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# Chance-Discovery and Chance-Curation in Online Communities

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## Abstract

In this paper, we consider chance-curation (the task of easing chance-discovery activities for agents) as far as it concerns information sharing in online communities, understood as Virtual Cognitive Niches. We claim that Virtual Cognitive Niches are digitally-encoded collaborative distributions of information and pieces of knowledge into the environment. The particularity of Virtual Cognitive Niches, as socially biased networks, is that they provide more ways for agents to interact than to control the quality of the information they share and receive. We contend that this social bias enables chance-curation strategies that agents cannot foster in real-life communities. In particular, the chance curation strategies that we discuss are: redirecting the attention of agents to the virtual domain, fostering an only-docility-based relation with truth, and increasing the social virtues of fallacies.

**Keywords:** Chance-discovery; Chance-curation; Online Communities; Cognitive Niches; Affordances.

## Introduction

The central concept we discuss in this paper is chance-curation, which is the activity of offering agents the opportunity to discover chances. In the chance-discovery literature, a chance is an event with a “significant impact on human decision making” (Ohsawa & Fukuda, 2002; Maeno & Ohsawa, 2007; Abe, 2010).

Abe (2010) first introduced the notion of curation in the framework of chance discovery where he reviewed some *display strategies* in particular contexts, such as exhibitions, galleries, archives, and museums. The task of promoting and enabling the availability of certain products of artwork and artifacts to appropriate audiences was the key to comprehend the connection between agents and the displaying framework as a performance of chance discovery. He also proposed an interesting list of features that describe chance-curation: 1) curation is a way to offer agents opportunities to discover chances; 2) agents that aim at performing processes of chance-curation should consider implicit and potential possibilities; 3) chances should not be explicitly displayed to agents. 4) However, such they should be rather easily discovered and arranged according to the agent’s interests and situations. 5) agents should have a certain freedom to arrange chances (Abe, 2010, p. 797).

Abe’s definition is particularly interesting if we consider online communities, such as social networking websites. Indeed, these platforms are engineered to be “fool-proof,” and to naturally co-opt human beings’ inferential patterns in settings of real-life cognition (Bertolotti & Magnani, 2015) (and hence chance discovery). Of course, some of these fostered cognitive abilities relate to social-cognition and one’s natural disposition towards sharing (Simon, 1993). To better understand and explain how online communities foster some cognitive processes in a different way in comparison to real-life communities, in this paper we are going to address this issue by referring to cognitive niches theories. Since the idea of cognitive niche stresses the local and social dimension, of the agents’ efforts, this theoretical approach is indispensable to investigate how socio-cultural and technological environments as online communities can foster and enrich cognitive processes as chance-curation strategies and chance-discovery.

This paper has three theoretical goals: 1) to show that the cognitive niche framework can foster comprehension with regard to the differences between the cognitive processes enacted in virtual environments and real-life ones; 2) to argue that virtual cognitive niches foster particular chance-curation strategies; 3) to investigate some of the most impactful implications of the chance-curation strategies on the discovery and exploitation of chance in online communities.

To better spell out our vision, we divide this paper into three main parts. In the first section, we frame online communities as virtual cognitive niches: we briefly explain the notion of cognitive niche, also by referring to the concept of *affordance* that, although not properly belonging to the chance-discovery paradigm, has already fruitfully interacted with the latter. In the second part, we focus on the particular forms of explicit and implicit communication agents perform in virtual cognitive niches. We argue that these communications enable chance-curation strategies that agents cannot foster in real-life communities cognitive niches. In particular, the chance-curation strategies that we discuss are: redirecting the attention of agents to the virtual domain, fostering an only-docility-based relation with truth, and increasing the social virtues of fallacies. In the third section, we investigate

more specifically the implications of the use (and abuse) of those chance-curation strategies.

### Introducing Cognitive Niches

Niche theories are clusters of interrelating approaches bridging biology, cognitive science, and philosophy, exploring the relationship between agents and their environment. Originated in biology in the early XX century, niche theories stress the functional notion of *niche* to explain *how* a species occupied its environment in opposition to the geographical notion of *habitat* (Pocheville, 2015). The niche *constructivist* approach (Odling-Smee et al., 2003) goes further, claiming that organisms actively modify their environment in ways that affect the local selective pressure, to the point of establishing an ecological inheritance system. Cognitive niche theories originated in the “philosophical sector” of cognitive science, to stress how human beings’ relationship with their environment was essentially information-based, as their success depended mostly on elevated cognitive capabilities (Tooby & DeVore, 1987; Pinker, 2003). From this perspective, cognitive niches are *constructed* by human actors by externalizing knowledge into the surrounding environment.

For our purpose, we should also underline some other particular features of cognitive niches, which have been provided by the initiators of cognitive niches theories, Tooby & DeVore (1987) and Pinker (2003). First, they describe cognitive niches as a prerogative of the human species as a cognitively proficient species. According to them, human beings in a cognitive niche apply instrumental intelligence to uncover and exploit, in a persistent way, cause-effect models of the external world. Specifically, since the human cognitive system is “knowledge or information-driven”, Tooby & DeVore (1987) highlight the role of the cognitive niche as the environment in which the employment of those cause-effect models of the world represent guides for prejudging which courses of action will lead to which results. Pinker (2003) suggested how human beings’ primary reliance on information and knowledge made “informavore” the cognitive niche. With this term, he highlighted how gathering and exchanging information is the substantial activity that sustains and modifies the welfare of cognitive niches.

Bertolotti & Magnani (2013) have already successfully connected the description of cognitive niches, as structures distributing information and knowledge in the agents’ environment, to the framework of chance-discovery. Activities of chance curation have an environmental (eco-cognitive) dimension and are so rightly part of cognitive niche construction, or, at least, as strictly interrelated with the latter (Magnani & Bertolotti, 2013). We can consider these activities as safeguarding the agents’ discovery and exploitation of cause-effect relationships in the world, their activities of information gathering and distribution, and their efforts to improve the richness of their cognitive niche. The last feature is particularly important when considering the epistemological and cognitive role of chance curation in *virtual* cognitive niches,

which are collaborative distributions of information into the environment using digital encoding.

The activity of cognitive niche construction reveals something important about human and animal cognitive systems. One of the main tenets of this approach is that humans do not retain in their memory an explicit and complete representation of the environment and its variables, but they actively manipulate it by picking up information and resources upon occasion. As already argued (Magnani, 2007), chances – understood as events with a “significant impact on a human’s decision making” – are data, or clusters of data, bearing a strong affinity with the concept of *affordance*, introduced within Gibson’s ecological psychology (Gibson, 1977): it is thus possible to rely on such concept in order to better understand the human part of chance discovery.

Gibson defined “affordance” as what the environment offers, provides, or furnishes. For instance, a chair “affords” an opportunity for sitting, air for breathing, water for swimming, stairs for climbing, and so on. It is important to stress that the notion of *chance* and that of *affordance* are not mutually interchangeable. Indeed, all chances – as qualities relevant for one’s decision making and behavior – are affordances. Conversely, not all affordances rise to the level of chances. However, we can elaborate on a shared characterization of affordances and chances, since they both set a relationship between an agent, her knowledge, and her environment. More than that: chance-discovery and chance-curation could embody the natural follow-up to affordance theory. Chance-discovery and curation are indeed about the discovery and construction, via human-computer interactions and through effective procedures of data analysis, of new complex affordances. In turn, those affordances offer agents unforeseen possibilities for decision making and action.

### Virtual Cognitive Niches and their Domains

We can frame the development of new informational environments through digital technology with niche constructing theory. Indeed, cognitive niches theories permit us to analyze the specific traits that have established human ecological and evolutionary success. Constructing *virtual* cognitive niches, in particular, is a fascinating dynamical behavior that our species alone has shown. The virtualization of niches starts with the creation of meta-environments through the employment of computers and the Internet.

The virtual cognitive niches created through digital technologies go beyond traditional ecologies, their ontologies, and what they can afford. They are the extension of cognitive niches through the informatization of the ecological space. In other words, virtual cognitive niches amplify the human ability to gather and exchange knowledge from the environment and to alter the environment so that it better serves cognitive aims. Indeed, in virtual cognitive niches, tasks of chance curation affect agents with a more extensive range, because instances of knowledge distribution represent the sole acts of ecological and cognitive importance. In virtual cognitive

niches, there is no gap between information and matter, since the latter is there coding, and the only “spatial requirement” is the memory available to host the coding. According to Clark (2005, 256–257), cognitive niches are structures built by animals to transform problem spaces “in ways that aid (or sometimes impede) thinking and reasoning about some target domain or domains.” In this case, virtual cognitive niches do not only have a proper target domain in the information contained in the digital reality but also afford problem-solving in the ecological one to which the digital niche refers.

Specifically, one category of virtual cognitive niches is of particular relevance for the investigation of chance-curation tasks: online communities, such as social networking websites, newsgroups, online chat rooms, forums, and others. They are online-based platforms where individuals interact - either through anonymous avatars or actual profiles, with a network of connections, sharing personal information and contents. These are cognitive niches since they provide agents with ways to gather and exchange information relevant to their decision-making. Otherwise said, they are chance repositories. Indeed, online communities as virtual cognitive niches modify the social pressure of the environment through the employment of forms of explicit and implicit communication performed in the online world. This situation calls for different chance curation strategies in comparison to “material” cognitive niches (Magnani & Bertolotti, 2013).

### **Chance Curation Strategies in Online Communities**

A chance curation strategy that online communities as virtual cognitive niches foster is what we call the “focus on the virtual domain”, which we can investigate through the implementation of Clark’s constructivist take on cognitive niches.

Clark (2005, 256–257) describes cognitive niches as the structures that are built by animals to transform problem spaces “in ways that aid (or sometimes impede) thinking and reasoning about some target domain or domains.” In online communities, the agent’s thinking and reasoning refer to two main target domains. On the one hand, they refer to the *virtual domain*, which is structured on the online platform and includes its objects and tools, the virtual personas of the agents, and the information shared – usually as “posts”. On the other hand, they refer to the *actual external domain*, which includes the agents using the online platform, their local and proximal environment, and the contents of the posts shared in online communities.

Indeed, the pieces of information embedded in posts do not always contain merely virtual contents: indeed, they also provide and refer to data regarding the external and material world. Indeed, one of the most relevant features of contemporary online networks is the extended possibility of sharing information and data regarding news, political events, scientific discoveries, and so on. Moreover, these data refer to external reality, which also encompasses the devices that create online platforms as objects. So, in an online network such as Twitter, we can find a post that links to an online journal’s opinion column regarding the usability and usefulness of Twitter

itself. The contents of that post do not refer to the virtual domain of Twitter, even if Twitter publishes them. Thus, the two domains are different, even if they interact massively.

So, after these clarifications, we can argue that online communities foster a particular chance-curation strategy: orienting the focus of the agents on the virtual domain. The virtual domain contains different cognitive artifacts that implement the communication and the sociability of the agents who share a particular network (as two-people and group chat-rooms, more or less public personal pages and profiles, group selection sharing, and so on). These tools contribute to generating what Acquisti & Gross (2006) called *imagined communities*, which are communities that agent project onto particular networks of people. So, as online communities provide agents tools to get in deep in the connections with the other people in the virtual domain, they also present them the opportunity to create and maintain imagined communities.

More than that: online communities offer agents the chance to keep in mind that the virtual version of people is not utterly equivalent to external and actual agents. The virtual versions appear based on agents’ virtual profile structure, who interact thanks to specific tools of the platform. The “external reality people” are extremely different from their virtual version and, in fact, more socially limited (they are rarely able to express their opinions and thoughts in front of vast audiences, for example). The focus on the online domain permits the agents to keep in mind the difference between virtual and external reality, making them able to adopt adequate behaviors and to exploit appropriate chances. For example, in the virtual environment, formalities and hierarchical positions depend almost only on the digital connection between people: this provides affordances and opportunities that the external reality does not offer (for example, the chance of becoming an influencer without any formal education or training).

As the structure of the network suggests the agents to maintain a focus on the virtual domain, it also enables them to build a docility-based relation with truth and to employ some useful fallacies, which embed social virtues on the framework of online communities. Docility is a concept introduced by Herbert Simon (1993) that describes the human agent tendency to lean on what other people say. The disposition is specifically related to the performance of problem-solving activities conducted on the base of social channels’ suggestions. Relying on aids and resources provided by their fellows, human agents have a significant cognitive advantage. They can trust other people and so have at disposal chances that, first of all, depend on others’ knowledge and experience, and, secondly, that they can easily pick up. Of course, in a situation in the external reality, trust is not informatively empty: one decides to trust another person because she has reasons to do so. The agent gathers several clues to consider a particular source of information as more or less trustworthy. But in an online community, trust can be a more complicated matter.

One the one hand, in an online community the shared information are not neutral – as impersonal or dispassionate:

every agent chooses what to share and when on the base of her interests, her desires and the effects she hopes to achieve through that particular sharing within the online community. On the other hand, every information is bound to the agent who shared it: every piece of data, personal or community related, is presented in the platform because a agent uploaded it and she is accountable for it. On a platform like Facebook, where the information are personally identified, this does not imply the trustworthiness of the information (the agent could share it for all kinds of epistemically wrong reasons), but the trustworthiness of the social connection between the information and the virtual persona. The virtual agent as vehicle for information, is a truth vector between a data and the adequacy of that particular data on her profile. This way, the agents can build an online community that can provide social-based chances, using a docility-based relation with truth.

This last feature leads the agent to adopt a more loose perspective on the use of recognizable fallacies. As suggested by Gabbay & Woods (2005), for example, there is a “doxastic irresistibility” induced by the diffusion of well spread “say so”. They suggest that a docility-oriented system drives to the application of an “ad ignorantiam rule” which describes the agents’ tendency to passively accept information unless they have reasons that stop them from doing so. Of course, the “ad ignorantiam rule” reflects the tendency of the human agent to economize the cognitive efforts in response to a free-given flux of information. Another ecologically well-fit reaction to a docility-based environment is the tendency to apply the *ad verecundiam* fallacy. The agents accept their sources’ assurances because they are justified in thinking that the source has good reasons (agents commit the fallacy when they fail to note that the source does not have good reasons for the assurances).

These tendencies, which are dramatically dangerous in a scientific or political domain, are at the base of the online community interactions: in a framework where there are no socially neutral communications, the validity of shared contents, comments, or notes depend on the trustability of the people who input them in a particular network. In this sense, *ad verecundiam* and *ad ignorantiam*, even if are forms of fallacious reasoning, stand for the cognitive legitimation of spaces of free discussions, where trust and responsibility weight on the agents’ online accountability. Since online communities are socially-driven systems, we can describe these forms of information-displaying processes as chance-curation mechanisms.

So far, we argued that some chance curation mechanisms enacted in online communities as virtual cognitive niches help agents to perceive a more interactive and honest imagined community out of the digital platform. These strategies contribute to increased distribution of information and knowledge (which refers to both domains, the virtual and the actual and external) also in terms of chances and affordances. At the same time, in rich virtual cognitive niches as online communities, we contend that chance curation strategies enacted

by programmers produce the generation of unexpected consequences, related to the interaction of the agents with the enhanced possibilities offered in those systems.

First of all, programmers and designers perform chance-curation by pushing the agents to elaborate the chances at their disposal through feed-back processes. Secondly, but more importantly, they can offer agents opportunities that the programmers did not expect to emerge, both useful and critical to the welfare of the niche. To speak about this problematic issue, in the next section, we will discuss the generation of these unexpected possibilities in terms of “imagined affordances” (Nagy & Neff, 2015) and “critical chances”. In particular, we will consider the case of communications and information-sharing in online communities during crises, which highly demand group interventions and so strong actions in rich cognitive niches.

## Social Media and Crisis Management

Crises, whether natural or human-induced, cause a strong demand for chances. During a terror attack, an incident, a riot, a flood, a fire, an earthquake, and so on, decision-making processes need to be quick and as much accurate as possible. Citizens need to know where they can take shelter, which areas are safe, and which they need to avoid. The government needs to know as much as possible about the emergency to decide where to allocate relief personnel or police forces in case of an attack. Evidence equals chances. Obtaining some evidence is an event that affects decision-making, usually for better (but also for worse, in the case of false evidence).

Data posted by agents over social networks and microblogging websites during a crisis are likely to include evidence that can be used either by other citizens or by the government to adopt adequate actions for the emergency. Otherwise said, social networks and microblogs become rich repositories of chances during crises that just need to be discovered and exploited. The presence of an opportunity does not automatically entail the exploitation of such a chance. For instance, there might not be time enough to situate a potentially game-changing chance, and the decision-makers might have to rely on a slighter chance if it is easier to locate and exploit.

At the same time, highly problematic situations can lead the agents to use certain objects, tools, and devices at their disposal differently from usual, discovering, and exploiting new chances. In rich virtual cognitive niches as online communities, this could lead to a group sharing of this discovery, implying a bottom-up modification of the digital resources and the exploitation of what Nagy and Neff called “imagined affordances”. Nagy & Neff (2015, p. 1) wrote: “Imagined affordances emerge between agents’ perceptions, attitudes, and expectations; between the materiality and functionality of technologies; and between the intentions and perceptions of designers.” In this sense, they discussed the idea of imagined affordances to explain the interaction between agents’ social context, abilities, and purposes with technologies. Those affordances are the results of: a) a productive interaction be-

tween designers and programmers' top-down manipulations of the structures of technologies; and b) the agents' bottom-up feed-back activities (as use, misuse and tentative actions) on them. They also implement "agents' perceptions, attitudes, and expectations" within the possibilities and boundaries of a given technology.

To make an example, we can speak about the process that leads to chance curation in crisis relief, which usually takes the form of enriching posts with tags and hashtags. *Tags* are additional information embedded (usually) to a picture, adding specification about the time and place where it was shot, on its subjects, and, if relevant, on who took it. Tagging, for instance, on Facebook, might directly link the post with other agents' profiles or, in case of a location, to other pictures coming from the same location and further information about it. *Hashtaging*, on the other hand, became originally widespread on Twitter and was later spread to other social networking websites such as Facebook: it implies marking a post with a tag preceded by a hash symbol (#), to highlight its belonging to a specific topic or conversation. The action of hashtagging became widespread for a bottom-up intervention of the agents on the functionality of Facebook posts: it is an imagined affordance that contributed to apply diverse mechanisms of agents' enacted chance-curation strategies on online communities during crises.

Although strategies of chance-curation aim to improve the chance distribution of a particular niche, offering tools and resources to enhance the niche richness (with the implementation of imagined affordances), they can also lead to the development of what we can call "critical chances." A "critical chance" is a chance that conceals a particularly good opportunity or a particularly dreadful risk. It also is the consequence of the further elaboration of chances by the agents, who invest their expectations and interests in a particular niche. The dreadful consequences of a critical chance can also endanger the welfare of the niche, where some possibilities can quickly become dangerous for some agents. One instance of this phenomenon in virtual cognitive niches can be traced in the 2011 Vancouver riots. Following a Hockey match, the city of Vancouver was invested on June the 15th by an unseen wave of hooliganism, vandalism, and looting. Citizens reported on social media to support crisis responders, not only by posting images but by tagging what was happening, where, and encouraging agents to tag whoever they managed to recognize among the rioters. These actions conceal great opportunities for the police forces, and the citizen had explored a chance that led to a particularly good result. Rizza et al. (2014) provide a thorough analysis of the phenomenon. Unfortunately, while the Vancouver Police Department initially asked for citizens' help in identifying the rioters, the situation soon took a grimmer outcome as the grass-roots identification process set the stage for a do-it-yourself justice. The activity of curation, carried out by enhancing posts, misfired because of the "unverifiable quality" of the media and the "unpreparedness" of the institutions. These implications led to the emergence

of a critical chance with a particularly bad outcome, which drove to a case of unintended "Do-It-Yourself Justice", supported by an unclear approval of a "Do-It-Yourself Society" (Rizza et al., 2014, p. 52). Despite the partial societal failure, though, the chance curation activity was successful at letting emerge a series of chances for restoring order, which might have gone unexploited by lack of information. The activity might have pushed the intended chances towards unintended recipients who were nevertheless able to act upon them.

For instance, Facebook was invented as a tool for keeping in touch with friends and acquaintances in a situation of high-and-far mobility, such as the one characterizing the contemporary US. There, people attend higher education in places that are not their hometowns and then move on to their professional careers in yet different locations. Facebook would afford answers to "What have you been up to these last few years?" or "Where did you go on holiday?". But when emergencies took place, agents realized that Facebook and other social networks, developed for other scopes, could afford to answer questions such as "Are you alright?", "What is happening?" (faster than traditional media), "Where should we go right now?". This was the relevant affordance imagined for distressful situations. Concerning hashtags, part of the curation process involves making hashtags as informative and less ambiguous as possible. This is particularly challenging in the phase when hashtags emerge spontaneously and are not enforced from some authority or authoritative group.

Spontaneous hashtags on social media also appeared to indicate resources-as-chances during crises – and not only to circulate evidence. The November 2015 terror attacks in central Paris left hundred of people stranded and unable to return to their homes in the middle of the night. In a grass-roots emergency response, many Parisians volunteered to host affected people. Social networks were the ideal setting for signaling this availability, but the chance had to be curated in order to facilitate recognition, and the #portesouvertes (open doors) quickly circulated. Chance curation, always relating to crisis response, can also be "superimposed" or "guided." Examples can be drawn from the 2015 terror attacks that shook France, first in January, and the already mentioned ones in November. In both cases, a collaborative navigation app, Waze, was put under scrutiny when authorities asked not to signal roadblocks and police cars as these pieces of information might be used by terrorists on the run to avoid apprehension. This reliance on Social Networks to enhance crisis response is a fair example of imagined affordance and the diffusion of so-called "critical chances". They are ways of perceiving possibilities in a certain artifact that were not intended by its developers.

Last but not least, we can frame the Facebook Safety Check tool<sup>1</sup> as crisis response in online communities in this analysis of chance curation. People rely on Facebook, a dominant social network in most of the world, as a provider of chances to know whether dear ones (or mere acquaintances) are hurt in

<sup>1</sup><https://www.facebook.com/about/safetycheck/>

case of major incidents. Usually, people are expected to state they are alright, either spontaneously or after being prompted publicly or privately by someone. Facebook developers curated this chance by introducing the Safety Check. In case of a major mishap in an area where the agent had been previously localized, Facebook asks the agent to confirm she is alright, and then publicly reports that she logged herself as safe: interestingly, this can be seen as the adoption, by the developers, of imagined affordances into the set of intended affordances of an artifact.

## Conclusion

In this paper, we analyzed the activity of chance-curation performed in rich virtual cognitive niches, considering the particular case of online communities.

This paper had three theoretical goals. First we aimed at showing that the cognitive niche framework can foster comprehension with regard to the differences between the cognitive processes enacted in virtual environments and real-life ones. To do that, we presented a comprehensive notion of virtual niches, considering the literature on cognitive niches and niche-construction. Then, we discussed the interesting feature of online communities as rich repositories of affordances as chances, and we pointed out the explanatory relevance of those concepts in cognitive niche theories.

The second aim of this paper was to argue that virtual cognitive niches foster particular chance-curation strategies. In particular, we discussed: the chance-curation strategies that we discuss are: redirecting the attention of agents to the virtual domain, fostering an only-docility-based relation with truth, and increasing the social virtues of fallacies.

Then, our last goal was to investigate some of the most impactful implications of the chance-curation strategies on the discovery and exploitation of chance in online communities. To do that, we have explored the case of chance-manipulation operated in online communities to respond to a crisis. This consented us to analyze the peculiar phenomenon of the exploitation of chances the programmers didn't expect to emerge, both as imagined affordances and critical chances.

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## References

Abe, A. (2010). Curation in chance discovery. *2010 IEEE International Conference on Data Mining Workshops*, 793–799.

Acquisti, A., & Gross, R. (2006). Imagined communities: awareness, information sharing and privacy on Facebook. *Privacy Enhancing Technologies*, 4258, 36–58.

Bertolotti, T., & Magnani, L. (2013). The role of cognitive niches in mediating knowledge, entropy and violence. *Proceedings of the 35th Annual Conference of the Cognitive Science Society*, pp. 954–959.

Bertolotti, T., & Magnani, L. (2015). Cyber-bullies as cyborg-bullies. *International Journal of Technoethics*, 6(1), 35–44.

Clark, A. (2005). *World, Niche and Super-Niche: How language makes minds matter more*. *Theoria*, 54, 255 – 268.

Gabbay, D. M., & Woods, J. (2005). *The Reach of Abduction: Insight and Trial* (Vol. 1). Amsterdam: North Holland: Elsevier.

Gibson, J. J. (1977). The theory of affordances. In R. E. Shaw & J. Bransford (Eds.), *Perceiving, Acting and Knowing*. Hillsdale, JN: Lawrence Erlbaum Associates.

Maeno, Y., & Ohsawa, Y. (2007). Human–computer interactive annealing for discovering invisible dark events. *IEEE Transactions of Industrial Electronics*, 54(2), 1184 – 1192.

Magnani, L. (2007). Creating chances through cognitive niche construction. In B. Apolloni, R. J. Howlett, & J. Lakhmi (Eds.), *Knowledge-based intelligent information and engineering systems* (pp. 917 – 925). Berlin Heidelberg: Springer.

Magnani, L., & Bertolotti, T. (2013). Selecting chance curation strategies: Is chance curation related to the richness of a cognitive niche? *International Journal of Knowledge and System Science*, 4(1), 50 – 61.

Nagy, P., & Neff, G. (2015). Imagined affordance: Reconstructing a keyword for communication theory. *Social Media + Society*, 1–9.

Odling-Smee, F. J., Laland, K. N., & Feldman, M. W. (2003). *Niche Construction. The Neglected Process in Evolution*. Princeton: Princeton University Press.

Ohsawa, Y., & Fukuda, H. (2002). Chance discovery by stimulated groups of people. *Journal of Contingencies and Crisis Management*, 10(3), 129 – 138.

Pinker, S. (2003). Language as an adaptation to the cognitive niche. In M. H. Christiansen & S. Kirby (Eds.), *Language Evolution* (pp. 16–37). Oxford: Oxford University Press. Retrieved from <http://www.isrl.uiuc.edu/amag/langev/paper/pinker03LanguageAs.html>

Pocheville, A. (2015). The ecological niche: History and recent controversies. In T. Heams, P. Huneman, G. Lecointre, & M. Silberstein (Eds.), *Handbook of Evolutionary Thinking in the Sciences*. Springer.

Rizza, C., Pereira, A. G., & Curvelo, P. (2014). “Do-it-Yourself Justice”: Considerations of Social Media use in a crisis situation: The case of the 2011 Vancouver riots. *International Journal of Information Systems for Crisis Response and Management*, 6(4), 42–59.

Simon, H. (1993). *Altruism and Economics*. *The American Economic Review*, 83(2), 156–161.

Tooby, J., & DeVore, I. (1987). The reconstruction of hominid behavioral evolution through strategic modeling. In W. G. Kinzey (Ed.), *Primate Models of Hominid Behavior*. Albany: Suny Press.