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A comparative ethnographic study of collective knowledge brokering across the syntactic, semantic and pragmatic knowledge boundaries in applied health research

Introduction

Knowledge brokering features significantly in the knowledge mobilisation literature as a strategy for facilitating knowledge exchange amongst the producers and users of research (Bornbaum et al. 2015). In everyday terms, brokers are intermediaries or go-betweens that facilitate transactions on behalf of clients (Ward et al. 2009); and what arguably started life as a descriptive metaphor has since become a descriptive (and even prescriptive) term for people or organisations that facilitate the creation, sharing and use of knowledge (Bornbaum et al. 2015; Ward et al. 2009). There have been two recent developments within the knowledge brokering literature. The first involves an emphasis on the activities of knowledge brokering, i.e. what strategies and actions are involved (Bornbaum et al. 2015), rather than focusing on the qualities of the broker (although these are inevitably connected). The second, recognises that knowledge brokering often involves multiple inter-connected activities undertaken by different actors working in coordinated ways (Waring et al. 2013). As such, there has been a shift in focus from 'individual brokers' to 'collective brokering' (Kislov et al. 2017).

Our paper contribute to these debates by examining how collective knowledge brokering needs to attend to and mitigate the boundaries within and between different epistemic communities. In developing our focus, we recognise that knowledge can take various forms, from more explicit information to more tacit know-how, and where such differences

complicate knowledge brokering (Waring et al. 2013). At the same, we recognise that knowledge is inherently embedded within bounded areas of social activity that are themselves reflective of different ways of knowing and associated with particular relations of power (Cetina 2009); especially where the production and control of knowledge is linked with competitive advantage (Currie and White 2012). To better understand how these issues condition collective knowledge brokering, we draw upon Carlile's (2004) understanding of knowledge boundaries, which highlights how syntactic, semantic and pragmatic knowledge boundaries complicate the sharing of knowledge. As such, it helps focus our analysis onto the different strategies needed to facilitate knowledge brokering in the production and use of knowledge.

Knowledge brokering: individual to collective perspectives

Whilst it is accepted that knowledge brokers - whether people, organisations or technologies - support the exchange of knowledge between separated communities, there remain many definitions and conceptual metaphors. Brokers are often associated with alliterative terms such as transfer, translation and transversality (Meyer 2010) and, in general, are depicted as spanning 'structural holes' between disconnected communities (Burt 1992). In the case of health research, for example, brokers are often presented as metaphorical bridges spanning the gap between the producers and users of research. We suggest the literature on knowledge brokering can be summarised along, at least, four lines.

The first stems from the study of social networks and knowledge diffusion (Burt 1992) and deals with the structural position of brokers. That is, how brokers are located within or between different communities and what connections they have to facilitate interaction between these communities. Gould and Fernandez's (1989) typology of brokering positions and relationships, distinguishes between 'coordinators' who broker between two or more actors from their own community; 'itinerant brokers' who mediate contacts within a community they do not belong to; 'gatekeepers' who broker incoming exchanges from outgroups; 'representatives' who broker out-going exchanges from their community; and 'liaisons' who broker exchanges between two or more communities to which they do not belong. Although this brings to light variability in brokers' positions and patterns of interaction, it does little to explain how these positions come about or the strategies associated with each position.

The second area of research is concerned with the activities of knowledge brokering. Hargadon (2002) describes it as, first, securing 'access' to knowledge 'resources located in different communities; second, 'bridging' between these communities to facilitate knowledge exchange; third, engendering 'learning' through the acquisition of new knowledge; fourth, 'linking' new and old knowledge to develop innovation solutions; and fifth, embedding and 'sustaining' innovation. Ward et al. (2009) further summarise brokering activities in terms of 'knowledge management' (identifying, accessing and synthesising knowledge found in separated communities), 'linkage and exchange' (building connections between communities), and 'capacity building' (supporting mutual learning). What is not always clear from such descriptions, is the nature of the boundaries that separate communities, nor the types of knowledge that brokers exchange. As explained below, some

studies treat knowledge as a tangible resource to be exchanged, whilst others emphasise the more tacit dimensions of knowing and the role of brokers in facilitating mutual learning (Nicolini 2016).

The third literature describes the skills and capabilities of the knowledge broker to fulfil these activities. In their review, Bombaum et al. (2015) emphasise the abilities to: identify, engage and connect stakeholders; facilitate collaboration; identify and obtain information; develop analytical and interpretative skills; create tailored knowledge products; coordinate projects; communicate and share information; network; facilitate change, and support sustainability. More provocatively, Phipps and Morton (2013) characterise the effective knowledge broker as nimble, dynamic and opportunistic; a cheerleader; creative; an effective communicator and listener; courageous; tactful and skilled in negotiation; and committed. What becomes apparent from such lists, is that it is unlikely that any one individual or group will possess all these qualities, leading to the idea that knowledge brokering will likely involve multiple actors with distinct capabilities. As such, it might be expected that one broker might be well positioned to identify and forge connections between disconnected communities, whilst another is more able to synthesise knowledge or facilitate learning.

The fourth literature deals with the tensions and dilemmas experienced in knowledge brokering, and knowledge mobilisation more broadly. Significant challenges relate to the persistence of social, cultural or epistemic boundaries that simultaneously define and separate communities, and represent underlying barriers to knowledge sharing (Waring et al. 2013). The persistence of professional boundaries, in particular, has led to the suggestion that 'hybrid' social actors who work across different occupational jurisdictions are better

placed – positionally, relationally and reputationally – to broker knowledge (Currie and White 2012; Kislov et al. 2016). In other ways, knowledge brokering is complicated by underlying differences in the types and sources of knowledge, especially when knowledge is linked to exclusive areas of professional practice, where the diverse tasks of brokering are beyond the scope of any one individual, and when brokers need to manage competing interests (Kislov et al. 2017). Kislov et al. (2017) conclude that a shift in emphasis is needed that moves away from thinking about individual brokers to collective brokering to reflects the idea that brokering is a complex and situated process involving constellations of inter-connected actors or ‘broker chains’ (Waring et al. 2013). This also reaffirms the ideas that greater attention needs to be given to the nature of the boundaries that define and separate communities, and in turn, the types of collective brokering activities needed mediate these boundaries.

Knowledge boundaries and brokering

As mentioned above, an initial point of clarification relates to the way knowledge, itself, is conceptualised and operationalised as a focus for knowledge exchange. There are two relatively distinct ways of thinking about knowledge (Waring et al. 2013). One tends to see knowledge as an explicit resource or tangible ‘thing’ that can be collected, codified and communicated through various exchange media. In contrast, knowledge is understood as a more tacit and intangible quality of social practice, manifest in the taken-for-grant ‘know-how’ that people acquire through socialisation, and which is closely associated with membership of a particular social groups (Lave and Wenger 1991). The significance of this distinction is that some knowledge brokering activities tend to focus on the more explicit

forms of knowledge, such as knowledge management interventions, whereas others focus on the more tacit forms of know-how, such as situated learning activities.

It is also the case that frameworks on knowledge mobilisation are premised on the idea that the producers and users of knowledge are in some way separated by boundaries, be they spatial-temporal, cultural, organisational or professional. Boundaries have become a prominent issue for contemporary social science because they highlight simultaneous processes of demarcation, differentiation and cohesion (Lamont and Molnar 2002).

Knowledge or epistemic boundaries are significant because they establish the parameters between what is known or unknown, what is legitimate or illegitimate knowledge, and who should or should not know; suggesting that knowledge and knowing are closely tied to social identity and practice (Nicolini 2016). The term 'epistemic community' (or culture) is often used to describe a social group with common and bounded forms of knowledge or knowing, and although members might stem from different social backgrounds, they tend to have common forms of socialisation, shared values, beliefs and identities (Cetina, 2009). Such boundaries are especially prominent in areas of 'knowledge work', where specialists are defined by their bounded claims to expertise around which claims to jurisdiction and power are often based (Abbott 1988).

To better understand these knowledge boundaries, and the strategies needed to broker them, we draw on Carlile's (2004) idea that knowledge boundaries are conditioned by degrees of novelty, dependence and difference. Novelty relates to the uniqueness or complexity of a given situation to which different forms of knowledge are needed to find a particular solution. It is generally assumed that greater forms of 'novelty' necessitate

innovation based on the sharing and synthesis of divergent forms of expertise. 'Dependence' relates to the extent to which separated communities need the knowledge of others to fulfil a given task; motivating their need to share knowledge, but also recognising that unequal dependence can frame conflict. 'Difference' describes the variable levels and forms of knowledge, such as the degree of specialisation or whether knowledge is tacit in character. Such differences are important because they influence actors' willingness and capacity to share, in so much that specialist expertise is often associated with a group's claim to exclusivity. In many public service settings, the tensions of difference and dependence create a paradox whereby multiple specialists are needed to tackle complex problems, but they are often unwilling to share their knowledge (Ferlie et al. 2013).

Building on these assumptions, Carlile (2004) elaborates three types of knowledge boundaries, where increased novelty, and in turn difference and dependence necessitate distinct strategies to mediate progressively more challenging boundaries. The most fundamental 'syntactic' boundary describes the differences in language or terminology between communities. The mediation of these boundaries typically involves standardising knowledge or agreeing a common lexicon that enables the 'transfer' of knowledge around relatively standard or non-complex issues. The 'semantic' boundary highlights more profound differences in meaning and deeper levels of understanding that come to light around more novel issues where different insights are needed. These are more often taken-for-granted and difficult to articulate, and require the 'translation' of meanings and know-how from one group to render them meaningful to another. Finally, the 'pragmatic' or political knowledge boundary acknowledges that social groups hold particular interests and agenda that further differentiate them, and which are implicated in the control of knowledge, especially where

knowledge is used to establish competitive advantage. Mediating political boundaries involves the 'transformation' of knowledge to find mutually agreeable agenda around which diverse groups see common value in sharing knowledge. Significantly these knowledge boundaries build upon each other, i.e. where a common political agenda requires understanding of diverse meanings, which is itself premised on addressing differences in terminology (see Figure 1).

< Figure 1 about here >

Carlile's (2004) work offers extended analytical possibilities for understanding the dynamics of individual and collective knowledge brokering to mediate the different syntactic, semantic and pragmatic boundaries. Brokering at the syntactic boundary might address easily recognised terminological differences to develop a common lexicon, whilst brokering at the semantic and pragmatic boundaries involves enabling actors to learn about their distinct meanings and interests through facilitating situated encounters or mediating political differences. In some ways, this is equivalent to the methodological principles of ethnography and the idea of emic understanding; which also highlights potential constraints associated with access, relationship building and the risk of 'going native' (Fetterman 2009). In other words, Carlile's (2004) ideas further reinforce the idea that knowledge brokering is a coordinated activity involving multiple actors with different positions, relationships and skills. Our paper aims to understand how individual and collective knowledge brokering activities mediate the syntactic, semantic and pragmatic knowledge boundaries that distinguish and separate epistemic communities.

Methods

Case Studies: context and selection

In recent years, health services research has become a prominent focus for research and theory on knowledge mobilisation. In the context of our study, the English National Health Service (NHS) has invested considerable public resources to close the ‘translation gap’ between research and practice (Davies and Walshe 2013), as exemplified by the creation of Academic Health Science Networks (AHSNs), Collaborations for Leadership in Applied Health Research and Care (CLAHRCs) and Knowledge Mobilisation Fellowships. In various ways, such initiatives have supported the mobilisation of evidence into frontline practice, often with a focus on ‘end-of-grant’ transfer and implementation, but increasingly with an interest in the way knowledge is co-produced. Knowledge brokering often features as a widespread strategy in both the production and transfer of applied health research (Kislov et al. 2017).

Our research investigated collective knowledge brokering within three applied health research projects. These cases were selected through a two-stage process that involved an initial desk review of the scientific protocols of 16 recently-funded studies with one region of the English NHS, taking into account study type, clinical focus and intervention, and their implementation plans. From this, three projects were purposively selected primarily on the basis of how knowledge brokering was described, including differences in role, purpose, and number of brokers. A description of each study is detailed in the subsequent findings section (see also Table 1). To ensure confidentiality and anonymity, all project names are anonymized and roles are noted as “research team”, “stakeholder” or “knowledge broker” (KB) in fieldnote extracts. All appropriate (U.K.) ethical approvals were obtained.

<Table 1 About here>

Study design and data collection

The research involved an ethnographic comparative case study with the three research projects. Ethnography aims to develop a “rich” descriptive and interpretative understanding of social and cultural processes, usually involving direct observations of everyday activities (Fetterman, 2009). This involved prolonged periods of observations with each study team, from the early stages of project design, through to data collection and analysis, to early dissemination. The fieldwork focused on how knowledge brokering occurred through a series of context-specific interactive situations or ‘happenings’ (Stake, 1995) each involving a different range of (inter-)actors, forms of knowledge and instances of knowledge exchange.

Data collection took place from January 2014 to June 2018, involving participant and non-participant observation. Participatory activities were carried out with project team meetings, where participation involved offering verbal updates on developments in the field of ‘implementation science’ and reflections on changing university priorities, such as the Research Excellence Framework. We were not ‘official’ members of the project teams. Non-participant observations were undertaken across various stakeholder events, research planning meetings, small group meetings, and dissemination activities. We shadowed knowledge brokers as part of their project activities to further understand how they supported the sharing of knowledge as they encountered different challenges within the research process. Observing activities provided us the opportunity to watch knowledge brokering unfold ‘in action’; for example, how brokers adapted language or communication

styles during community events to ensure knowledge was readily understood. In total, 157 hours of observations were undertaken with the three teams.

We also carried out 54 semi-structured interviews . This included 28 interviews with people directly involved in the three selected projects (Alpha Study: 6; Bravo Study: 10; Charlie Study: 12), including lead researchers (4), methodologists (2), project researchers (7), PPI representatives (1), health professionals (8), service managers (1), and project administrators (5). A further 26 interviews we carried out with knowledge brokers from the other 13 projects identified during the preliminary desk review with the purpose of relating in-depth findings from the three cases to the experiences of other brokers. Interviews lasted between 20-90 minutes, were digitally recorded and transcribed verbatim, including questions on how participants became involved with the research, what motivated and how they experienced involvement, what they felt worked well, and what was challenging.

Data analysis

Interpretative data analysis was carried out concurrently with data collection (Corbin and Strauss, 1991). Taking a comparative case study approach (Stake 1995), iterative analysis first described the early findings from individual cases, with empirical themes identified in one case informing questions of others. In data analysis meetings, authors considered alternative interpretations, guiding subsequent data collection. As the study progressed, the aggregated body of data were subject to qualitative coding (Braun and Clarke, 2006). This was initially undertaken by one researcher, with coded data reviewed by all authors to review the internal consistency and relationships between codes. Analysis focused on describing how knowledge brokering activities supported the circulation of knowledge amongst different

project stakeholders. Our findings first describe the configuration of the project teams and brokering roles, before examining how collective brokering did (or did not) address the syntactic, semantic and pragmatic boundaries within and between project stakeholders.

Findings

The project teams

Each project team was composed of a 'core' grouping of health services researchers, research-active clinicians, managerial representatives, and public and patient involvement (PPI) representatives. Alpha's core team comprised two medical doctors, one PPI representative, two health services researchers and one project manager; Bravo's comprised three health services researchers, one medical doctor, six representatives of allied health professionals, three PPI representatives, one project manager and one administrator; and Charlie's comprised two medical doctors, three allied health professionals, two researchers and two service managers. We observed how team members operated within and across one or more epistemic communities, such as 'scientific' (e.g. trial methodologies, educational research, social science research), 'clinical' (primary care, mental health, adult nursing), 'managerial' (service management, commissioning) and allied or psycho-social (education, psychologists, therapists). For example, research-active clinicians were able to bring together distinct ways of knowing from their clinical practice and scientific training to inform project planning.

Each project engaged a wider 'peripheral' network of stakeholder communities located in different educational organisations, care services, commissioning agencies, regulatory and

professional bodies, and service-user communities. What made these groups 'peripheral' was their limited direct involvement in project activities and their overriding concern with the relevance and 'use' of evidence. These peripheral stakeholders reflected similar and additional epistemic communities to those of the core team, in terms of different areas of clinical practice, service management and commissioning, scientific research, as well as community interest groups or people with experience of illness. As such, each project was characterised by a constellation of epistemic communities.

Of interest to our study, was the need for knowledge to be brokered within and between these core and peripheral epistemic communities. Each project had a distinct (but changeable) configuration of people performing brokering activities. All project had a number of formally recognised 'core' team members to support brokering activities, such as research specialists or PPI representatives, whose work was explicitly framed in terms of working with particular 'peripheral' communities. In addition, each project also engaged a range of other more peripheral actors, often on an informal or ad hoc basis to help interact with particular communities around specific issues. In most cases, these people were not core team members but rather had loose affiliations, and acted as gatekeepers or conduits to wider stakeholder networks. Our findings focus on five situations in the research process where knowledge brokering appeared to have significant bearing the exchange of knowledge; situations that offer opportunities for learning for other research projects.

Intervention Specification

A preliminary task for each project team was revising and specifying their particular clinical intervention to the operational realities of their local service context, given that each intervention had been developed in a controlled or different service setting. Although the core members of each team had clear assumptions about how their respective interventions 'should' work, they each needed to engage in two parallel, but linked forms of knowledge brokering. One related to understanding how the intervention might be modified to fit within existing service models; the other to understand how the interventions could be more accessible and usable to particular service user communities.

In addressing the first of these, both Alpha and Bravo projects engaged local service representatives, via the clinical members of the core teams, to explore how best their respective education and self-management interventions should be adapted. The Alpha team, for example, engaged the help of three GPs within the local community to gain insight about local service priorities, workload pressures, and how best to reach marginal communities. These peripheral GPs had a longstanding collaborative relationship with GPs in the core study team.

'I draw upon my professional networks, I might see them at an event or something, or I invite them to a learning event, make sure there is good food, offer an interesting talk and get them to help with the work' (Bill, Alpha clinical lead)

In addressing the second of these challenges, all project teams engaged in a variety of activities to adapt their interventions to the language and cultures of 'target' service-users. As is common, the primary source of insight was through each project's appointed PPI

representative; however, these individuals typically acted as conduits to community representatives. The Bravo team, for example, wanted to understand how service users currently experienced services and what might motivate them to participate in the self-management intervention. In this case, the project's PPI lead contacted two further service-user representatives, neither directly involved in the study, to deepen understanding of service users' lived experience. Through these interactions relevant 'life-style' factors about service use were communicated via the PPI representatives into to the core team to inform intervention specification. Similarly, the Alpha team needed to ensure its diabetes education intervention was sensitive to the language and cultural expectations of multiple ethnic communities through engaging a local educational specialist to revise patient materials for speakers of Urdu and Bengali, and taking into account religious considerations associated with diet and lifestyle.

'[P]utting it in a language that everyone will understand, realising that there are clinicians, academics, Patient Public Representatives, commissioners, people who might not have intimate knowledge about some of the issues being tackled in the proposed research but who still are interested in taking part.' (Mandy, Broker from research community)

'I think you need to speak to people at the right level and in the appropriate language. You need to take their views into account. You will not always succeed, and you need to keep trying.' (Miguel, Alpha research team member)

A common challenge in applied health research relates to securing research governance approvals. We observed how different knowledge brokers were instrumental in supporting this process, especially through drafting Participant Information Sheets and Consent Forms, and with navigating the procedures of university and NHS bodies. As above, all project teams asked their PPI representatives to use their service-user networks to clarify how to describe the purpose and benefits of the study on patient-related documentation. In addition, PPI representatives were asked to lead sub-groups to clarify the wording of surveys questions in light of language and cultural differences.

Other brokers were involved in navigating the procedural technical steps of applying for research governance approvals, meeting regulatory checks and securing the sponsorship of various university and NHS groups. The Charlie project delegated application tasks to a university administrator, whilst working closely with methodologists and PPI-representatives to clarify the intent of research activities. We also observed how all teams relied upon their affiliations with university or NHS organisations to secure research sponsorship, which involved presenting the studies in ways related to risks and liabilities, as much as care outcomes. As such, a range of different brokering activities were carried out simultaneously by different actors to move forwards research governance.

‘[Wendy] has been a big help with the research ethics and approvals process. She works on these all the time and so has a good grasp of how to complete the forms, which frankly seem to change every couple of years. So, it makes sense to ask her to do it as part of her role within the university’ [Meeting discussion 5/5/2015]

Access and recruitment

Each project team needed to secure and maintain access to frontline care settings to study the operation of their respective interventions, as well as to recruit patient and staff representatives to study the experiences and effects of these interventions, and to gain access to routine service data related to patient numbers, costs or clinical outcomes. We observed how 'high-level' access negotiations between the project teams and NHS services were carried out by the designated project lead and other project members with relevant clinical or management expertise. However, we also observed how these negotiations were often informed by earlier and parallel engagement activities with wider clinical or managerial networks to better understand the incentives, inducements or '*buttons to press*' to secure on-going NHS participation.

'It's about the negotiation again and what's in it for them... so why would somebody do something different from their current practice. What would make them want to change.' (Jim, Broker from support community)

This multi-stage 'strategic' brokering was observed with the Alpha team, where two people based within the local authority were invited to join the core team to help refine the interventions (as outline above), act as local champions or advocates, and to help support the on-going delivery of the intervention in local education and leisure facilities. Their strategic involvement ensured context-specific understanding about local services was brought into project management, but more importantly it created a sense of local ownership of the intervention that secured on-going participation. For all projects, clinical or service-facing

representatives provided important insight about the operational demands and priorities of local services to help manage the relationship with external partner organisations.

Harry (research team) says that the study is meant to fit alongside everyday practice so it can be adopted easily in to everyday practice. Clifford (stakeholder) says that it is difficult because things are changing so rapidly within services and it is difficult to identify the referral service. Harry says he is unsure of what all will be needed so he suggests that Peter (research team) have a discussion with Nick (stakeholder) rather than setting up 'elaborate plans'. (11/06/2015)

A more negative example was observed with the Charlie project, which needed the support of a specialist third-sector organisation to deliver the CBT intervention. Although the project leader had pre-existing connections with the charity, there was no formal linkage with the organisation, and members of the charity reported being marginalised from project meetings. Overtime we observed how the charity gradually became less supportive of the study. In other ways, the Charlie team took an exclusionary approach to project planning and rarely engaged knowledge brokers to help understand the changing interests of local service partners. As an illustration, during one project meeting, the research leader failed to circulate a project planning document beyond the core project team, which meant external partners could not contribute to project planning.

'Michael (research team) and Jessica (research team) explain they have been working on standard operating procedures. However, they did not bring enough copies for everyone in the meeting. Michael says he could circulate them to

everyone for comment. Gordon (research team) nods but Charles (research team) says, 'Well who is for? It depends on who it is for.' This is not answered. Gordon questions one of the steps about GP contact. Michael and Jessica exchange a look and Raymond (research team) steps in to say it depends on the site and where it is at in the process. Gordon interrupts saying there needs to be mention of GPs. Michael says this is perhaps why it needs to be circulated so that people can comment and discuss these things. Charles replies again that it depends on who it is for [...] It is not resolved and the conversation moves on.'

(Meeting, 21/07/2015)

A parallel issue related to the recruitment of service-user participants. Although each study routinely engaged appointed PPI representatives to manage recruitment, we found that Alpha and Bravo teams also reached out to local community advocates to communicate the purpose and benefits of the research to wider service-user communities. For example, one of the Alpha team's knowledge brokers - with a background in public health and a shared cultural heritage of one local ethnic community – delivered a series of public talks to promote the study to local community groups, which involved using their detailed understanding of this community's culture to re-frame the study purpose.

'Ahan explains about diabetes amongst South Asians, how they are six times more likely to get diabetes than White-British people. He explains what diabetes is, how it works and what pre-diabetes is. He asks people to raise their hands at who has diabetes and several hands shoot up. One of the women ask a question and the translator asks if Ahan would mind speaking in Hindi as they are really struggling to

follow what he is saying. Many of the women nod at this. Ahan agrees and repeats much of what he said earlier but in Hindi.’ (Event, 29/02/2016)

We also observed that brokers were often called upon to explain problems with recruitment. The Bravo team, for example, asked one of the PPI representatives to contact service-user communities to investigate the reasons for low recruitment, which brought to light unanticipated lifestyle factors. One of Bravo’s clinical brokers also used her contacts within GP surgeries to ensure eligible patients were being offered the opportunity to participate in the project. As in other projects, multiple brokers with access to different communities were important for both understanding and addressing the practical problems of recruitment.

Data collection and analysis

In contrast to the activities outlined above, there were comparatively fewer instances of knowledge brokering between core teams and peripheral stakeholders during the period of data collection and analysis. We observed that some project researchers had regular ‘catch-up’ or feedback meetings with local study partners – typically the clinical or service lead at the research site – where research progress and early findings were discussed. On occasion we observed discussion about the resource implications or negative experiences of frontline staff in delivering the interventions, which would be communicated back to the core team.

In general, knowledge brokering was more evident when the project teams faced significant challenges during data collection. The most common example related to recruitment difficulties or maintaining site access, as outlined above. In these instances, service-user and staff representatives were often asked to investigate problems and liaise with local

communities to identify possible solutions. This type of problem-solving relied upon core team members' pre-existing connections with and understanding of service settings, i.e. their ability to engage key advocates or service leaders. Additional instances of problem-solving brokering were related to methodological challenges, where specialist guidance was sought from university-based researchers to clarify, for example, sample-size calculations or the procedures for certain statistical tests.

'And that's the great thing about having that university affiliation. I can reach out to people with the right skills to help check things like our sample size calculation or whether we are following the most appropriate statistical procedure' (Miguel, Alpha research team)

It is noteworthy that Charlie project was terminated by its scientific steering committee during data collection because of the problems in engaging NHS service providers and reaching its recruitment targets. An observation during this period showed how the core team repeatedly failed to take on board the recommendations of service representatives:

'[D]o you ever get that, it's like when you dream, I think we keep saying something and no one is listening. That's what it felt like.' (Anita, Charlie project)

'...you felt like you'd given some really great input and it'd been taken on board and then steps seem to go backwards again, just a few months down the line.'
(Suzanne, Charlie project)

More broadly, it was surprising to find that knowledge brokering with external groups was relatively limited during data analysis. It often seemed that the practical procedures of data management and analysis were carried out by technical experts in more backstage (university) settings, involving specialist analytical techniques. This limited the involvement of non-specialists, and all teams showed little expectation that external groups would participate in these activities. Where brokering did become more evident was when external stakeholders, especially patient representatives, were invited to comment on the interpretation of emerging findings. In these situations, brokers were asked to describe the detailed data-sets or abstract findings in more general terms to facilitate sense-checking against 'real-world' experience.

'A handout of summary data tables is distributed to all [core team] participants. The lead researcher uses Powerpoint to present and describe the preliminary analysis. Much of the emphasis is given to statistical significance in the analysis of outcome measures... Most participants comment or reflect on the findings. There is little discussion of the findings mean for service users or healthcare services.' (Event 21/04/16)

Dissemination and Implementation

Although dissemination and implementation might be viewed as the 'end-stage' of research, our study showed how forms of dissemination were integral to the on-going success of the Alpha and Bravo projects. That is, it was important to share knowledge with external stakeholders about the research processes and emerging findings on an on-going basis to

maintain access and intervention implementation. Looking more narrowly at the end-stage of dissemination and implementation, two prominent broker activities were identified.

The first involved core team members, usually project leads and methodologists, working with external partners to translate and re-frame scientific findings to make them more accessible and relevant to 'target' communities. Both project teams used specialists in 'science communication' based within their respective university settings to help with the presentation and communication of research findings through various news media. These were employed with the express purpose of support the translation of research findings based upon their developed communication skills and connections with national or regional stakeholders.

'People like Neal have fantastic relationships with regional and national decision-makers. Look at what he achieved with the [name] study. It wasn't just that the study showed it was unequivocally positive, but he used his relationships to have it recognised in the national guidance.' (Event 27/07/17)

Other brokers were approached by project teams based, less on their technical skills, but rather their connections with and appreciation of certain stakeholder communities, often based on past experience of working in a given care setting or lived experience of a condition. For example, both projects engaged clinical representatives working 'on the margins' of the project, i.e. in study sites, to identify and develop the key messages for clinical practitioners, such as staff newsletters or clinical briefing documents. Similarly, project leaders approached

'friendly' managers from commissioning organisers to understand which service priorities to emphasise in their feedback reports, i.e. cost-saving or clinical outcomes.

'...depending on who you're talking to, if it's a CCG Chair, you might be talking about reduced workload and cost-effectiveness, reduced admissions. Someone interested in [chronic disease] I'd be more talking about the risk factor management etc. So, you have to tailor your spiel to who you're talking to.' (Miguel, Alpha Research Team).

Additional forms of engagement were undertaken with participating study sites to encourage them to sustain the intervention beyond the study. The Bravo project leader worked, for example, with front line clinicians and service-user representative to lobby commissioners to maintain funding for the (now 'evidence-based') intervention beyond the study. This combination of perspective made it possible to present a more complex rationale that combined more scientific 'outcome' or 'cost' data, with the 'voices' of service users. It seemed therefore, that the project leaders mobilised their brokers in a type of 'pincer' movement using different strategies to simultaneously persuade stakeholders.

Discussion

Our study investigated how collective brokering activities can help close the 'translational gap' exists between the 'producers' and 'users' of research. Through our three empirical case studies we elaborate this 'gap' in terms of the distinct and relatively bounded epistemic communities (Cetina 2009) of 'core' and 'peripheral' stakeholders. Although much research has examined this 'gap' in terms of knowledge transfer and implementation in the later stages of research, we focused on collective brokering across the knowledge production

processes. This brings to light how a range of different actors participate in the brokering of knowledge within and between epistemic communities.

A preliminary point for discussion is that those involved in knowledge brokering appeared to have subtly different relationships, especially with core project teams.

We found that some had more formal and 'designated' brokering roles, with corresponding recognition in their job plan and financial compensation for their time. They were often recruited to join the project teams expressly to facilitate knowledge exchange within one or more communities based upon their organisational or professional affiliations, lived experience or other relational connections. In contrast, a range of other more informal, temporary or 'un-designated' brokering actors were identified that provide voluntary and ad hoc brokering to support particular tasks. There seemed to be subtle differences in how designated and non-designated brokers were utilised and valued by project teams; with the former regarded as core members and the non-designated as more instrumental 'fixers'. And yet, our study suggests that, in many instances, knowledge brokering relied upon a combination of these actors, often working in a coordinated way, such as where designated brokers reached out to a network of non-designated brokers to mediate different boundaries.

It was also interesting to find that, for all projects, brokering activities were seemingly more valued at the earlier and later stages of the research process. We characterise this as 'bookend' brokering whereby external knowledge is required during earlier phases of project specification to clarify evidence needs, and then later to help translate evidence into practice, but with only limited and partial need for brokering during data collection and

analysis, e.g. related to recruitment or clarifying findings. Although our study collected only limited data on longer term translation and implementation of evidence due to the time-constraints of our research. During this middle period, it seemed the methodological routines of applied health research came to the fore of project management and the core teams looked inwards to their research and methodological specialists. This 'bookend' approach might be interpreted, somewhat critically, as a resulting in a limited and instrumental view of knowledge brokering that does not support the on-going co-production of knowledge (Bevir et al., 2018). Extending this line of critical analysis, it might be argued that knowledge brokering can be adopted as a technical means of knowledge exchange to serve the established goals of applied health research, rather than a basis for fostering shared understanding and collaborative working. It is not clear from our study whether the instrument use of knowledge brokers is due to the research teams' limited understanding of brokering or due to restrictions placed on brokers time and resources constraints (Kislov et al, 2017).

Notwithstanding this point, our study provides additional understanding how knowledge brokering within and across multiple epistemic communities is often a collective, rather than individual activity (Kislov et al. 2017). We elaborate these ideas along two dimensions. The first dimension considers the form of collective brokering. In their study of intra-hospital knowledge brokering, Waring et al (2013) identify 'broker chains' where linked brokering activities facilitate the movement of knowledge from one community to the next. We similarly find examples of this 'sequential brokering' where discrete brokering tasks for the accessing, translating and sharing knowledge (Hargadon 2002) are distributed across a division of labour reflecting the given positions (Gould and Fernandez 1989) or capabilities of

actors (Bombaum et al. 2015). In contrast, we also find examples of ‘parallel brokering’ where multiple brokers engage and share knowledge with distinct epistemic communities simultaneously. This parallel brokering was often based on a broker’s position, pre-existing connections and/or developed understand of an given community, rather than their discrete skills or capabilities (Gould and Fernandez 1989).

Our second dimension elaborates this idea by suggesting ‘sequential’ and ‘parallel’ brokering can be both ‘coordinated’ or ‘uncoordinated’. In some instances, it seemed to be an explicit strategy for multiple brokers to engage multiple communities simultaneously, or to distribute broker activities amongst actors with distinct skills or capabilities. In other instances, it seemed more coincidental or an emergent feature of a relative new area of activity where brokers experimented with different strategies often on an ad hoc and independent basis. A further point to emphasise is that brokering is inherently multi-directional and recursive. It does not necessarily involve the linear flow of knowledge; rather effective brokering seems to involve an iterative and on-going process in which knowledge circulates within and amongst different communities (Nicolini 2016).

Drawing on the work of Carlile (2004), our study aimed to understand how individual *and* collective knowledge brokering can mediate the syntactic, semantic and pragmatic knowledge boundaries that separate epistemic communities. Our study sheds light on the different brokering activities needed to mediate these boundaries (see Table 2), which as discussed involved a range of sequential/parallel and un/coordinated brokering activities.

<insert Table 2 here>

Syntactic boundaries, relating the distinct terminologies and languages of communities were prominent across many project activities, especially in the interaction with service-user communities. In addressing this boundary, brokering typically involved activities for knowledge 'transfer' based on re-wording texts or developing common terms of references.

Semantic boundaries, relating to the distinct meanings, beliefs and assumptions of different communities, were often less obvious and more difficult to articulate. All project teams faced the challenge of how incorporate the 'real-world' experiences, values and beliefs of service-user and service-providers into their project planning. In addressing this boundary, brokering involved multiple strategies for accessing and understanding the meanings and beliefs of given communities, and then facilitating the 'translation' of this know-how into form that was meaningful to other communities, e.g. religious or cultural preferences related to diet and lifestyle.

Pragmatic boundaries, relating to the political or purposeful intent of knowledge, seemed especially significant in the project teams' relationships with clinical-researchers, service commissioners, and service managers where each had different interests in the production and use of evidence. In addressing this boundary, brokering often involved forms of negotiation and mediation to reconcile different agenda; which seemed less about accessing or sharing knowledge, and more about appreciating the sensitivities surrounding the implications of evidence in decision-making. These activities tended to focus on mediation, alignment and blending of interests.

Reflecting further on our findings, there were subtle variations in the significance of these three knowledge boundaries in relationships between core teams and different peripheral stakeholders. It seemed that syntactic and semantic boundaries were especially significant in the relationship between research teams and service-user communities, i.e. where the clarity of language and meaning was necessary to facilitate engagement and participation. Whilst it seemed the semantic and pragmatic boundaries were more important in the relationship with service commissioners and providers, i.e. where understanding the operational and political needs for evidence were essential for framing study design and dissemination. Extending the line of critical thinking outlined earlier, this distinction might risk treating these service user communities as more passive recipients of research rather than active political partners in knowledge co-production.

By re-engaging with the existing literature on both knowledge brokering (e.g. Ward et al., 2009) and knowledge boundaries (Carlile 2004), and theorising beyond the findings of our empirical study we propose a tentative maturation model for brokering across knowledge boundaries. This tentative, and largely theoretical model, recognises the distinct, but progressively generative and mutually reinforcing, brokering activities required to mediate syntactic, semantic and pragmatic boundaries. Although far from being a linear process, we see this as a stepped or incrementally graduated model in which syntactic brokering (establishing a common language) can provide the foundations of semantic brokering (establishing common meaning), and in turn these provide the foundations for pragmatic (establishing common purpose).

<Insert Figure 2 about here>

Elaborating this maturation model, we first suggest that many preliminary brokering activities relate to identifying and establishing relationships with and between communities (Hargadon 2002). This is often undertaken by individual brokers who act as ideal-typical 'go-betweens' akin to a ferry or shuttle 'boat' spanning the translation gap. These brokering activities can be relatively dynamic involving multiple points of 'entry' and 'exit' between multiple communities, and often concerned with identifying distinct resources and building connections. As these relationships mature, and brokers gain understanding of the distinctions and differences between communities, they can start to address the syntactic boundaries through developing a common lexicon to facilitate interaction, exchange and 'transfer' (Carilie 2004), perhaps at first as a form of pidgin and later a creole language.

Over time, and as these relationships mature, actors within respective communities may seek to standardise and regularise knowledge 'transfer' through supporting more stable media or 'bridges'. These bridges typically take the form of information communication channels with agreed or standardised modes of exchange. Such standardisation is often streamlined and efficient, but tends to have relative fixed connections, costly to create, and difficult to adapt to unanticipated problems. Interaction between communities will subsequently rely less on individual brokering, and more on coordinated efforts in building and maintained communication infrastructure.

Through the emergence of shared terminology and exchange media, knowledge brokering can attend to more complex or novel issues that involve the 'translation' of meaning and

'negotiation' of political agenda across semantic and pragmatic boundaries. These activities often involve knowledge dependencies amongst multiple communities and therefore more collective forms of brokering. Our research found this involved the 'blending' of local customs and practices that enabled knowledge producers and users to work towards more bespoke solutions to complex problems. Through working towards the co-production of knowledge disconnected communities have the potential to address common or shared problems in ways that might to the formation of new 'bonded' epistemic communities (Lave and Wenger 1991). That is, new epistemic communities form around given problems, made up of multiple actors from different knowledge domains. This is merely a tentative outline of a potential model, which we suggest requires empirical development.

Concluding remarks

Drawing on Carlile's (2004) framework for the management of knowledge across boundaries, our study reaffirms the idea that it is difficult for one broker to undertake the diverse and variety brokering tasks (Ward et al 2009), especially when these operate at syntactic, semantic and pragmatic levels. The study shows that collective brokering involves sequential and parallel activities that can also be coordinate or uncoordinated. Furthermore, the study shows the importance of both designated and non-designated brokers undertaking these activities, and the importance of research teams to recognise and value the different contributions brokers can make the knowledge mobilisation.

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Contributor statement

JW designed and managed the study, carried out data analysis and interpretation and lead manuscript writing

JC designed and managed the study, carried out data collection, analysis and interpretation, and contributed to manuscript writing

RV carried out data collection, analysis and interpretation, and contributed to manuscript writing

Conflict of interest statement

The authors declare that there are no conflicts of interest