Organisational culture and its role in developing a sustainable science communication platform

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\section*{ABSTRACT}

There is an ongoing tension for scientists when deciding to engage with the public about their research as many scientists view direct participation as peripheral to their role. Pressures of time, lack of support by management and a lack of communicative skills are identified by scientists as reasons for not committing to communicative initiatives. We aimed to explore and explain the organizational culture of a research community that activity communicates with the public and has an international research culture. The Centre for Brain Research (CBR) was identified as a model and was analyzed using the concept of Complex Adaptive Systems (CAS). Twelve participants (scientists (8), clinicians (1), community liaison people (2)) and an identified director of the organization were interviewed. Direct quotes from interview were used to provide examples of the characteristics of CAS for example a variety of agents interacting, adapting the learning within the organization, non-linear dynamic behavior that is a result of aggregates of groups with actions emerging from self-organizing behavior and the development of an emergent culture. This analysis showed that complexity theory was a suitable framework for analyzing the sustainable communicative organization within CBR.

\section*{Introduction}

It has long been acknowledged that public engagement with scientists will not happen without scientists receiving recognition for their efforts and a supportive infra-structure being provided in which such engagement can take place. The importance of these factors was highlighted by the findings of the BA/Royal Society Conference in 2004 (The Royal Society, 2007). Subsequently, they have been reinforced in numerous international publications (Dudo, 2013; Poliakoff & Webb, 2007; The Royal Society, 2006).

In various studies, scientists have opined that barriers to communication are time and perceived value. In the BA/Royal Society survey (2006), almost a third (29\%) of the group of 1485 survey respondents believed that taking part in a public engagement activity detracted from the time they would spend on research and was a major drawback to them taking part. The majority (64\%) stated that research activities were more important than outreach and qualitative data suggested a role for the research assessment exercise in encouraging a narrow focus on publishing papers. It was noteworthy that 20\% of this sample agreed that scientists who participated in engagement were less well regarded by other scientists and subsequent interview data provided comments...
that public engagement was done by those who were ‘not good enough’ for an academic career. In fact, science communication was viewed as ‘altruistic’ and not a central part of academic life.

This finding has since been corroborated by work examining motivations for US scientists to undertake outreach with young people (Andrews, Weaver, Hanley, Shamatha, & Melton, 2005). The participating scientists indicated that such activity was viewed as volunteer work outside their normal duties and consequently time constraints due to higher priorities; the lower value placed on outreach by departments; and a lack of detailed information about these opportunities were all significant barriers to participation.

This equivocation about scientists’ views of value of such communication is supported in Besley and Nisbet’s (2013) survey of past studies. Although scientists believed that they should have a role in public debate, they were less convinced of the personal benefits for this investment in time. Furthermore, a secondary data analysis of two large-scale science surveys show that their motivation for participation was complex and there was a need for more research on how organizational factors could influence scientists’ perceptions of the personal worth of engaging in public debate (Besley, Oh, & Nisbet, 2013).

Notwithstanding the perceived barriers that scientists acknowledge there seems to be an underlying acceptance that public engagement with scientists is a worthy undertaking. Having read these reports and being aware that many funders, particularly in the UK, are expecting grant recipients to commit to outreach activities (Palmer & Schibeci, 2014; The Wellcome Trust, 2014), we, the researchers in this study, wanted to explore the management style of an organization that professed to promote science communication.

Furthermore, scientists’ views that the barriers of time and personal benefit are substantiated when they are expected to justify their research funding to management. This career requirement is to the fore when governments have developed policy and funding models that focus on research outputs (e.g. the research assessment exercise or the application requirements of funders such as the Research Councils in the UK). We were interested to see whether the overall culture of a science organization could simultaneously manage the drivers of money and publishing and also encourage employees to undertake communication activities that they reportedly have very little time for. We were also interested in determining whether science communication activities for these scientists enhanced or detracted from their primary research goals.

Consequently we decided to focus on a research organization that actively communicates with the public and identified a group researching neuroscience. Neuroscientists, like all science researchers, are being urged to communicate their work with the public, both to justify public research funding, and also to convey societal implications of neuroscience research (Dowie & Nicholson, 2010). Neuroscience findings are especially relevant for public dissemination as they inform ethical decisions about human behavior as well as health decisions in brain disease (Iles et al., 2010).

In New Zealand, the Centre for Brain Research (CBR) is a centre for neuroscience research. It was selected for this research because its profile was strongly linked to science engagement. Avenues for science communication can take many routes and achieve different outcomes but the essence of public engagement is ‘the involvement of specialists listening to, developing their understanding of, and interacting with, non-specialists’ (as defined by Higher Education Funding Council for England, 2006). Using this definition, the CBR shows a complexity of science communication interactions ranging from: face-to-face discussions to newsletter updates and social media connections (details can be found on their website—www.fmhs.auckland.ac.nz/en/faculty/cbr/our-people/structure-and-location.html). Specific examples of the specialist interacting with a non-specialist include the annual science festival ‘Brain Day’ (which allows Aucklanders to attend workshops, lectures, demonstrations and interactive encounters with scientists) and the annual ‘Brain Bee’ (a national competition where hundreds of secondary students compete for the right to take part in an international competition) (Rowe & Frewer, 2005).

Contrary to the beliefs reported by scientists in previous research, public engagement did not hamper their research; as in the past, this centre has been awarded substantial funding as a Centre
for Research Excellence. We hoped that analysis of the culture within the CBR could provide information about how such diversity of engagement had occurred, how the culture of engagement with the public had been established and if there was an explanation for this culture being maintained.

**Description of the CBR**

The CBR is a partnership between scientists, clinicians and the community that was established in 2009. These scientists carry out neuroscience research with over 300 researchers working in 50 research teams at the University of Auckland. Their disciplines include clinical neuroscience, cognitive and computational neuroscience, molecular and cellular neuroscience, and sensory and motor neuroscience. The CBR accommodates these research scientists as well as neurosurgeons and physicians from the Auckland Regional District Health Boards, along with community liaison workers from non-governmental organizations such as Alzheimers NZ, Epilepsy NZ, Huntington’s Disease Association, Motor Neurone Disease Association, Multiple Sclerosis Society, Muscular Dystrophy Association, Parkinson’s NZ and the Stroke Foundation.

The CBR explicitly states that communication of the centre’s research is a core aim. To make sure this occurs, there are community representatives within its management structure. The web page describes the organization ([www.fmhs.auckland.ac.nz/en/faculty/cbr/our-people/structure-and-location.html](http://www.fmhs.auckland.ac.nz/en/faculty/cbr/our-people/structure-and-location.html)) as being built on three pillars of interaction—that is, by scientists, clinicians and the community. This collection of scientists, hospital organizations and community-interest groups, geographically spread over the wider Auckland region, demonstrate a capacity to communicate not only internally but also with the wider community. The centre also carries out direct health-centric involvement practices (Bovaird, 2007) where community non-governmental organizations are encouraged to interact with the CBR operations, such as fundraising, scientist dialogues, and scientist-patient interactions, which ensure personal experiences inform research decisions (Fogg, 2009).

**Explaining the vision for the CBR**

The Director of the CBR (Distinguished Professor Richard Faull (RF)) was interviewed to provide information about his vision for communication within this organization. It was decided that it would be impossible to anonymize his contribution and he consented to be interviewed and have his opinions documented.

Here he describes the importance of this three-pillar structure in CBR communication:

… part of the ethos of the centre is to show scientists that their science doesn’t just exist in the lab but exists in the community and what we’re doing here is actually serving the community and you must never forget that. That’s why the Centre for Brain Research has these three pillars. You’ve got the scientist, the clinicians and the community and it’s sort of the holy trinity of brain research if you like.

When asked why the structure developed as it did, he talked about the history of the CBR and the role of the Human Brain Bank where tissue from over 400 normal and diseased brains are catalogued and stored. The Human Brain Bank evolved from Professor Faull’s research on the occurrence of Huntington’s and Parkinson’s disease in deceased patients and the experience of families donating the brains of their loved ones who had died:

It started our human brain bank which we didn’t realise we’d started until 20 years later because we unconsciously developed it, you see. Then we found to understand the brain, we had to talk to the community, and so I brought other researchers in from psychology, and I talked with families and had strong links with them, and they went out and talked to the families whose brains we’d received over 20 years ago and got all the stories, and then we found new things which were unexpected so we needed more information. So it grew …

As a result of this long interaction, the facility has a close relationship with the community organizations supporting people and relatives with these diseases:
... with the human brain bank all the different community organisations are involved anyway because they help to put that profile out there.

As the organization has developed and grown, the community links forged through the Human Brain Bank have remained. Over time the number and diversity of communication activities has increased. Big note communication events include:

.. our Brain Week .. and Brain Day [which] is an open day for people to learn about our brain research. We get over 3,000 people coming. We have lectures. We have seminars. We have workshops. We have special activities for children, for kids to have fun with doing plays about the brain. We have brain demonstrations. All the community organisations have their own booths. There’s 13–15 different organisations.

There is a CeleBRation Choir, where people with different types of brain disease meet weekly for a community music therapy session. Another example of science/community engagement is the establishment of a research volunteer register for people who want to be involved in the centre’s research.

To augment communication between individual research teams and the communities they serve, there is the Brainwaves Group.

When asked about the factors contributing to the communication ethos of this science research community, he stated that it was important to document the people and achievements of the centre. He identified a profile booklet that documents people and outcomes at the CBR:

It outlines all the areas of our research activity and all the people working in it, and it’s sort of a bit like the Bible. In addition … we have a website which [our communication liaison manager] keeps right up to date in terms of what we are doing, what things we’ve achieved and where things are going and so on, and that’s a pretty critical element of it.

Pressures of time provided barriers for scientists and especially clinicians with their patient commitments. He recounts how this barrier was overcome by organizing internal communication events in the home territory of the clinicians:

We have communication activities which bring the researchers and clinicians together. Once a month we have our CBR Seminar Series where we have a scientist presenting and a clinician presenting in a particular area. We have that over in the hospital. So all the scientists get out and walk across the road and that’s a mindset change. They’re actually taking their research … over there you see and so the important aspect … is that the clinicians are busy, but if we meet on their territory … it breaks down the barriers.

Overall, Professor Faull describes the culture and activities in terms of New Zealand’s relationship to rugby. In 2011 the national team of All Blacks won the rugby world cup:

... I don’t use the term ‘All Black’s team for brain research’ lightly. That’s what we are in a way. If you regard all the research groups as being all the little provincial rugby teams in their different ways, and bringing it together and capitalising on the strength; everyone basks in the glory you see.

He suggests that the success of this team could be attributed to a high level of provincial involvement. His premise is that this level of involvement provides people with the justification to feel good about their success. Whether such an analogy is pertinent when describing the collective contributions of all members of CBR, his comments reflect a view that everyone in this community contributes and enjoys the reflected glory of the achievements of CBR research and clinical outcomes.

We propose that this interview provided us with evidence of Professor RF as a driving actor whose value orientations and dreams for this community could be identified as ‘science communication as policy’ (Ogawa, 2013, p. 9) in that his management style influenced how this community of participants interacted with various communities.

### Justification of CAS as an organizing framework

Rather than researching to identify the communication model that best described the CBR’s communicative interactions (Stockylmayer, 2013), this project was focused on how such a community
had developed to produce such a strong and sustained engagement. Recognizing the complexity of interactions between researchers, clinicians and the community of support (government and non-government) (Figure 1), we identified a concept of management that appeared to explain how this myriad of science communication events had evolved and been sustained in this organization. The concept of Complex Adaptive Systems (CAS) originated as a way of explaining biological systems and it has been used in management to explain multifaceted human interactions (Holland, 2006). It was decided to use this organizing framework to analyze participant interviews, in order to uncover the complexity of interactions in this science communication field (Stockylmayer, 2013, p. 32), and provide some information about the organization of this community.

CAS are defined as systems that have a large number of components (agents) that interact and have the capacity to adapt and learn (Holland, 2006, p. 1). CAS is used to understand diverse contemporary problems: for example when identifying and explaining business systems that support innovation; when understanding how markets react to changing economies; when explaining the ecology underpinning the preservation of ecosystems; when considering how to control the internet.

This paper provides research data illustrating how CAS could be used to explain how science communication is made effective with a loosely connected group of components; that is agents working singly, in groups or as a complex organization. The underpinning concept is that it is the diversity of agents interacting with each other and mutually affecting each other which generate behavior for the system as a whole.

Harkema’s (2003) interpretation of CAS suggest that the way in which agents interact and the strategies they pursue within an organization, have properties that are identified as non-linear (dynamic) behavior. These properties result from aggregations of groups where the actions emerge from this group activity which is self-organizing. The flows of information and resources that result from this interaction can be influenced by ‘tagging’ (i.e. naming) as well as the modeling of implicit values that can be replicated in different circumstances. The following discussion explains the properties of CAS and then identifies the mechanisms that could be considered to alter the evolutionary direction of such an organization (Holland, 1995).

The first feature of a CAS is that it must contain a diversity of agents who are the decision-making units and who drive the evolution of the communicative process by their interaction and the strategies they pursue (Harkema, 2003). The CBR has such an organization of diverse agents—that is scientists, clinicians and support communities all interacting. If these individuals are provided

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**Figure 1.** The communities involved in the CBR
with support there is the potential for them to form aggregates—that is collections of self-organizing
groups whose behavior together provides a greater impact than would be expected as individuals (Clippinger, 1999).

Aggregation is an emergent property. For example Holland (1995) illustrates such emergence
when describing a game of chess where the outcomes (moves and endpoint) depend on the inter-
action of the agents playing within the rules of the game. Each of the players will affect the outcome
through the strategies chosen by each player and the mental models that each player employs. He
asserts that throughout the chess game, player (agent) interactions will provide differing feedback
—consequently the process is complex, the outcome is unpredictable and emerges bottom up, rather
than a predicted (top-down) outcome. Furthermore the emergent outcome (the whole) is greater
than the sum of the parts. It was anticipated that emergent outcomes could arise from differing
activities of the agents (members of the CBR) and perhaps the whole would have a greater effect
than individual action.

Another property of CAS is the presence of flows, webs or networks of interactions. The direction
of such interactions can be altered by ‘lever points’, where a simple intervention can cause a lasting
effect; for example an introduction of a vaccine into an ecosystem (Harkema, 2003). Such a ‘lever point’
could be linked to the mechanism of ‘tagging’, which labels or gives significance to something
that links it to action (Clippinger, 1999). It appears that tags can launch group self-organizing beha-
viors, and it would be useful to see if firstly, there were lever points visible that provoked a long-last-
ing influence on this community, and secondly, whether the mechanism of ‘tagging’ occurred.

Another characteristic of ‘tagging’ is to label or perhaps identify membership. This mechanism
could provide boundaries to a CAS. Holland (2006) explained this mechanism using a cell metaphor,
where he observed that cell boundaries are attuned to chemical signals. It would be useful to identify
the way in which the boundaries of the CBR are signaled; for example how the language and mod-
eling of the CBR director are picked up by the interacting agents (scientists, clinicians and commu-
nity liaison organizers).

In contrast to linear behavior, where there is a causal relationship between input and output,
there is no linearity of behavioral interaction in a CAS, so minor changes and variations can
lead to unexpected and unpredicted effects that can increase over time. Lorenz called this the ‘but-
terfly effect’, where small changes at one point can lead to larger changes later on (Lorenz, 2000).
This property of non-linear behavior (dynamic behavior) is caused by the interaction of the indi-
vidual, the aggregate (group) and contextual elements making up the system. This dynamic behavior
has the potential for developing complexity because of the variables that are possible not only
with the agents but also with the context in which each interaction may occur.

Within CAS, interactions tend to behave in a self-organizing way. That is not from rules imposed
from management, but instead an accepted way of acting emerges from the process of the inter-
action. These actions can be enhanced by internal modeling by fellow members of the group, and
by a process of replication where associated repertoires of action develop as the group recognizes
the reusability of their activities and exploit different communication situations (Clippinger,
1999). For example, ways of interacting with groups both large and small are presented then refined
and reused.

This self-organization tends to adapt over time in response to the professional situation where
these agents work. This process is open-ended and can result in the evolution of an initial simple
system into one that demonstrates an increasing diversity of interaction and signaling (Holland,
2006). It was anticipated that examples of self-organization would be apparent in the CBR.

Finally, the energy for CAS is provided by diversity. With greater diversity of agents there is
greater opportunity for new interactions. When Clippinger (1999) makes links to CAS within
business models, he regards diversity ‘as a form of economical and social wealth’ (p.15). Conse-
quently, this property of CAS will be given significant attention, as it is apparent that the variety
of people working in different contexts within the CBR are the drivers for this communicating
community.
The research data will be analyzed using the significant properties and mechanisms of CAS. They are the

- diversity of agents;
- non-linear (dynamic) behavior resulting from interactions;
- aggregation of agents that result in an emergent philosophy and action;
- webs and networks of interactions that are affected by tagging and
- mechanisms (tagging, using models and building blocks) that enhance this CAS.

As mentioned previously, the organizing framework of CAS can be used to explore a range of different elements of management and organizations. In this study, we focused on how CAS could help explain the development of an active science communication culture within a research institution. It is hoped that such an analysis could contribute to an understanding of the importance of the management structure in supporting science communication generally.

**Methodology**

The overall research question framing this research is:

How does a sustainable science communication culture develop in an organization?

It was important for participants to have the space to explain and reflect on their science engagement and communication about science; therefore, an interpretivist methodology was selected (Neuman, 2011). When developing the research design, it was anticipated that a potential conflict of interest could have arisen as one of the research team (Laura Fogg-Rogers (LF)) was the communication liaison manager for the CBR. Her involvement in this research could have affected who chose to take part, as well as their responses. Consequently she absented herself from the selection of the participants and their subsequent interviews.

A large pool of interview prospects were purposively sought to represent a range of views from across the diversity of job roles in the CBR. Ethical agreement was provided by the University of Auckland Human Ethics Committee and Laura provided a list of interview prospects ($N = 46$) that included clinicians ($N = 5$), principal investigator scientists ($N = 19$), early career science researchers (postdoctoral fellows and doctoral students) ($N = 17$) and community group representatives ($N = 5$).

As scientists make up the largest proportion of the CBR, six scientists were selected from the principal investigator scientists and early career researchers. To counter the criticism that these scientists were selected to provide a biased positive view of the organization, they were identified according to their level of public engagement involvement in the CBR: two with high involvement—more than five activities per year; two with moderate involvement—around three activities per year; and two with low activity—one or no activities per year. Two clinicians were contacted to provide their perspective on communication activities while working with the CBR and the Auckland District Health Board. Two community liaison people were also contacted to represent these groups engaging with the CBR.

Ten participants were purposively selected from this list by the two non-CBR research team members. They sent out invitation letters, conducted the interviews, returned the interviews to participants for editing and anonymized the data before analysis.

In total, 12 participants were interviewed, which was a deviation from the expected sample size and composition. Clinicians proved difficult to recruit to the project due to their time constraints. Consequently interviews were conducted with one clinician (medium involvement), two community liaison people (one medium and one high involvement) and eight scientists (four high, two medium, two low involvement).
In addition, the Director of the CBR (Distinguished Professor RF) was also interviewed and the reasons for his identification have been previously explained.

The following semi-structured interview protocol provided the base line for the participant interviews. These questions were posed to identify their communicative interactions, their awareness of the culture of the CBR and how their communication interactions had been viewed and supported.

1. Describe a science communication activity that you have been involved with while working at the CBR.
2. What did you do?
3. Who got you involved in this communication event?
4. Why did you agree to participate?
5. Why do you undertake these communication activities?
6. Could you please describe the culture around communicating science in this organization.
7. How do you think this culture has developed?
8. Who are the key players and why are they key?
9. What contribution do you feel you make to this culture?
10. How is your contribution supported?

When quotes are used they are identified as: Scientist—S, Clinician—C and Community Liaison person—CL. It was considered that it was not appropriate to record their level of involvement as this would be a key identifying feature. Quotes from Professor RF and the reporting of LF’s work as the community liaison manager are also identified.

Data analysis

Firstly, all the participants were asked to describe a science communication activity they had been involved with and what they did. As expected, there were a variety of activities for example: a clinician and scientist taking part in a CBR seminar discussing the potential clinical direction that the science was going to take; a scientist engaging with a group of young children to tell them about their research; a focus group discussion with Parkinson’s disease sufferers and their family about the feasibility of choir therapy; community groups manning their stalls at Brain Day; new scientists speaking at the Brainwaves group for emerging researchers; an emerging scientist giving a public lecture about dementia; scientists interacting with families at a Human Brain Bank meeting; scientists taking part in a Talking Heads program at the Auckland Museum; emerging scientists in the Brainwaves group organizing outreach for scientists and Ph.D. students at an intermediate school; scientists developing the Brain Bee challenge and planning for new people to run it; workshops organized by scientists to enable emerging researchers to present at science seminars; and senior scientists speaking at a fundraising event. All these stories about how the participants communicated demonstrate not only the diversity of activity that is possible for participants in this community, but also how they responded to these engagement challenges.

The descriptions of their interactions showed that these participants knew that there was a place for their preferred interaction; ranging from child to scientist or scientist to clinician, and everything in between. The quote that summed up this awareness that everyone could be a participant in the way that suited was provided by the scientist who noted that it was not uncommon to see a scientist playing on the floor with a child during the Brain Day:

...you’ve got all sorts of different ways of being able to do it and I think people will find their own niche. We recognise that there are different forms of dissemination and communication and some will be very good at certain types. When you have these open days as an example and it surprises you who actually steps up. They may not be delivering a lecture because it may not be their thing but interacting with kids on the floor playing [with models of brains] or something, they just love it. So everybody finds something I think. (S.5)
The following accounts provide examples from CBR that illustrate diversity of these agents and their interactions.

**Diversity of agents**

Holland (1995) asserts that agents are at the heart of CAS and these agents can be individuals, teams or organizations. The following examples demonstrate that this diversity of interaction.

**Scientist to scientist:** An important skill for scientists is an ability to talk about your work to the science community; this is practiced in the CBR through a group called Brainwaves (catering for up and coming researchers). A scientist discussed running the group for:

... young scientists mostly at early postdoctoral level and PhD students who actually practice to communicate their science to the larger audience. ... they get feedback from their peers who can give a different angle, and sometimes they are more critical than the supervisors, ... most of the senior researchers attend these events, so it’s a rather unique way to actually communicate science. (S6)

**Scientist to clinician:** A clinician talked about a presentation they shared with a scientist at a CBR seminar. They spoke about a future study and the possible future directions of treatment for patients. The clinician was unsure of the value of this interaction before taking part:

It was really interesting because even on the day, and leading into, I was thinking this is going to be a complete waste of time. I just imagined standing up there, saying stuff, having all these questions and then dead silence. That’s what I thought potentially could happen. But it was actually the complete opposite. And afterwards, for the whole rest of the day I was just blown away. I was like, wow sometimes these things do work. (C1)

The clinician reflected on the benefits of having these seminars despite their time pressures:

So I think the culture, it is driven passionate people that want to ... collaborate with each other, but it’s finding those interlinks, and also from a clinical point of view, it’s just finding the time. Cause we are just, between seeing patients ... and all the teaching and stuff, there is hardly any time ... I think the recognition of the importance of the marriage between scientists and clinicians. [And] what I benefit from is the sort of clarification of things that I wonder about and think about for patients. (C1)

**Scientist/clinician to community liaison workers:** A component of the CBR are the field workers who liaise between the community support groups and the scientists and clinicians. This community liaison field worker felt secure that there was an opportunity to check on information with scientists at the CBR:

A lot of our people are looking at the internet now. They ring us up and say we’ve just seen this and we’ve just seen that. Or what do you think about lemon balm and all the rest of it. And it’s so good to be able to ... speak to one of them [scientist]. There’s a lot of people doing research and we can just check up and say what do you think, where is it up to? The vaccines and things like that coming through. So you know you’ve got that back up there. (CL2)

**Scientist to support organizations:** Links to support organizations are common with most participants indicating a commitment to engaging with these groups. A senior researcher commented about these interactions:

We have to ... have relationships with people that are real and sincere and involve them in being part of what we do ... I think the Centre for Brain Research has actually been doing that for quite some time with respect to the lay societies that have supported the Human Brain Bank. It’s that relationship that ... was established quite some time ago through that research work. I think that the relationship that was established with the purpose to receive the bequest of tissue to the brain bank has been extended in a much, much broader sense to really encompassing and working with the community. It’s one of the pillars of the Centre for Brain Research. (S4.)

**Non-linear dynamic behavior**

A feature of dynamic behavior is the butterfly effect, where minor changes and variations could lead to unexpected effects that increase over time. For example, the need for a close association with
donor relatives from the Human Brain Bank has resulted in a culture where community associations are nurtured and valued:

I think that relationship that was established with that purpose to receive the bequest of tissue to the brain bank has been extended in a much, much broader sense to really encompassing and working with the community. And it’s one of the pillars of the Centre for Brain Research and it’s evident not just in the CBR, but I think it’s evident in the university now; the importance of developing these relationships. (S4)

The effect of this initial contact multiplied to a recognition within the CBR of the importance of building bridges between community groups:

… if we don’t put our research out there and the importance of what’s been done and trying to build that bridge between community groups and raising awareness, but also the clinical side of things … I think yeah it would be a very small community because no one would know about it. (S3)

And from the community perspective, the close ties with the CBR had the flow-on effect of increasing their professional standing as an organization:

Yes. It’s an important connection. But NGOs in the past have not been regarded very well. So it was my desire when I joined up here with [the organisation] to professionalise it If we had professionals in the key roles, we could then actually bridge the gap with the clinicians and the researchers … So we actually need to be regarded as yet another professional body that happens to be a not for profit. So that’s what we’ve been working at and we seem to have established ourselves at long last. (CL2)

The next section illustrates the property of aggregation where this group of scientists have demonstrated an emerging awareness of the responsibility of scientists.

**Aggregation of agents that result in an emergent philosophy and action**

An emergent feature from all these interactions is the scientists’ self-realization that they have an obligation to communicate science that is accessible to all. One scientist voiced this obligation:

Yeah I think it’s the responsibility of scientist to be able to do that. I’m grateful in many ways to have received funding that I have got that allows me to pursue my passion for science and my research and I’m well aware that this is publicly funded money that people have donated to and so I see it as part of our responsibility to get out there and tell the public what we’re doing with it. (S1)

As well as being a responsibility, another scientist commented that nowadays a culture of communication had evolved where it was assumed that many people took part, rather than just the senior ‘stars’:

… I think it’s an evolutionary issue. Probably in the past there wasn’t much of a culture that supported it and if there was … the communication was done by people who were fairly senior. I know that there was always edicts would go out and say you mustn’t communicate with the media unless you’ve had it approved by the dean or something like that and that’s sort of shifted. (S5)

Alongside the commonly held view that communication was the responsibility of everybody, there was an awareness that not everyone was able to identify opportunities and adapt their methods of presenting their work without assistance:

… I think a lot of people who have spent a lot of time in universities find it quite difficult to know how to best convey information, because you are trained in this very, very specific and very dry way. It often takes other people to come in and say; these are opportunities to present our work, this is how you might want to do it, these are the kind of activities that can take place. Then people tend to be pretty keen and jump on board once somebody has actually set those foundations in. (S8)

Notwithstanding this difficulty, there was an acknowledgement that the science may not be understood, even by other scientists. This scientist noted that there was the need to explain the science, without compromising its integrity, when making it easy to understand:
we’re very keen at communicating our science to other scientists but the interesting thing is [that] other scientists don’t necessarily understand what you’re saying either. You do have to still get your story across and being able to communicate the story but not denigrate the science. (S5)

This scientist went on to reveal an awareness that there are different audiences to be catered for:

I think what’s important is that we are true to what we’re trying to do so we have, and we recognise the different groups actually require a different strategy. There’s no point in going to the community groups with very, very detailed science information but you don’t want to dilute the science, you want to actually make it more accessible. (S5)

This emerging awareness of the complexity of such engagement was indicated by this scientist commenting about the need for active mutual involvement between engaging participants:

… there’s a realisation now I think amongst scientists and in the university itself that we do have to be much better at communicating what we do if we want people to support us … We have to actually have relationships with people that are real and sincere and involve them in being part of what we do. (S4)

And the need for mutual involvement was signaled by this scientist, who realized that such communication activities are intertwined:

Part of that communication with [the] public is about demonstrating and feeding back what you’re doing but demonstrating the quality of science and therefore getting people to support you as a research community, so it’s all entwined. (S5)

This emergent view of the interconnectedness of the different teams resulted in action—communication training for graduates:

We’ve got this three pillar idea we’re keen that we sort of develop teams where the graduate student in particular might be teamed up with a clinician who normally has got some sort of community interaction anyway, so you end up with students understanding learning a lot about conditions they might be working with, almost by osmosis process. (S5)

This web or flow of interaction with the public was augmented by actions (interventions) that created an environment where such self-organizing systems could emerge.

Web and network flow of interactions

It became apparent that together with an emerging understanding that effective communication was a complex activity, there was a developing awareness that it was important to enable all members of the CBR to communicate more effectively.

One scientist commented that although this supportive culture had emerged, they still needed help:

Supporting people and making, introducing them to the idea that people should do it and that they can do it and that it’s important …. One thing that might be useful is more help. We have had a few seminars and workshops but [need] some more input into training people to do it because there might be people who aren’t very good at it, or are enthusiastic about it but could do with a bit of training. (S7)

While another scientist commented that workshops were occurring to support such science communication activities:

I don’t know quite how well they’ve been going but we’ve set up so the media training and science communication training and the groups that really take to it are the graduate students and the younger people. We require them to participate in community activities and communicate their science to lay audiences or an informed but non-scientific group. (S5)

It appears that lever points (Harkema, 2003) were responsible for funneling changes in behavior and outcomes. For example, the appointment of the communications manager was such a lever point. Her role was to package all the activities of the CBR and provide a framework for the diversity of interaction:
I think because Professor Faull has ... employed people who are skilled, not only in the science but skilled in communication. You have a communicator who’s trained in marketing who is a scientist by trade, who can put feet in lots of camps and join people together. (CL1)

More specifically, there was an element of tagging that occurred, with LF giving significance to the formation of committees involved in organizing and supporting communicative interactions. The way in which these committees work is described by the following scientist who chairs a committee of 10 that meets during work time. He commented that this committee commitment is valued by the CBR with minutes going to LF who is the link to management. This researcher illustrates the role of tagging, in that their committee work is valued and recognized with this formal reporting:

But there’s definitely a culture there of supporting it. People are made aware, introducing them to the idea that people should do it, they can do it and that it’s important. I feel like I’m very well supported by people like Richard and others within the centre, in my role as the chair of the [xxxx]. (S7)

This committee’s autonomy is evident from this scientist’s comment that the committee minutes inform the group rather than the management:

Well I think it’s nice that it’s informal, that it’s something that’s done by the students and the junior people. It’s bottom up not top down, so I think the idea is that by leaving us to let it develop how we want it to develop, it’s not seen as if we’re being told what to do by Richard or other people. It’s definitely supported and it’s something that Richard is very clear, he wants us to do [it] but it can be done on our [terms]. (S7)

An acknowledgment of the autonomy of the committees gives significance to a flat management structure, which is evident when this scientist talks about arrangements for the strategic planning meeting that occurred at the beginning of the year:

… we’ve got for example our strategic planning meeting coming up in February. We’ve got half the day where the community groups as well as the clinicians, as well as the scientists, will be there together. (S5)

An indication of support was the following comment from a scientist who noted that there were more representatives wanting to come than could be accommodated:

Yes, we’ve had to be a bit selective because we don’t have a room big enough but it’s trying to sort of acknowledge that those groups actually do have, or have the opportunity to have a voice into the organisation. (S5)

**Mechanisms enhancing communicative interactions**

Tagging can also be employed overtly, such as the presentation of the communication activities to the wider world. Such branding appeared via publications. These scientists commented on the publicity brochures as well as the magazine *Connections*, indicating yet another component of this communication network:

I think the profile of the CBR is fairly large and a lot of that I think has come through having really nice brochures ... But I guess that’s letting people be aware of the organisation. It doesn’t necessarily involve communicating science to them. ... we could do a lot more for actually communicating the science. But I think that will come in time. I think it’s something that first of all you have to be seen as being a reputable outfit. (S1)

Less obvious but equally important are the mechanisms of modeling and the replicative process of providing building blocks that are proposed in this concept of a CAS management style. As Clippinger (1999) states, internal modeling is a way of presenting types of models that could anticipate internal behaviors. He unabashedly calls these internal models ‘stereotypes’. It needs to be acknowledged that the modeling of a desired communicative behavior by the leader of a community could be perceived as being directive and provoke unanticipated negative responses. However, it appears from the comments made about Professor RF’s way of interacting with the CBR and the wider community that in this situation his modeling of communication strategies provided a mechanism to enhance the capacity for individuals to communicate.
Comments by the members of the CBR reflect the power of his modeling on the continued evolution of this management structure. The following quote demonstrates that this scientist is aware of the evolving nature of this culture with RF modeling this ethos but now devolving many responsibilities. However, he acknowledges that RF still is the motivational heart of the CBR:

I think, well obviously Richard Faull is sort of the head of the whole centre and it really has coalesced around him in that way ... what he has done that is reasonably unique in my experience of these things ... he has remained as someone who has this kind of motivational role in the centre and has devolved a lot of the responsibility for different things to other people in the centre. So he hasn’t kept it as an empire. He has this pretty flat structure and he wants people to have an input and for younger scientists to have a role as well. (S8)

As well as modeling his views on management, Professor RF’s comments about the importance of communication show that his commitment is heart-felt:

... well I think communication is at the heart of what good science is. It’s not right to do science in oblivion of the people who are going to benefit from it. We’ve got to tell them the good news, we’ve got to give them hope. We won’t solve all the diseases, we haven’t solved any disease but just for them to know we’re doing this is huge. That’s important. (RF)

Instead of directing staff to take part, he has led by example (modeled) and explained why he believes it is important. This scientist is able to identify with RF’s vision:

Well ... like I said earlier Richard has kind of led, it’s the way he does things and he’s been very good at making people, [see], the importance of communicating your science to the community. (S7)

Another mechanism in CAS is the use of building blocks which enable the development of a complex organizational structure. Rather than developing new solutions or activities, such repetition can provide efficiencies in the repertoire of actions that may occur when people are setting up communicative interactions. Consequently the use of building blocks may reduce time and energy expended by individuals.

A reiterating refrain from these scientists was the pressure of time and little time for communication with the community:

I think finding the time is a really key problem. (S8)

An example of building blocks in action at the CBR were the set of guidelines that the communication manager put in place. These guidelines were constructed to accommodate the variety of communicative activities as well as the people (agents) taking part:

She ... creates these opportunities and communicates them really clearly, and tells people what is expected. Not in a harsh way, but just to empower them. (S3.)

Communication strategies also provided access to these communities, as well as guidance about the coherent message of communication about science and the interactions that were possible:

now that she’s [LF] come on board in her role [of] communications officer ... she’s put a lot of systems in place to try and enhance ... and make people aware of getting other people out to the community. (S3)

**Discussion**

The CBR provided a rich case study for analyzing a science communication culture. We assert that its diversity of agents and activities provides an appropriate model for many large research organizations. Lewin and Regine (1998) argue that the management within such organizations is undergoing a paradigm shift from the more traditional linear, hierarchical organization, to a model built on the principles of complexity theory. Based on this assumption we used a lens of CAS to learn more about how science communication at the CBR is sustained.

As well as the variety of interactions and agents involved with communication at the CBR, this research has identified the following examples of emergence. These are: that scientists have an
obligation to communicate science; that science needs to be communicated on the listener’s terms; and that scientists carrying out this communicative activity need training.

It appears that the mechanisms of tagging, modeling and providing building blocks enhanced the communicative interactions within the CBR and enabled a CAS management style to evolve. Tags were officially used to identify and celebrate connective behavior with branding in the official magazine *Connections* while less overt tags were used to identify the importance of committee work and structure that contributed to complex adaptive management. Professor Faull ‘managed’ the communicative activities of this organization by recognizing and rewarding (tagging) behaviors that showed initiative. He managed people by supporting them to self-organize/aggregate around their favorite topics/research interests. The following quote illustrates how this philosophy of self-management works:

… we try not to become directive and we are hell bent on providing an environment which facilitates collaborative research. (RF)

The following comment from Professor RF identified his views about the obligation of scientists to communicate with the public:

We see it as a responsibility that you’ve got to keep. Universities are here to serve the people. It’s as simple as that. We are the repository of knowledge. We need to let them know and understand some of the excitement going on inside their walls. A lot of that excitement results from their collaboration and it is actually right and proper that you should thank them and tell them what you are doing. We have very strong values and the very nature of our research … because it’s ultimately paid by the community or the public or the government … we are accountable. (RF).

His modeling of this obligation is echoed by the scientists in the CBR, with one asserting that communicating science was critical:

I would say it’s like giving back to the community (S8).

This analysis has shown that the concept of CAS has the capacity to illustrate a management style that fosters communication amongst this variety of people working and interacting with CBR. Rather than a hierarchical management structure, this evolving communicative community illustrated the properties of CAS in action (i.e. aggregation, non-linearity, flows and diversity) as well as the techniques (mechanisms) that managers can use to effect changes in an organization.

It would be presumptive to draw lessons from this research that could be applied to other organizations and individuals. We are aware there are other organizations developing their own communicative strategies, but we hope that this story of communication and its management will allow others to reflect on the similarities that they may encounter in their organization. In summary it could be said that this communicative science culture was enhanced by role modeling of communication at the top levels and by the appointment of a support person who could remove administrative barriers and facilitate aggregation of interest groups allowing training and empowerment to emerge.

But perhaps the secret ingredient within a sustainable communicative community is as Professor RF says:

Putting science first, it’s putting people first, and it’s talking to everyone that matters.

**Disclosure statement**

Laura Fogg-Rogers was the Communications and Liaison Manager for the Centre for Brain Research at the time this research was conducted.

**Note**

1. Centre of Research Excellence (CoRE) were established in 2001 to encourage the development of excellent tertiary-education-based research that is collaborative, strategically focused and creates significant knowledge transfer
activities. The CBR is co-host for the Brain Research New Zealand—Rangahau Roro Aotearoa research group that was confirmed for five years of CoRE funding in 2014. http://www.royalsociety.org.nz/programmes/funds/cores.

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