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

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Abstract

There is an on-going 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 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 analysed using the theory of Complex Adaptive Systems. Twelve participants (scientists (8), clinicians (1), community liaison people (2)) and an identified director of the organisation were interviewed. Interview quotes were used to provide examples of the characteristics of Complex Adaptive Systems for example a variety of agents interacting, adapting the learning within the organisation, non-linear dynamic behavior that is a result of aggregates of groups with actions emerging from self-organising behavior and the development of an emergent culture. This analysis showed that complexity theory was a suitable framework for analyzing the sustainable communicative organisation within CBR.

Introduction

It has long been acknowledged that significant public engagement with scientists will not happen without scientists receiving full 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; Royal Society, 2006).

The highest barriers to communication are time and perceived value. In the BA/Royal Society survey (2006), the majority (64%) 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. It was significant 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. A review of past studies on perceptions of engagement also indicated that scientists viewed direct participation and involvement with the public as peripheral to their role, and there were no personal benefits to them (Besley & Nisbet, 2011).

However, these pressures aside, there seems to be an underlying acceptance that public engagement is a worthy undertaking. The BA/Royal Society results showed strong agreement (70%) that funders should support public engagement activity and there needed to be guidance and supportive structures for public engagement work; for example mentors, technical help and direct support from science communicators. It was significant that 73% of junior staff within the sample commented that support from their head of department would encourage them to undertake public engagement activities.

Having read these reports and being aware that many funders, particularly in the UK, are expecting grant recipients to commit to outreach activities (The Wellcome Trust, 2014; Palmer & Schibeci, 2014) we, the researchers in this study, were interested in the role of organisational culture in science communication. Consequently we decided to focus on a research organisation 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 (HEFCE), 2006). Using this definition, the CBR shows a complexity of science communication interactions ranging from; face to face discussions, newsletter updates and social media connections (details can be found on their website – www.fmhs.auckland.ac.nz/en/faculty/cbr.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).

Contrary to the beliefs reported by scientists in previous research, public engagement did not hamper their research as these research scientists were able to carry out significant internationally relevant research. The centre has been awarded substantial funding as a Centre for Research Excellence[1]. Indeed, it appeared that this science research activity paralleled their engagement as active communicators (www.tec.govt.nz/Funding/Fund-finder/CoREs/Current-CoREs/). Therefore, we hoped that analysis of the culture within the CBR could provide information about how such diversity of engagement had occurred.

Such a culture does not appear out of nowhere. As well as asking the obvious questions;

- 1) Why is this organisation so successful at communicating? and
- 2) Why do so many scientists participate in CBR communicative activities?;

We believed it was important to find out 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 Centre for Brain Research (CBR)

The CBR is a partnership between scientists, clinicians and the community that was established in 2009. These scientists carry out internationally recognised 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 organisations 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.

From the outset it is obvious that the CBR has a slightly different approach to science communication. It is one of the few research organisations that the researchers have come across which explicitly states that dissemination of research is a core aim and also includes community representatives within its management structure. The web page describes the organisation (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 organisations 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 organisations are actively encouraged to interact with the CBR operations for example; fundraising, scientist dialogues, and scientist-patient interactions, which ensure personal experiences inform research decisions (Fogg, 2009). It appears that science communication is alive and well within this Centre of Research Excellence, supporting their core assertion that 'scientific discovery and dissemination are at the heart of everything we do'.
A diagram illustrating this organization is shown in Figure 1

Understanding the vision for the CBR

The Director of the Centre for Brain Research (Distinguished Professor Richard Faull) was interviewed to provide information about his vision for communication within this organisation. It was decided that it would be impossible to anonymise 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.

[Figure 1]

Figure 1. The communities involved in Centre for Brain Research

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 initial involvement of researching the occurrence of Huntingdon'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 organisations 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 organisation 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.

Then the description of science communication activities continues with the 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.

Professor Faull also raised the challenge of scientists communicating between individual research teams.

> We also have the Brainwaves Group. This is a group of our emerging neuroscientists and they organise a seminar series and workshops and so on. So that's communicating at that level.

These formal communication networks were augmented by members of the community attending and sometimes contributing to these research seminars.

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.

However, lack of time as a barrier for public engagement was also recognised by Professor Faull. In fact, he noted that time is even more of a barrier for clinicians than scientists in this centre. He recounts how this barrier was overcome by organising 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 as:

> …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.

This interview provided us with evidence of Professor Richard Faull as a driving actor whose value orientations and dreams for this community, could be identified as 'science

communication as policy' (Ogawa, 2013, p. 9), influencing how this community of participants interacted with various communities.

Justification of CAS as a theoretical framework

Rather than researching to identify the communication model that best described the CBR's communicative interactions (Stocklmayer, 2013), this project was focused on how such a community had developed to produce such a strong and sustained engagement. Recognising the complexity of interactions between researchers, clinicians and the community of support (government and non-government) (Figure 1), we identified a need for a theoretical lens through which to make sense of this myriad of science communication events. The theory 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. It was decided to use this theory to analyse participant interviews, in order to uncover the complexity of interactions in this science communication field (Stocklmayer, 2013, p. 32), and why this organisation was so successful in communicating.

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; and when considering how to control the internet.

This paper provides research data illustrating how CAS could be used to explain and theorise how science communication is made effective with a loosely connected group of components; that is agents working singly, in groups, or as a complex organisation. This theory asserts 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 organisation, have properties that he identifies as non-linear (dynamic) behavior, that result from aggregations of groups where the actions emerge from this group activity which is self-organising. The flows of information and resources that result from this interaction can be influenced by 'tagging' as well as 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 organisation (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 organisation of diverse agents – that is scientists, clinicians and support communities all interacting. If these individuals are provided with support there is the potential for them to form aggregates – that is collections of self-organising 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 interaction 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 that 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-organising behaviors, and it would be useful to see if firstly, there were lever points visible that provoked a long-lasting 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 modeling of the CBR director are picked up by the interacting agents (scientists, clinicians and community liaison organisers).

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 'butterfly 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 individual, 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-organising way. That is not from rules imposed from management, but instead an accepted way of acting emerges from the process of the interaction. 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 recognises 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-organisation 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, 2005). It was anticipated that examples of self-organisation 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' (2000, p.15). Consequently, 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 analysed 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;
- mechanisms that enhance this complex adaptive system.

As mentioned previously, CAS theory can be used to explore a range of different elements of management and organisations. In this study, we focused on how CAS theory 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 organisation?

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) 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 reflect both positive and negative views on the science communication culture, these scientists were recruited 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 anonymised 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 Richard Faull) 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 organisation.
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 Richard Faull (RF) and the reporting of Laura Fogg-Rogers' (LF) 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 programme at the Auckland Museum; emerging scientists in the Brainwaves group organising outreach for scientists and PhD 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 made clear 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 such a singularity. The quote that summed up this awareness that everyone could 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. It actually surprises you though. 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 (1998) asserts that agents are at the heart of CAS and these agents can be individuals, teams or organisations.. The following examples demonstrate that this diversity of interaction is augmented by the variety of contexts that are accessible within CBR.

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. So it's interesting because they get feedback from their peers who can give a different angle, and sometimes they are more critical than the supervisors, so it's quite interesting and 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. It was really quite good. (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 (p. 74). [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: An important 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 organisations: Links to support organisations were very strong, 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 the researchers have been led by Richard Faull... it's a wonderful 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)

> I think the difficulty is that people are kind of on their own road, and that's how life is. You kind of get on your road, you are driven by your passions … all the sort of lines going in parallel, … you do almost have to have a sort of chance kind of zing and I guess that's the good thing about having the seminars when you've got enough people in the room with similar interests, that there might be that connection. So I think the culture, it is driven passionate people that want to kind of collaborate with each other, but it's finding those interlinks, and also from a clinical point of view it's just finding the time. (C1)

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. I think that is where that ethos, that culture started from. (S3)

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

> 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 awarenss of the responsibility of scientists.

Aggregation of Agents that result in an Emergent Philosophy and Action

The most striking emergent feature from all these interactions is the scientists' self-realisation that they have an obligation to communicate science that is accessible to all. Two scientists voiced this obligation:

> …that we in the university, we as scientists, have an obligation, particularly [when] we're publicly funded, and we have an obligation I think to disseminate that information in a way which is accessible. (S5)

> 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 an obligation, this scientist also 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 I think … 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, and so 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 there is I mean 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. So the science still has to be accurate but it's actually enabling access to that information. (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 no doubt that communication is now perceived to be very important…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 signalled by this scientist, who realised 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-organising systems could emerge.

Web and Network Flow of Interactions

It was 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, I guess help. We have had a few seminars and workshops but 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 or whatever. But there's definitely a culture there of supporting it. (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, and we do the same here with my group where we have, 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 organising and supporting communicative interactions. The way in which these committees work is described by the following scientist who chairs a committee of ten 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 recognised with this formal reporting.

> But there's definitely a culture there of supporting it. People are made aware. 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. 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] which I guess within the centre is now my main role in terms of communication and engaging with people. (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, then 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 acknowledgement 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)

The involvement of everyone was apparent from the following comment saying 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)

> I think they excel at communicating the science. Their [magazine] is really interesting. They make science accessible and fascinating and interesting. There's some wonderful articles about the young scientists, that they are supported coming back from overseas and the work that they're doing and they keep them short and snappy and interesting. (CL1)

Less obvious but equally important are the mechanisms of modeling and the replicative process of providing building blocks that are proposed in this theory of CAS. As Clippinger (1999) states, internal modeling is a way of presenting types of models that could anticipate internal behaviours. 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 Richard Faull's way of interacting with the CBR and the wider community that such modeling can be a powerful positive 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 Richard Faull's comments about the importance of communication, shows 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 (modelled) 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 important mechanism in CAS is the role of building blocks which enable the development of a complex organisational 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.

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 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.

> I think Laura would be a huge part of developing that culture. 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. So she very much leads by example. She communicates very clearly herself. (S3.)

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

> But I also think in terms of this .. 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 analysing science communication culture. With such a diversity of agents and activities it provides an appropriate model for many large research organisations. Lewin and Regine (1998) argue that the management within such organisations is undergoing a paradigm shift from the more traditional linear, hierarchical organisation, 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.

The mechanisms of tagging, modelling and providing building blocks enhanced the communicative interactions within the CBR and enabled a CAS to evolve. Tags were officially used to identify and celebrate connective behaviour 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 'manages' the communicative activities of this organisation by recognising and rewarding (tagging) behaviours that show initiative. He allows people to self-organise/aggregate around their favourite topics/research interests and supports any development. 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)

It was very evident that Professor Richard Faull lived out his beliefs about communicating science to the community. .

> 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).

Whereas another scientist's response was to say rather than communication being a culture of science, such communication primarily came from working at the CBR.

> No I don't think it is the culture of science I think it is the culture of working here. (S7)

Overall this analysis has led us to the conclusion that the framework of CAS was an important tool in unraveling the success of the CBR communication strategy. Support rather than explicit direction was provided, and momentum developed rapidly once each researcher, clinician and community liaison person was allowed to find their personal communication 'comfort zone'. The role of a communication manager was critical to this development as her appointment provided a lever point to empower others, maintain networks and allow scientists and clinicians to develop their own communicative strategies. If one had to identify the management style of Professor Richard Faull it could be as a coach, facilitating a spontaneous development of a critical mass of people involved in communicating the science of the CBR. He modeled the need and obligation to communicate science with the public and mobilised appropriate resources that enhanced the self-organising behavior in evidence. Critically he had the wit to trust his team and not control the process.

It would be presumptive to draw lessons from this research that could be applied to other organisations and individuals. We hope that this story of communication and its management will allow others reflect on the challenges that organisations face when promoting science communication. However, it could be said that this communicative science culture was enhanced by role modeling of communication at the top levels and the appointment of a support person who could remove administrative barriers and facilitate aggregation of interest groups allowing training and empowerment to emerge.

In summary, when Richard Faull was asked about the secret ingredient for such a sustainable communicative community he said.

> Well it's putting science first, it's putting people first, and it's talking to everyone that matters. (RF)

Notes

1. [1]Centre of Research Excellence (CoREs) 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 Centre for Brain research 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

Disclosure statement

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

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