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Neural imaginaries at work: Exploring Australian addiction treatment providers' selective representations of the brain in clinical practice

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Abstract

Although addiction neuroscience hopes to uncover the neural basis of addiction and deliver a wide range of novel neuro-interventions to improve the treatment of addiction, the translation of addiction neuroscience to practice has been widely viewed as a 'bench to bedside' failure. Importantly, though, this linear 'bench to bedside' conceptualisation of knowledge translation has not been attentive to the role addiction treatment providers play in reproducing, translating, or resisting neuroscientific knowledge. This study explores how, to what extent, and for what purpose addiction treatment providers deploy neuroscientific representations and discuss the brain in practice. It draws upon interviews with 20 Australian treatment providers, ranging from addiction psychiatrists in clinics to case-workers in therapeutic communities. Our findings elucidate how different treatment providers: (1) invoke the authority and make use of neuroscience in practice (2) make reference to neuroscientific concepts (e.g., neuroplasticity); and sometimes represent the brain using vivid neurobiological language, metaphors, and stories; and, (3) question the therapeutic benefits of discussing neuroscience and the use of neuroimages with clients. We argue that neurological ontologies of addiction, whilst shown to be selectively and strategically invoked

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CRediT authorship contribution statement

Anthony I. Barnett: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Martyn Pickersgill:** Conceptualization, Writing - original draft. **Ella Dilkes-Frayne:** Writing - review & editing. **Adrian Carter:** Supervision, Writing - review & editing.

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None to declare.

in certain circumstances, may also at times be positioned as lacking centrality and salience within clinical work. In doing so, we render problematic any straightforward assumption about the universal import of neuroscience to practice that underpins narratives of ‘bench to bedside’ translation.

Keywords

Australia; Addiction; Clinical practice; Drug treatment; Neuroscience; Neuroimaging; Translation; Qualitative

1 Introduction

Despite substantial global investment in neuroscience research, including the *Human Brain Project* (Human Brain Project, 2017) in Europe and *The US BRAIN Initiative* (US National Institutes of Health, 2019), the translation into clinical practice of addiction neuroscience research continues to face challenges. There is a widely acknowledged “bench to bedside gap” (National Institute on Drug Abuse, 2016, p. 5) that characterises the difficulties research programs internationally have faced when attempting to translate research on the brain into clinical treatments. Efforts to bridge this gap have recently been revitalised. For example, the newly formed *Neuroscience Interest Group* within the *International Society of Addiction Medicine*, including among others, Australian, UK and US neuroscience researchers, published a consensus statement and ‘roadmap’ to better integrate neuroscience-informed interventions into addiction treatment (Verdejo-García et al., 2019). Moreover, efforts to overcome these difficulties have increasingly focussed on ‘rapid translation’ (Ostergren et al., 2014) to ‘unlock’ the clinical potential of neuroscience by accelerating the development of novel therapeutics (e.g., pharmacotherapies, gene therapies, gamified cognitive training) to treat drug addiction.

However, the framing of translation as a ‘bench to bedside’ process is oversimplified in its linear conceptualisation of knowledge transfer (Martin et al., 2008) and does not consider how treatment providers interact with, resist or reproduce addiction neuroscientific knowledge in clinical encounters and practices. In attending to the complexity of the translation of addiction neuroscience and its effects, our study is situated within a wider body of science and technology studies (STS) scholarship that explores how the emergence of addiction phenomena is unstable and context specific. By examining how treatment providers' practices contribute to the enactment of addiction in different ways, our work adds to previous STS efforts that have explored how addiction problems are enacted in, for example, policy (Fraser, 2016), law (Seear, 2019), youth drug education (Farrugia and Fraser, 2017) and online counselling (Savic et al., 2018).

The ‘bench to bedside gap’ metaphor tends to focus on the failure to deliver novel biotechnologies, including treatments (e.g., pharmacotherapies) and tools (e.g., advanced neuroimaging), to clinical practice. Often, however, little attention is paid to contemporary social effects of translating neuroscience into clinical interventions and policies, and the implications of framing addiction in neuroscientific terms. Given the critical role that treatment providers play in clinical translation and the potential impact of treatment

providers' representations of the brain, their role in communicating and translating neuroscience on the front line of addiction treatment remains under-researched.

This study addresses this limitation by examining whether – and, if so, how – addiction treatment providers discuss neuroscience with clients and employ neuroscientific models in clinical practice. Through interviews with treatment providers working in a range of different professions in Victoria, Australia, we shed light on why neuroscience is at times discussed, but on other occasions avoided, and also how different methods are employed when discussing the brain (including through narrative accounts or analogy). Our findings elucidate the pivotal role that treatment providers play, and the varying techniques they adopt, when translating neuroscience to practice. In doing so, we complicate a simple ‘bench to bedside’ translational pathway by attending to treatment providers' roles in influencing translation, and also contribute to an ongoing debate (e.g., Fraser et al., 2014; Hall et al., 2015) about the relevance of the neurobiological within contemporary addiction treatment settings.

2 Neuroscience, personhood and discussing the brain in practice

There is a growing body of scholarship tracing the links between neuroscience and personhood, in particular examining how individuals draw upon neuroscientific concepts to understand themselves and others. The constitution of individuals as ‘cerebral subjects’ (Vidal, 2009) has been the focus of recent work that explores an increasing “neurologisation of the person” (Singh, 2013, p. 813). Although running the risk of becoming an overdetermined sociological term (Pickersgill et al., 2011), the employment of the verb ‘to neurologise’ and the process of ‘neurologisation’ has facilitated a conceptual critique exploring how different actors (e.g., patients, clinicians, scientists) deploy neuroscientific terms and frameworks to apportion responsibility and construct and position themselves and others in varying ways (Buchbinder, 2015; Pickersgill et al., 2011; Singh, 2013).

In constructing ‘cerebral subjects’, the compelling nature and rhetorical function of brain images has received considerable attention (Choudhury and Slaby, 2016; Dumit, 2004; Rose and Abi-Rached, 2013). Through primary and secondary sources, Rose and Abi-Rached (2013) traced the development of different brain visualisation techniques from the early nineteenth century through to the present day. They cast light upon how neuroimaging techniques, via the visualisation of often unforeseen neural structures or phenomena, have served to bridge the gap between the theoretical and observable in clinical medicine, and allowed for the proliferation of a wide range of neuro-biological explanations. Such visualisations are epitomised by the *Glass Brain* (Neuroscape, 2016): a ‘state-of-the-art’ 3D brain visualisation technology that combines magnetic resonance imaging (MRI) and electroencephalogram (EEG) to display real-time brain activity and connectivity between regions. Earlier critiques have been made about the highly aestheticized construction of contemporary neuroimages (e.g., fMRI images) that are often incorrectly presented as direct pictures of brain activity which constitute, for example, ‘madness’ as residing within the brain or mental illness caused by a damaged region of the brain (Dumit, 1999).

Within critical addiction scholarship, it has been argued that neuroimages, as part of a wider dominant neurobiological discourse, perform the function of characterising addiction as a disease of the brain (Fraser et al., 2014). The *brain disease model of addiction* (BDMA) that represents addiction as a chronic, relapsing brain disease (Leshner, 1997; Volkow et al., 2016) has received strong support among policymakers and neuroscientists, particularly in the US. Researchers from the US *National Institute on Drug Abuse* (NIDA) argue that chronic drug use ‘hijacks’ the brain’s reward systems, making it difficult for people to stop using drugs and resulting in high rates of relapse (Dackis and O’Brien, 2005). There is an ongoing debate, however, about whether the BDMA is supported by neuroscientific evidence (Hall et al., 2017), and whether it has delivered on its promises to benefit treatment and reduce stigma for people with addiction (Fraser et al., 2017; Hall et al., 2015; Heather et al., 2018; Lewis, 2015). Although there has been research on treatment providers’ views about disease models of addiction and their clinical impact (for a review, see: Barnett et al., 2017), little research has been conducted on how treatment providers discuss the brain more generally in practice, including whether they employ terminology familiar to the brain disease paradigm. Our paper addresses this gap in the literature.

Of particular relevance to our own study is Buchbinder’s (2015) examination of the social implications of neuroscientific thinking and the creative uptake of neurobiological discourses by clinicians working in a US paediatric pain clinic. Buchbinder’s ethnographic inquiry illustrated how, through discussing and rhetorically mapping the brain with patients as a therapeutic tool, physicians engaged in a distinctive form of neuroscientific representation: *neural imagining*. Buchbinder posited that neural imagining within the pain clinic relied on a distinctive clinical epistemology that privileged creative imaginaries over visualisation techniques (e.g., fMRI), which notably were often absent or technically impossible, to reveal truths about the body. Aided by the use of an ‘imaginary toolkit’ consisting of vivid neurobiological language, images, and metaphors, neural imagining was employed by clinicians to: reduce stigma and legitimise pain symptoms; reaffirm adolescent identities affected by chronic illness; and, to offer a glimpse of a world in which intractable pain could not only be visualised, but also cured. Neural imagining allowed for a metaphorical means to spatially locate pain when visualisation and diagnostic technologies could not. For example, hypnotherapy as an alternative therapy for pain was ‘imagined’ in the context of ‘rewiring circuitry’ and ‘reprogramming the pain map’. Thus, by foregrounding a picture of a highly plastic brain, neural imagining offered a more hopeful alternative to dominant popular and scientific representations that viewed the teenage brain through a lens of pathology.

One question that is receiving increased attention within sociology, STS, anthropology and beyond is the relevance, or indeed *irrelevance*, of neuroscientific understandings of health and disease amongst a web of other biological, psychological and social concerns encountered in everyday life. Empirical findings increasingly demonstrate that neuroscientific concepts rarely “cleanly eclipse” (Buchbinder, 2015, p. 13) the person. Rather, neuroscientific concepts compete and integrate with other forms of subjectivity (e.g., psychological, social), with subjectivity being constituted via more than just the brain (Meurk et al., 2016; Pickersgill et al., 2011). These empirical findings have highlighted the limitations of concepts such as the ‘neurochemical self’ (Rose, 2003), by disrupting

over-theorised accounts that privilege neuroscience and characterise the brain as constituting the “epicentre of personhood” (Pickersgill et al., 2011, p. 362).

In this study we apply a critical lens to addiction clinical practice by exploring the ways in which treatment providers discuss and represent the brain. Specifically, our analysis aims to explore how, to what extent, and for what purpose addiction treatment providers invoke neuroscientific representations or discuss the brain in practice. In exploring these dimensions, we shed light on broader questions relevant to the uptake of biomedicine that examine whether neuroscientific ways of understanding addiction have universal import in different settings. Our analysis provides fresh insights into how treatment providers engage with neuroscience in healthcare practice, and in doing so has implications for: (1) the translation of addiction neuroscience via a nuanced understanding of current ways treatment providers adopt and deploy neuroscience; and, (2) organisations responsible for developing engaging and relevant clinical resources (e.g., health promotion materials) that incorporate addiction neuroscience.

3 Methods

In this paper, we present data generated from 20 interviews conducted in 2015–16 with treatment providers working in five drug and alcohol treatment settings in Victoria, Australia (participant details are summarised in Table 1). The interviews were conducted as part of a wider mixed-methods project that explored addiction treatment providers' views about a wide range of topics. These included how they viewed alcohol and other drug problems and the aetiology of addiction, what types of treatment models they used in practice, and how, if at all, they drew upon (and ascribed relevance to) neuroscience in their clinical practice. The project was granted ethics approval by the Monash University Human Research Ethics Committee (CF15/2656–2015001096).

Potential recruitment sites were identified from the first author's networks and the alcohol and other drug treatment services online listing (<https://www2.health.vic.gov.au/alcohol-and-drugs/aod-treatment-services>). Potential sites were purposively selected to recruit a variety of different types of providers from settings with varying treatment philosophies (e.g., harm reduction, abstinence), funding models (including both public and private), and geographic locations that spanned urban and rural areas in the state of Victoria. At the outset, six sites provisionally agreed to participate in the research. However, one site (a private service that charged clients fees) disengaged from the project citing lack of available staff resources.

The five recruitment sites that participated in the study included services based in inner and outer Melbourne that offered a range of different interventions. Sites A, C and E (refer to Table 1) were metropolitan Melbourne interdisciplinary clinics that offered services including: assessment and referral, counselling, psychiatry and addiction medicine, along with harm reduction interventions (e.g., pharmacotherapy, needle and syringe programs). In contrast, site B was a therapeutic community based in a rural setting where residents lived on site and participated in an abstinence-based recovery program. Site D was a private psychology practice. All sites, except for site D, were linked to publicly-funded health

services or non-government organisations; part of the wider Victorian public alcohol and other drug treatment sector; and, were generally free in terms of cost. Site D was outside the Victorian public alcohol and other drug treatment sector and clients were charged fees for service (of which many clients could apply for a government rebate under mental health care public funding).

Once a site had provided local ethics approval for the research to proceed, a primary contact at each site advertised the study to other treatment providers following a “gatekeeper referral” method (Jessiman, 2013). The study advertisement informed prospective participants that their participation would involve an interview about their views on alcohol and other drug addiction treatment, practice, neuroscience and the BDMA.

The 20 participants across the five sites included Addiction Medicine Specialists, Psychiatrists, Nurses, Social Workers, Psychologists, Counsellors and Case Workers, along with others working in addiction treatment services. They comprised 10 men and 10 women, ranging in age from 32 to 66 years. Their length of employment at their current workplace ranged from less than one year to 14 years. Participants had worked within alcohol and other drug treatment for between one year and 31 years. Demographic data was unavailable for one participant.

The interview schedule was designed to explore participants' views about a wide range of topics including the aetiology of alcohol and other drug addiction, treatment models and the relevance of neuroscience to clinical practice. All interviews were conducted face-to-face and on site at treatment providers' places of employment. The mean duration of interviews was 44 min, ranging from 18 to 69 min.

Interview transcripts were anonymised and analysed using NVivo, Version 11. Data were coded by the first author (AB) following a two-staged approach in line with the constant comparison method (Seale, 1999). During the first stage, as part of the wider project, transcripts were read and preliminary codes were applied to emergent themes. These themes related to participants' views about: drug and alcohol problems (e.g., aetiology, treatment); social and psychological models and their relevance to treatment; and, (the focus of this current paper) the relevance and clinical utility of the brain and neuroscientific models for addiction clinical practice. A detailed coding structure was formed from this initial coding stage. From this first stage, data (not used in the current article) were presented in another paper that explored how neuroscientific discourses problematised addiction (Barnett et al., 2018).

Following on from the initial study, we also wanted to explore how addiction treatment providers invoked neuroscientific representations and whether they viewed discussing the brain as relevant to practice. However, it was apparent that the first coding procedure had generated a broad coding structure that was insufficiently granular to answer the specific research questions asked in this article. Therefore, a second, more detailed coding of participants' references to the brain and views about neuroscientific models was performed in order to reinterrogate the initial coding framework to obtain a more detailed picture of why and how treatment providers discussed the brain with clients. For our discussion below,

we draw out key themes that arose following this two-staged analysis and provide illustrative quotes for each.

4 Findings

In what follows, we explore how different treatment providers: (1) invoked the authority and made use of neuroscience in practice; (2) represented the brain and engaged in neural imagining (Buchbinder, 2015); and, (3) questioned the therapeutic benefits of discussing neurobiology and the use of neuroimages with clients.

4.1 Making use of neuroscience

The extent to which treatment providers discussed neuroscience with clients varied. Some described how they often spoke about the brain with clients, for example: *“It’s all very neurobiological the discussion”* (A1). Several participants explained how they invoked the authority of neuroscience to explain what was happening for clients in *“scientific”* terms. For instance, an Enrolled Nurse (A7) talked about how she felt that talking with clients about addiction in neuroscientific terms was beneficial to her practice because clients were *“pleased that they can explain what’s happened to them, and it’s science”*. Similarly, an Addiction Medicine Specialist (E1) explained how discussing the brain, and deploying a neurobiological model as an explanatory tool, gave clients insight into what was *“actually”* happening:

Absolutely I use that [neuroscience] all the time. I use, if you like, a neurobiological model of addiction and behaviour to try and explain things to people because I think it’s really important that individuals understand what’s actually happening for them.

Many participants viewed discussing the brain as providing clients with increased insight into their condition. For instance, in the context of abstinence and possible anhedonia associated with cessation of methamphetamine use, a Counsellor Psychologist (A3) believed that deploying neuroscientific concepts could offer her clients an explanation for their symptoms:

[...] with stimulants, amphetamines - you know, another hot topic now, ‘ice’ - people find that if they’ve been using stimulants for a long time that when they stop, what they - I guess their brain gets used to such a high level of stimulation, but when one goes back to normal it feels like depression. I’ll say something like that. I’ll discuss that on that level with them. That’s as far as I’ll go with things of neuroscience but that makes sense to me and makes sense to them.

A Dual Diagnosis Clinician (A9) with a social work background believed that delivery of neuroscientific information by, or in the presence of, someone with neuroscientific training strengthened the veracity of the information. Participant A9 gave an example of this in the context of discussing synthetic cannabis and its effects on the brain:

[I talk about the brain] when talking about synthetic cannabis – the perfect binding to the CB1 and CB2 receptors – not only binds way more powerfully than marijuana but doesn’t disintegrate. [...] So we do a lot of that stuff without trying to

be brain experts [...] I will say: “listen you are listening to it from a social worker” – so it's a bit sort of downplaying it [...] sometimes we'll take along a psychiatrist to be the scientist.

In these instances, neuroscientific knowledge and biomedical expertise were afforded epistemic authority over other ways that clients' drug and alcohol problems might be understood, such as in terms of social, cultural, or environmental factors.

Some participants strategically invoked research on the effects of drugs on the brain as a deterrent to future use. For example, a Manager and Counsellor (B1) working in a therapeutic community selectively discussed the brain to associate alcohol use with damage to the brain: “*so we'll talk about your brain, brain function, those sort of things. We might do it in conjunction with talking about alcohol in particular and the damage that can come [from drinking]*”. This example reflected how certain treatment providers in our study recalled discussing the brain as an entity, without necessarily offering clients more detailed neuroscientific explanations (for example, by discussing ‘neuroplasticity’ as is mentioned in the next example).

In contrast to the use of neuroscience to describe the toxic and damaging impact of drugs on the brain, other participants employed neuroscience to reduce self-blame and generate optimism. For example, when describing the utility of deploying neuroscientific models a Psychologist (D1) said: “*So I think the neurology is really helpful for people to sort of start to begin to shed some of the shame around it [addiction]*”. Several treatment providers mentioned that they may explicitly discuss the concept of ‘neuroplasticity’ and the brain's ability to change over time with clients, in order to “*use neuroscience in order to create that hope*” (B2; CBT Trainer) about recovery.

In sum, the epistemic authority of neuroscience was strategically invoked in certain circumstances, in order to enjoin clients to embrace particular models of addiction or to discourage further drug use. It was also used to encourage both an empathetic relation with the self, and optimism about recovery and capacity for change.

4.2 Representing the brain

The majority of respondents described how they deployed various concepts (e.g., neuroplasticity, brain damage) with clients at different times. Some providers, though, gave more detailed accounts of how they discussed neuroscience with clients using vivid neurobiological language, metaphors, and stories. Informed by Buchbinder's (2015) notion of ‘neural imagining’, we discuss how metaphors were deployed to communicate complex neuroscientific concepts and translate these into accessible stories for clients. As we will show, neural imagining took place within wider treatment contexts and was designed to construct the problem of addiction, and the solution to it, in a specific way for particular types of clients.

The first example comes from an interview with a Dual Diagnosis Clinician (A9), who had experience of working in treatment delivery in the USA and Australia. Explaining how he spoke about addiction when teaching young people during a workshop, he stated:

[The metaphor] I'd use with kids was 'Russian Roulette' [...] I had a classroom full of kids and I'd say: "a certain percentage of you may have a natural tolerance. Another proportion of you are going to teach yourself to become attached to alcohol in an addictive way." [...] I probably mightn't have said "your brain is going to be hijacked", but, I'd use a very similar word which was - I'd use the word 'hostage'. "So you're a hostage. Your brain will become a hostage. You're not already but - you can do something about it - but you may become a hostage." [...] It's a similar metaphor to hijacking - but it's all metaphoric I think. But I like the word hijacking.

Though not employing the BDMA language of 'hijacking', this participant described his use of a similar metaphor about the brain becoming a 'hostage' to addiction. This description emphasises the belief in the difficulty of escape or recovery once addicted, while the Russian Roulette metaphor framed drug use as an inherently risky process. Buchbinder (2015) observed that neural imagining was employed in the pain clinic to reduce stigma, legitimise symptoms, and to offer hope that intractable pain could be cured. In contrast, by explaining addiction in terms of 'Russian Roulette' and the potential for the brain to become 'hostage' to drug use, neural imagining is used with a non-clinical audience with the aim to discourage youth from using alcohol and other drugs. Neural imagining in this instance provides a less flexible and less hopeful image of the brain than that constructed through the talk of Buchbinder's respondents.

In another example, an Addiction Medicine Specialist (E1) described how they viewed addiction not as a disease, but rather as a "conditioned response" or "a learned state". This participant said that their view of the aetiology of addiction was better matched to Marc Lewis' (2015) neurodevelopment model, that characterises addiction as a process of deep learning underpinned by reversible forms of neuroplasticity, rather than a disease of the brain. Consistent with this view, participant E1 deployed metaphors that represented addiction as a process of learning. Neural imagining in this example references a neurodevelopmental model of addiction, comparing addiction to learning an instrument:

That's just the way the brain works, I don't see it being separate from learning a behaviour. I use the illustration [with patients] if you were learning a musical instrument, your brain is developing new pathways and the better you get at it the more automatic that behaviour becomes. That's actually what's happening when people use drugs, it's just the drugs are much more highly rewarding and so those pathways are being developed much more rapidly.

In our final example, another Addiction Medicine Specialist (C4) talked about using metaphors in the context of educating patients about the effect of opioids on the brain and opioid replacement therapy. He deployed a lock and key metaphor with certain patients, depending on their health literacy, to explain the neuropharmacological effects of drugs on the brain and pharmacotherapies such as opioid replacement therapies:

I use a metaphor a lot with talking about opioid substitution: the 'key in the lock'. [I explain to patients] – "when you take an opioid, such as if you're going to use heroin, heroin is like an external key that opens the lock. The body produces a whole lot of locks [...] and when you stop taking heroin, you've got all these

locks sitting here, and your body just stops making keys in the body factory. So, what happens is the doors don't open and the locks are locked and you get sick. [Replacement therapy] keeps you well and sober" [...] certainly opioids are very suited to those sorts of metaphors.

However, the respondent further described how he avoided the 'lock and key' metaphor and references to the brain or science when treating patients who also worked in healthcare:

With an impaired physician [...] you don't want to pitch at that level, necessarily, because they'll start rolling their eyes. But then again, you don't want it to descend into an academic, intellectual discussion about addiction which a lot of doctors do [...] you've got to be really careful that they're a patient, and this isn't a discussion about another patient. You wanted to bring it back to them. Their knowledge, or the level of detail about the science of addiction isn't really relevant. It's how they're feeling.

This example illustrates that for some patients, neural imagining (here, a 'lock and key' metaphor) was accounted for as having explanatory value insofar as translating complex pharmacological processes into something more comprehensible for people without specific expertise. For patients without a medical background, the use of the 'lock and key' metaphor framed (the solution to) addiction as residing within the brain. However, for doctors and nurses in treatment, the deployment of this metaphor was avoided for two reasons. First, it may be perceived as an over-simplistic representation of addiction and the brain. Second, it characterised addiction as being a biomedical problem with a technical solution (e.g., pharmacotherapies). In doing so, it depersonalised the problem of addiction for a patient population that may require their subjectivity and emotions to be specifically attended to in order to derive therapeutic gains. Thus, neural imagining was used strategically, as part of a broader process of 'selective neurologisation' that we discuss next.

4.3 Selective neurologisation

Despite the invocation of neuroscientific notions by several respondents, many treatment providers – as we have seen – recalled how they refrained from deploying neuroscientific accounts with every client. Although the central theme of the interviews was about how the brain was discussed, some participants in the initial interviews referenced how images may, or may not, aid discussions with their clients. Therefore, we asked specific questions about treatment providers' engagements with visual representations of the brain in subsequent interviews. In this section, we include reflections on the accounts of the use, or non-use, of images within therapy.

An Addiction Psychiatry Registrar (C3) was one example of a participant who did not fully embrace a neurobiological model in interactions with clients: she said that she discussed the brain only "*Sometimes [...] in fairly vague terms*". Likewise, a Manager and Counsellor (B1) at another service stated that "*we might have those conversations [...] it [the brain] might come up, but it might not*".

Decision-making about whether to introduce neurobiological concepts and language within therapeutic discourse was, for most participants, guided by whether a neuroscientific

account was perceived to have clinical utility for a particular client. The following excerpt exemplifies such selective neurologisation. When asked whether they discussed the brain with clients, an Addiction Psychiatrist (C2) responded:

Yes, not always. So not 100 per cent. I usually pick the client, who, first of all, might express an interest in it, then I always would [...] So I guess what I'm saying is I tend to discuss it [neuroscience] only when I think it's helpful for whatever reason. It isn't always kind of an essential part of how I discuss diagnoses.

However, in the majority of cases, respondents spoke about how they *“usually [don't] go into that sort of depth [i.e. talking about neuroplasticity]”* (A2; Registered nurse), since *“you just have to keep it simple for the patients”* (C1; Addiction Psychiatrist). Participant C1 also questioned the clinical utility of showing a client an image or model of their own or another person's brain:

I don't have a model of the brain on my desk. I know some GPs do. But even then, I'm not sure how helpful it would be. Well, some people, it might scare them. If they've had a brain scan, a CT or MRI of their brain, and it shows shrinkage, for some people that may register impact. [For others] it may be a bit late [to be helpful], if you see that, actually.

Another Addiction Psychiatrist (C2) reflected on how she might use a diagram with clients that presented the relationship between different emotions and behaviours; however, the diagram did not present a visualisation of the brain per se.

Of course, participants' clients may have been exposed to visual representations of the brain during their treatment via other avenues; for example, through leaflets given to clients, on websites of the services, or where clients themselves may have researched addiction neuroscience on the internet. It is worth noting, though, that when referring to their clinical interactions with clients, participants in our study generally described visual representations of the brain as having only limited (or no) capacity for enjoining their clients to consider their addiction in neurobiological terms, with a view to advancing therapy.

The main factor influencing perceptions of clinical utility - and, hence, if and how the brain was introduced by treatment providers - was whether neuroscientific concepts were judged to align with clients' own perspectives on (their) addiction. For example, one respondent (A8; Enrolled Nurse) noted that neuroscience was discussed only when perceived to be desired by the client:

You really have to choose the level that you deliver the information - yeah. Some people want it and some people don't, so it's - yeah, definitely, you're not going to discuss that [neuroscience] with every client.

Another provider (A3; Counsellor Psychologist) stated that they would not discuss addiction in neurobiological terms with clients *“unless they were ‘into it’ [...] usually it's not brain stuff they come up with. Yeah, so I match whatever language they use”*. In a similar vein, this participant also described how visual representations of the brain were mainly relevant for the education of treatment providers, but not necessarily clients:

We might not show them pictures of MRIs and things that we might have seen and looked at in our PDs [personal development sessions] and discussed, but we will convey that information to clients if that makes sense in some way.

She went on to describe how MRI images with localised areas representing changes in specific brain regions were not helpful for clients in practice:

We're not going to tell the clients: [...] "this one thing in your brain here lights up [pointing to an imaginary picture], that's why you have this addiction." That's not helpful to anybody.

For some participants, discussions of the brain were avoided, as neuroscientific concepts were not seen to align with, or be relevant to, clients' own views concerning their addiction. Providing an illustrative example, a Case Manager (B4) expressed the view that discussing the brain with clients often failed to align with clients' own conceptions of their addiction and could be disengaging (stymieing the therapeutic process). She stated:

I don't think they [clients] would gravitate to that type of speak to be perfectly honest. [...] I've seen sometimes someone start speaking about all your neuron transmitters [*sic*] and this and that happening in your brain and they're all just like: "what the fuck?" [...] they're not really interested that there was a neuron transmitter that's gone wrong in their brain. They're really pressured about "what is going to become of me?"

Despite the enthusiasm of some participants for neurobiological framings of addiction, others believed that discussions (and images) of the brain were to be avoided in certain therapeutic settings. Thus, notions and concepts from the neurosciences were used strategically and selectively. This related to perceptions of clinical utility, which were accounted for as resting upon provider opinion on whether neuroscientific concepts would align with, or be relevant to, clients' own views concerning their addiction. Hence, in some instances it would be therapeutically unproductive or even disadvantageous to introduce them.

5 Discussion

Our findings underscore how neuroscientific representations of addiction were selectively deployed by treatment providers for presumed therapeutic purposes. This process of (what we term) 'selective neuro-logisation' of clients' actions and experiences was driven by two key, and partially connected, factors: (1) whether a neurobiological account was perceived by providers to resonate with clients' own imaginaries of the ontology of addiction; and, (2) the extent to which providers thought invoking neuroscience had clinical utility. Elaborating on the second point, providers described a range of potential therapeutic benefits of discussing addiction in terms of the brain. These included (a) making sense of clients' feelings (e.g., depressed mood); and experiences; (b) enjoining clients to concur with providers about the import of certain actions in the future (e.g., refraining from drug consumption); and, (c) fostering optimism about the future and reducing clients' selfblame and guilt for past actions.

There were many instances where neuroscience was invoked for its scientific authority in order to explain drug problems in terms of what was “actually” happening for clients. The ‘epistemic authority’ (Boswell, 2008) that neuroscience commands in legitimating the existence of various phenomena and substantiating access to resources has been the subject of critical analysis within other spheres, for instance, the effects of neuroscience within social policy (Broer and Pickersgill, 2015) and early childhood development policy (Edwards et al., 2015). Challenging claims about the progressive effects of neuroscience, Edwards et al. (2015) found that ‘brain science claims’ essentialised mother-child relations and biologised ideas concerning childhood deprivation when invoked within childhood development policy and practice. Our findings (perhaps more optimistically) indicate that the decision about whether to deploy neuroscience for its epistemic authority within addiction practice was conditional, based on a strategic choice guided by whether treatment providers perceived neuroscientific representations to be clinically advantageous. Thus, rather than observing universal effects of neuroscientific discourses within addiction practice, our findings provide insight into the role addiction treatment providers play as *agents* in deciding whether to deploy neuroscience (including for its epistemic authority) for therapeutic benefit.

Further exploring the ways neuroscience was deployed, it is worth reflecting on the flexibility and effects that neural imagining (Buchbinder, 2015) affords in clinical practice. At one level, our findings indicate that when addiction treatment providers assess it to be clinically advantageous, they translate concepts emerging from neuroscience research such as brain damage linked to drug use, or ‘neuroplasticity’, highlighting the brain’s ability to change. At another level, this translation of individual concepts progresses into a completely different style of communication: neural imagining (Buchbinder, 2015) in the form of detailed neurobiological accounts using vivid metaphors and stories. As Buchbinder (2015) notes, neural imagining serves to represent the brain through language by enrolling materiality as a rhetorical resource, whilst offering a ‘pliable’ form of expression that operates to resist the “verisimilitude of diagnostic imaging techniques in favour of creative forms of expression” (Buchbinder, 2015, p. 2). Thus, for Buchbinder in the pain clinic, neural imagining afforded the teenage brain to become a space of possibility, “not to map things as they are, but rather, things as we hope they might be” (Buchbinder, 2015, p. 2). Buchbinder’s theory about neural imagining may explain why addiction treatment providers tended to avoid the use of images, and instead to engage in verbal, highly metaphorical representations, that afforded a more flexible and tailored approach when communicating about the brain and addiction with clients.

Treatment providers’ avoidance of presenting neuroimages to clients stands in contrast to what we might have expected from the range of social scientific work emphasising the salience, function and effects of brain images (e.g., Dumit, 1999; Dumit, 2004; Rose and Abi-Rached, 2013). Although critics have drawn attention to the often-incorrect presentation of neuroimages as direct pictures of brain activity that aid in the constitution of mental pathology (e.g., Dumit, 1999), our own empirical work indicates that treatment providers did not perceive the presentation of neuroimages as necessary or helpful. Given participants generally did not report considering visual representations whilst working with clients as of clinical benefit, the question is raised about the possible effects and benefits of images or

artistic impressions of the brain presented in public health campaigns and client resources (e.g., websites about addiction). We see examples of neuroimages in many contexts, for example, within a resource for Indigenous people in Australia named the *Grog Brain Story* (Cairney et al., 2009), through to the US where NIDA presents resources such as *Drugs, Brains, and Behaviour: The Science of Addiction* (National Institute of Drug Addiction, 2014). In the future, moving beyond our own sample, cross-cultural research of treatment providers' views about the effects of neuroimages and how they present neuroscience in practice, along with the views of clients themselves, presents an interesting opportunity for research, particularly in light of the proliferation of addiction neuroscience and neuroimages in the media and elsewhere.

At times, neuroscience was specifically framed as irrelevant by the treatment providers we interviewed. This resonates with other work (e.g., Fraser et al., 2018; Meurk et al., 2016; Pickersgill et al., 2011; Pickersgill et al., 2015) which has shown how those often posited as likely beneficiaries of neuroscientific concepts and findings can reflexively elide or problematise this knowledge. Somewhat less considered within the addiction literature have been analyses of treatment providers themselves (though see, for examples: Barnett and Fry, 2015; Bell et al., 2014; Fraser et al., 2018). Our contribution provides further evidence that amongst treatment providers who are both biomedically trained (e.g., addiction medicine, psychiatry) and those with other educational backgrounds (e.g., social work), neurological ontologies can be at times positioned as lacking centrality and salience within clinical work. It is worth noting, however, that these research examples of treatment providers' views (e.g., Barnett and Fry, 2015; Bell et al., 2014; Fraser et al., 2018) and our own work represent what appears to have become an increasingly Australian branch of research exploring addiction treatment providers' perspectives about neuroscience and the clinical impact of the BDMA. Care should be taken in making assumptions that similar findings hold true in other international contexts. Moreover, given that the BDMA receives particularly strong support from policy-makers (e.g., NIDA) and treatment provider representative bodies such as the American Society of Addiction Medicine (2011) in the US, a similar analysis of US treatment providers' views about neuroscience requires further attention.

Finally, what do our results mean for critical work on translation? Given that providers did not view as mandatory, nor always attempt, to enrol clients in a neuroscientific understanding of their addictive behaviour (i.e., for clients to consider their own drug use in terms of neuroscience), a neuroscientific idiom was not an “obligatory rhetorical passage point” (Broer and Pickersgill, 2015, p56; cf. Callon, 1984, p. 205) for provider-client interactions. Rather, treatment providers strategically and contingently decided upon whether to deploy neuroscientific representations within practice. These treatment practices led to addiction being enacted in varying ways and with different effect. Our work adds to existing STS scholarship (e.g., Farrugia and Fraser, 2017; Fraser, 2016; Savic et al., 2018; Sear, 2019) by demonstrating the different ways addiction is problematised through clinical practice and how its construction is highly context dependent.

Our work further renders problematic any straightforward assumption about the universal and/or linear import of neuroscience to practice, of the kind that is commonly implicit and sometimes explicit within narratives of ‘bench-to-bedside’ translation. Importantly,

given that there are other examples of the translation of neuroscience to practice (e.g., how treatment providers conceptualise the brain when prescribing pharmacotherapies; or how they perceive client autonomy in light of the damaged brain), the future holds many opportunities for the application of social science studies of biomedicine to further interrogate what it means to ‘translate’ neuroscience into clinical practice.

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Table 1
Participants.

Recruitment site	ID	Role
Site A: Outer Melbourne inter-disciplinary clinic	A1	Addiction Medicine Specialist
	A2	Registered Nurse
	A3	Counsellor Psychologist
	A4	Primary Health Care and Needle and Syringe Programme Worker
	A5	Counsellor
	A6	Enrolled Nurse
	A7	Enrolled Nurse
	A8	Enrolled Nurse
	A9	Dual Diagnosis Clinician
	A10	Nurse - assessment
Site B: Therapeutic community	B1	Manager and Counsellor
	B2	Cognitive Behavioural Therapy (CBT) Trainer
	B3	Case Worker
	B4	Case Manager
Site C: Inner Melbourne inter-disciplinary clinic	C1	Addiction Psychiatrist
	C2	Addiction Psychiatrist
	C3	Addiction Psychiatry Registrar
	C4	Addiction Medicine Specialist
Site D: Private psychology practice	D1	Psychologist
Site E: Inner Melbourne clinic linked to hospital	E1	Addiction Medicine Specialist