and "Stop the drill" episodes, many of the motifs with the highest Z scores showed mutual interdependence among the three roles. For instance, in the motifs with the two highest Z scores in the "Boycott BP" episode, as indicated with arrows from amplifiers to advocates and supporters, amplifiers' activity depended upon advocates' and supporters' activities (e.g., through the use of the retweet feature), and advocates' activity depended upon supporters' activity (e.g., through the use of the "@" feature). In the

Table 6. Clusters and Tweeters per CAE

		Tweets	Tweeters	Tweets/ Episode	% of Tweeters
Boycott BP	Cluster 1 - Advocates	196	38	5.16	6%
	Cluster 2 - Supporters	99	79	1.25	13%
	Cluster 3 - Amplifiers	604	485	1.25	81%
Stop the drill	Cluster 1 - Advocates	184	22	6.09	4%
	Cluster 2 - Supporters	105	94	1.12	19%
	Cluster 3 - Amplifiers	402	384	1.2	77%
Hair & Fur	Cluster 1 - Advocates	11	7	1.57	3%
	Cluster 2 - Supporters	102	86	1.19	33%
	Cluster 3 - Amplifiers	171	165	1.04	64%

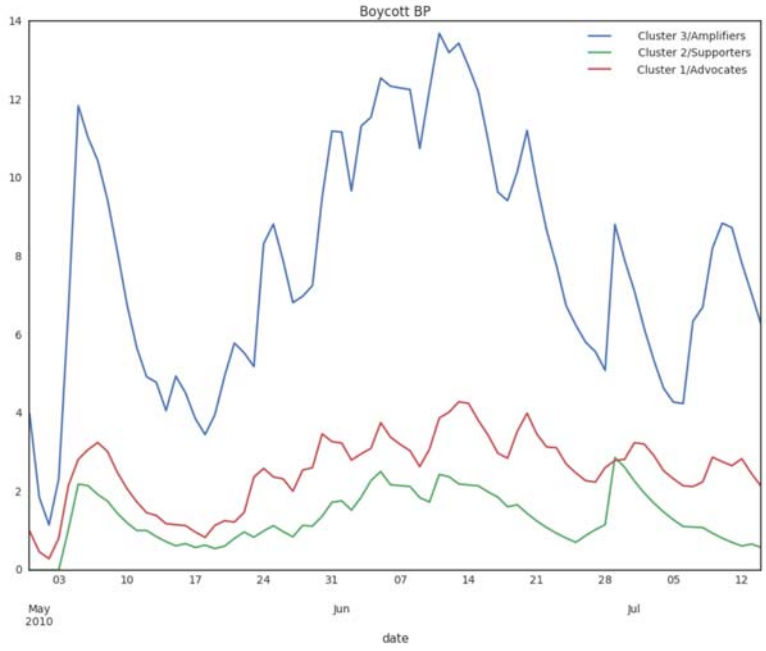


Figure 5. Clusters' Activity in Boycott BP CAE

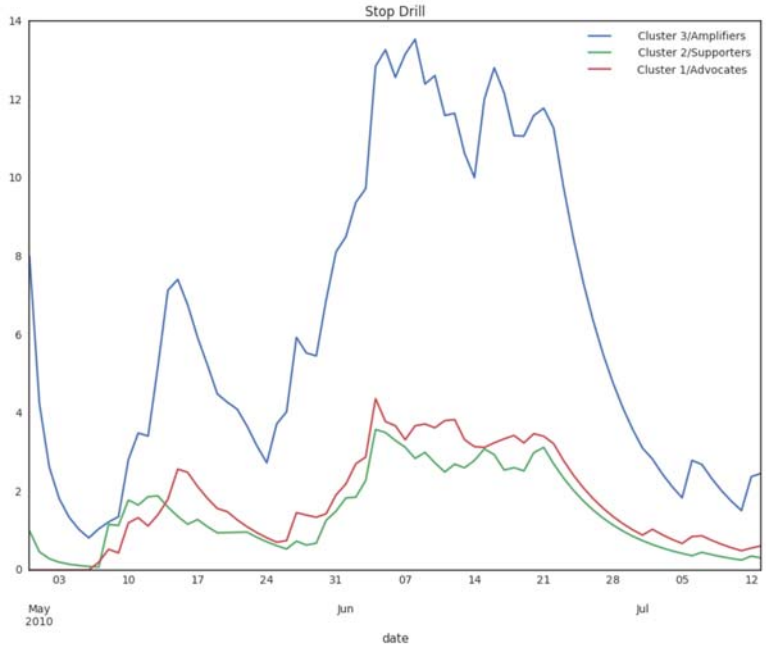


Figure 6. Clusters' Activity in Stop the Drill CAE

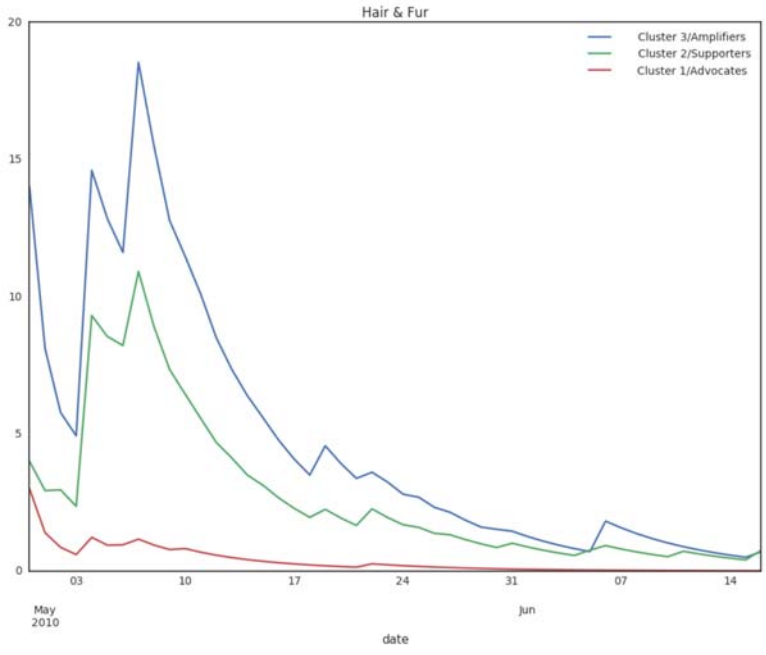


Figure 7. Clusters' Activity in Hair and Fur CAE

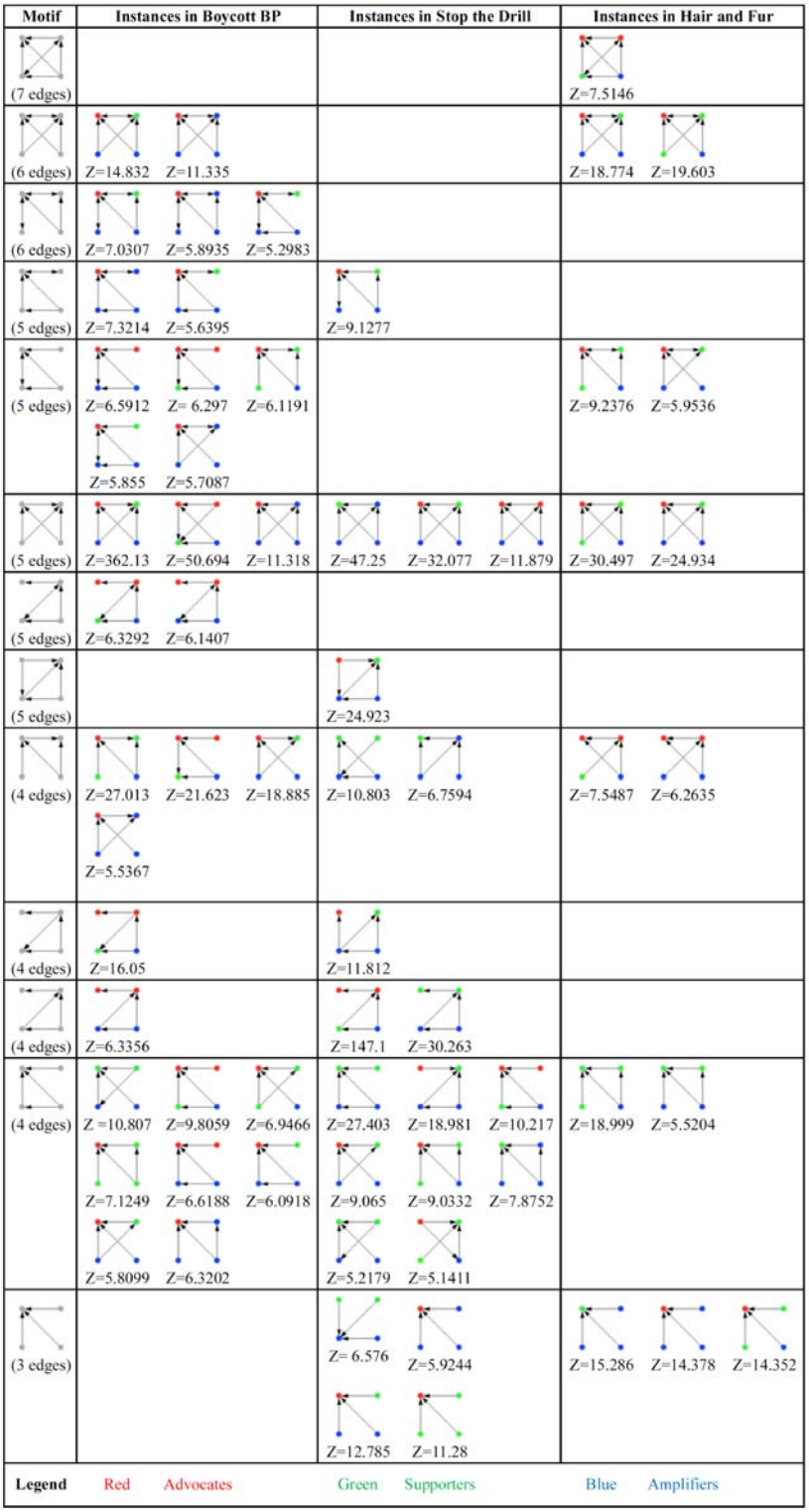
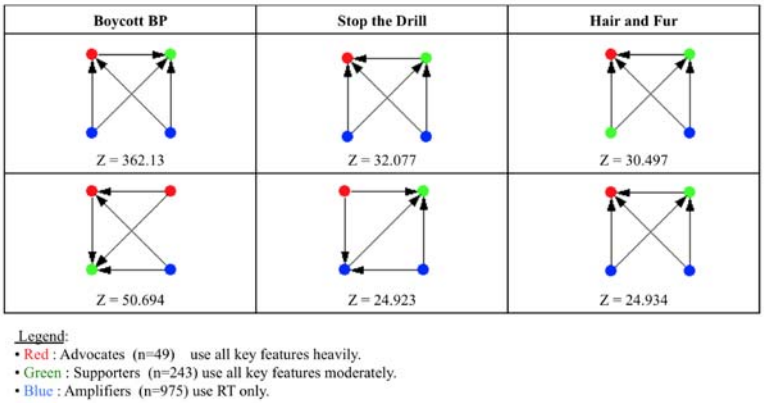


Figure 8. Motifs, Size n = 4, Z > 5, in Three CAEs Ordered by the Number of Edges with Variations in Each CAE Based on Roles Involved

Vignette 3. An Illustration of a Motif with a High Z Score for the Three CAEs

Among the motifs with the highest Z scores, we noticed declinations of similar motifs among the three CAEs. The figure below shows variations of a pattern of interdependence among advocates, supporters, and amplifiers. The interdependence among roles was captured through the use of the retweet feature (for amplifiers in particular, but also for advocates and supporters) and of the "@" feature, whereby a Twitter user addressed another user (for advocates and supporters, but not amplifiers).



As the figure indicates, the patterns showed amplifiers retweeting advocates, supporters or even other amplifiers, and advocates and supporters either retweeting others' tweets or directing tweets toward others. These motifs illustrate amplifiers retweeting content put forth by advocates and supporters or even retweeting other amplifiers' retweets. Amplifiers thus depended upon advocates and supporters' own tweeting activity to use the retweet feature. Supporters directed some of their tweeting activity towards amplifiers by retweets or directed tweets and were either addressed to or retweeted by advocates and amplifiers. Advocates directed their activities through directed tweets or retweets towards supporters, and amplifiers and other advocates. These motifs therefore illustrate mutual interdependence among the three roles, as well as variations in the patterns of this mutual interdependence.

motif with the third highest Z score, the activity of some advocates depended upon supporters' activity, supporters' activity depended upon advocates' activity, and other advocates' activity depended upon other amplifiers' activity. The "Boycott BP" and "Stop the drill" CAEs thus displayed instances of mutual interdependence among the three roles for many of the motifs with the highest Z scores. Moreover, since these motifs differed from one another and revealed different mutual relationships among the clusters, the patterns of interdependence appeared to be fluid rather than fixed.

This situation calls to mind what Van de Ven et al. (1976) called "team" interdependence. Building upon Thompson's (1967) original work, Van de Ven et al. conceptualized team interdependence as an extension of reciprocal interdependence. Under team interdependence, actors are jointly, mutually, and simultaneously engaged in the work. Moreover, while with reciprocal interdependence "the structure of member roles is externally imposed" (Saavedra et al. 1993, p. 63), with team interdependence, the structure of members' roles is more fluid and changing. In the "Boycott BP" and "Stop the drill" CAEs, most of the motifs with the highest Z scores indeed revealed mutual engagement among the three roles: the activity of each role depended upon the other two roles' activity. There were also several distinct ways in which amplifiers, advocates, and supporters were interconnected as these motifs differed widely. The combination of most of the motifs with the highest Z scores for the "Boycott BP" and "Stop the drill" CAEs therefore illustrated team interdependence among the roles.

In the "Hair and Fur" episode, as seen in Figure 8, the two motifs with the highest Z scores also displayed mutual relationships among the three roles. However, many of the other motifs with the highest Z scores for this CAE tended to show unidirectional relationships between two roles rather than mutual relationships among the three roles. These other motifs primarily showed supporters and amplifiers directing their tweeting activity toward advocates (e.g., an amplifier retweeting an original tweet from an advocate, a supporter directing a tweet to an advocate). Many of the motifs with the highest Z scores for the "Hair and Fur" episode thus revealed

mostly patterns whereby amplifiers' and supporters' activity was dependent upon advocates' activity, or amplifiers' activity was dependent upon supporters' activity, but advocates' activity was not as dependent upon amplifiers' and supporters' activity. For the "Hair and Fur" CAE, then, while a few of the motifs with the highest Z scores seemed to depict team interdependence, many of the other motifs seemed closer to "sequential interdependence" (Thompson 1967) between roles two by two.

Discussion and Implications

This research set out to understand how social media use affords new forms of organizing and collective engagement encapsulated in the concept of connective action. Building upon the initial theoretical development and the findings from three connective action episodes related to the Gulf of Mexico oil spill, this section provides answers to our research question and discusses contributions to scholarship on technology affordances, social media, and collective use in connective action. It advances theory by characterizing the type of interdependence found in connective action and by introducing the concept of connective affordances. It develops the theoretical and practical implications of this work before acknowledging its limitations and suggesting promising avenues for future research.

Discussion and Theory Development

The empirical findings of this research helped us understand how connective action unfolded in the episodes and how the three emerging roles of advocates, supporters, and amplifiers participated in connective action through distinct but interrelated patterns of feature use of microblogging. Observations revealed how advocates and supporters engaged in personalized expressions and communications as well as in the sharing of content related to various causes, whereas amplifiers exclusively engaged in sharing others' content. Specifically, in the investigated CAEs, advocates initiated and guided the connective action through their particular pattern of feature use (including frequent original postings and intense use of most features). Their activity was mutually dependent upon supporters' and amplifiers' activity. Supporters, with their own distinctive pattern of feature use (including more moderate postings but with relatively high level of use of the tagging feature), further qualified the connective action. Amplifiers, also through their pattern of feature use (i.e., the exclusive use of the retweet feature), echoed others' content. Without supporters' activity, advocates' activity would have lacked further production of content. Without amplifiers' activity, advocates' and supporters' content would not have been further circulated. Without advocates and supporters' activity, amplifiers would not have been able to circulate new content.

The empirically identified roles involved in connective action during the oil spill were interdependent in ways that could not be conceptualized simply as pooled, sequentially, or reciprocally interdependent (Thompson 1967). The interdependence was not simply pooled because the enacted roles depended upon others' distinct patterns of feature use of microblogging for their own pattern of feature use. The interdependence was also not just sequential because the relationships among roles did not go into a single direction and were not in a straightforward temporal succession. The interdependence was not simply reciprocal because in the CAEs we examined, the tweeting activities of the three roles were all mutually related. Advocates,' supporters,' and amplifiers' tweeting activities were interconnected and there was reciprocal interdependence among the three roles, rather than between roles two by two. Moreover, with microblogging use, during the oil spill the roles of advocates, supporters, and amplifiers were emergent, rather than predetermined and fixed as in Thompson's conceptualization.

The findings thus instead revealed the interdependence among the three roles to be closer to what Van de Ven et al. (1976) called team interdependence. Our empirical findings and this extension of Thompson's original work on interdependence show how, in the examined CAEs, the enacted roles of advocates, supporters, and amplifiers were emerging and their membership and behavior could change, but the engagement in connective action required team interdependence among all of these enacted roles. This was illustrated in the "Hair and Fur" CAE where there was relatively less activity from advocates than in the other two CAEs. The relative lack of activity from advocates jeopardized the team-based interdependence, made it more difficult for the other roles to be fulfilled, and threatened the connective action. In contrast with the other two episodes, the "Hair and Fur" episode, in which there was relatively less team interdependence, was also the one in which the connective action did not maintain its momentum over time.

Building upon these findings and considering what they mean for how social media use affords connective action, we introduce a new type of affordances, which we call connective affordances. Connective affordances correspond to collective-level affordances of a technology—in this case, social media—that are actualized as actors, who take on emerging roles, display shared patterns of feature use within roles as well as distinct patterns of feature use among roles. Rela-

tionships among these emerging roles, enacted by technology use, are team interdependent. Figure 9 visually depicts these ideas and contrasts connective affordances with other affordances.

Compared with individualized affordances, connective affordances are collective level affordances: users are thus mutually dependent upon each other. Compared with collective affordances where the interdependence among actors is fairly minimal (i.e., pooled interdependence), with connective affordances there is mutual dependence among technology users. The enactment of the diverse emerging roles is conditional upon the interdependent actualization of connective affordances.

Furthermore, compared with shared affordances, there is mutual dependence among all enacted roles and these enacted roles are not predetermined and fixed but, rather, are emerging and fluid. Yet, if one of these emerging roles goes missing, or if activity from one of the roles becomes relatively lacking, then the team interdependence among all roles is threatened and the connective affordances may not be actualized. The pattern of feature use for one emerging role is tightly related to the different patterns of feature use for the other roles. If a role does not use the technology in ways that enable team interdependence, then it will be difficult if not impossible for the other roles to be fulfilled with technology use and for connective affordances to be actualized.

Implications for Scholarship on Technology Affordances

Our study contributes to the literature on technology affordances by taking further the conceptualization of affordances at the collective level. The characterization of connective affordances relies not only upon shared patterns of feature use within emerging roles, but also upon mutually dependent yet distinct patterns of feature use among emerging roles. This paper adds to the rich and vibrant IS literature on technology affordances (Faraj and Azad 2012; Leonardi 2013; Volkoff and Strong 2013) by revealing how, with connective affordances, what is afforded to one role depends upon how other roles use the technology. This research adds to the literature on affordances by considering the importance of the relationships among emerging user groups. Connective affordances bring to mind the very definition of affordances as a relational concept (Faraj and Azad 2012; Orlikowski and Scott 2008). They are defined in the relationships not only between technology features and users, but also between technology features and the interdependence among users. These are collective-level affordances that are synergistic in that their actualization relies upon the team interdependence among users' actual patterns of feature use of the technology.

We offer here that connective affordances are not exclusive to social media use, although the characteristics and features of social media (e.g., platforms where user-generated content is produced and circulated widely) (see boyd and Ellison 2008; Kane et al. 2014) make it especially likely for connective affordances to be present. Moreover, we propose that connective affordances may be actualized when actors mutually engage in collective endeavors other than connective action in which roles are emerging rather than predetermined. For instance, the coordination of expertise among groups responding to disasters studied in Majchrzak et al. (2007) could be considered from the perspective of connective affordances. This would allow researchers to conceptualize how emerging groups whose tasks and assignments are unstable and whose relationships are not clearly defined yet are deeply interdependent upon one another actually provide relief. Such emerging groups may arguably coordinate their work as they actualize connective affordances of technologies that include, for instance, emergency response systems, wikis, or other applications. Relief comes from these emerging groups that are placed in a situation of team-based interdependence being able to do their own work and to complement one another. Distinct yet team interdependent patterns of use of technologies can make it possible for emergency services to be completed.

Implications for Scholarship on Social Media

Much IS research so far had tended to focus on what happens with social media use to formal organizations and to users in established roles (e.g., employees, customers) (Gibbs et al. 2014; Huang et al. 2015; Leonardi and Vaast 2017). There has so far been little research on how social media use shapes new, informal forms of collective engagement and organizing. Yet these new processes that go beyond established formal roles and organizations are particularly significant when examining social media use, given their characteristic user-friendliness and ability for all users to produce, circulate, and share multimedia content (Kane et al. 2014; Kaplan and Haenlein 2010). This research contributed to address this gap in the IS literature on social media by focusing on social media use in collective processes taking place beyond organizations and established, formal roles.

It did so by providing a close consideration of patterns of feature use. This responds to calls for IS research to be more specific in its investigations and to examine feature use more closely (see Burton-Jones and Straub 2006; Markus and Silver

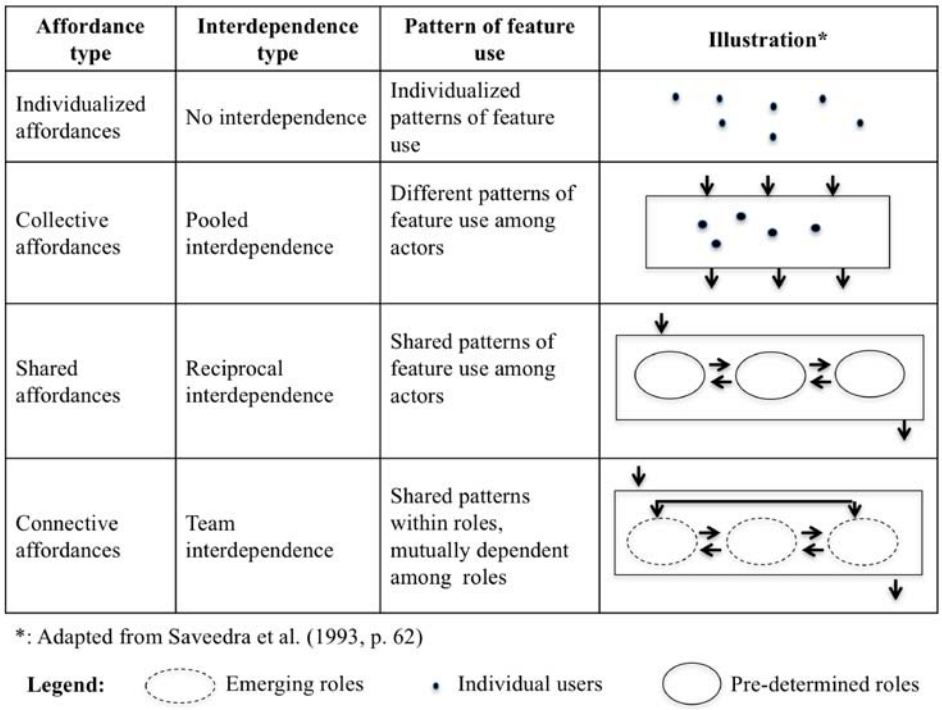


Figure 9. Connective Affordances and Interdependence Type

2008). This is particularly relevant for the investigation of social media use, because social media typically constitute technologies that are fairly simple and user-friendly, with a limited number of available features (boyd and Ellison 2008; O'Reilly 2007). The theoretical approach and methodology adopted in this study can help investigate other original contexts and complex impacts associated with social media use (Kallinikos and Tempini 2014; Kane et al. 2014; Orlikowski and Scott 2014). For instance, Kallinikos and Tempini (2014) examined the process of health data collection with social media as patients originate their own data. The concept of connective affordance as well as the methodological apparatus proposed in our study can further the examination of changes in such health information processes as well as in other processes by identifying emerging roles, characterizing their interdependence type, and investigating their collective outcomes.

Implications for Scholarship on Collective Use and Connective Action

This research also participates in the interest in IS research on use at the collective, rather than individual, level (see Burton Jones and Gallivan 2007; Lapointe and Rivard 2005). This research specifically adds to this literature on collective use a consideration of the implications of the type of interdependence among users for social media use. In particular, it elaborated upon the relevance of team interdependence (as defined in Van de Ven et al. 1976) for collective use. The notion of connective affordance that derived from this consideration adds to IS research on collective use by suggesting potential interlocking effects among use at different levels. In such view, the potential effects of a technology for different groups can only be "unlocked" through use if the (different) potential effects of the same technology for other groups are also unlocked through use. We believe that these ideas could be useful to further the understanding of other contexts, such as, for instance, knowledge exchanges in online communities (Johnson et al. 2015) or work processes in open source software development (Shaikh and Vaast 2016). In such environments, relationships are mediated electronically, and various actors engage jointly yet distinctly in a collective endeavor. They may use differently the various features of the different technologies at hand and their uses may be mutually dependent and characteristic of the emerging roles they take on in the collective endeavor. A consideration of connective affordances can help shed light onto the collective use of technology and can help understand why a collective outcome may not be reached even as a technology seems to be heavily

used by many potential users (e.g., if an emerging role and its corresponding pattern of feature use is missing or not as active).

Findings from this research also respond to calls for IS research to investigate the use of new technologies and phenomena that go beyond the organizational level (Kane et al. 2014; Majchrzak et al. 2016; Wattal et al. 2010). This study provided a theoretical lens, based upon connective action (Bennett and Segerberg 2012) and technology affordances, and a methodological apparatus geared toward examining systematically and making sense holistically of the engagement in connective action. Existing research on connective action had so far posited that social media make it possible for connective action to happen (Bennett and Segerberg 2012; Lim 2013), but it had not really questioned how social media use actually enabled connective action. This paper contributes to this nascent stream of research as it showed how specific patterns of social media use help generate and sustain connective action. It uncovered how some actors were engaged in personalized expressions of identity and communications, while others only shared existing content. Through a fine-grained examination of microblogging feature use, the study thus revealed how different groups of actors constituted emerging roles in connective action and shaped its unfolding.

Practical Implications

From a practical standpoint, our study brings insights that might help shape the use of social media for connective action. This research revealed emerging, informal roles that can be enacted through differentiated patterns of feature use of microblogging. It may thus be of help to users who wish to engage in connective action and make a more impactful use of the specific features of microblogging. Our findings could also encourage users to think about the patterns of their social media feature use to help them steer and maintain the connective action's momentum. They could also inspire some actors to engage in specific initiatives to help bring online and offline mobilizations together.

Having a better sense of the different patterns of microblogging feature use can help users be more mindful of the roles they or others enact in connective action. Activists willing to participate in or mobilize others to a connective action via the use of social media could in particular learn to develop their own pattern of feature use while also assessing and responding to others' patterns. Activists would do well to grasp the multiplicity and diversity of participation in connective action with social media use. Having a sense of how different actors organically take on various roles in connective action can inspire activists to use specific social media features not only to benefit the cause of the connective action, but also to stimulate others to fulfill complementary roles in it.

Moreover, this research could hold implications for actors engaged in dealing with and responding to acute crises such as the one depicted in the Gulf of Mexico oil spill. Responders and rescue actors could take advantage of the immediacy of social media applications such as microblogging to identify problems and crises as well as to pinpoint some resources to address them. Following the diversity of reactions via social media use to situations such as the oil spill can help responders understand who is involved or how to get more directly involved, as well as how the responses to the situation may need to change over time.

Limitations and Future Research

This study has limitations that are related to the boundaries of its investigations and that offer opportunities for future research. First, we recognize some empirical limitations associated with our analysis of microblogging use during the Gulf of Mexico oil spill, which is specific of an environmental crisis. There is the risk that the results of our study might be unique to such a case, including the nature of the connective action episodes we identified and of the patterns of feature use. We invite future research to examine other types of crises and connective action episodes to see if patterns hold. In our study, we identified three emerging roles that were specific to the CAEs we investigated. Future research might seek to confirm if these actors' roles stand across different types of connective actions and/or reveal other meaningful roles and patterns of use that contribute to shape the connective action.

Another limitation of our research is that we focused our analyses on the use of a single microblogging platform. We thus did not, for instance, examine the use of other social media applications or the unfolding of events that were taking place on the ground and that could have complemented the use of microblogging in the investigated CAEs. We believe that this represents an opportunity for future research. It would be interesting to examine how connective and collective actions complement each other and how these may eventually overlap. In particular, it may be insightful to identify whether and how connective action may turn into more traditional collective actions and, thus, to question "the boundary zone in which what we refer to as connective action gives way to collective action" (Bennett and Segerberg 2012, p. 745).

Finally, this study focused on connective action episodes that occurred at the apex of the oil spill and is thus limited in time. It would be interesting to have a longer-term perspective on events. This could help us understand how CAEs evolve over time as well as whether and how differentiated patterns of use and related roles change. Here, an interesting avenue for future research would be to perform a network analysis of microblogging feature use and to compare networks over time to see how they evolve with the unfolding of connective action.

Conclusion

The advent of social media has been associated with new forms of organizing and collective engagement shaped by informal, emergent, and interdependent roles enacted by multiple actors. This research examined how social media use affords some of these new forms of organizing encapsulated in the concept of connective action. It revealed how social media use allows multiple actors to take on interdependent emerging roles and actualize what we called connective affordances. Conceptualizing connective affordances as collective level affordances actualized when actors spontaneously and informally take on team interdependent roles helped us understand how social media use affords connective action. This research added to scholarship on social media use and new forms of collective engagement a theoretically elaborated and empirically supported distinction among complementary roles as well as a consideration of how these roles are dynamically enabled by connective affordances through distinct and team interdependent patterns of feature use. We hope that other researchers will find the theoretical and methodological approaches developed here useful to continue examining the fascinating new processes made possible by the use of technologies such as social media.

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