



Title: Laboratory production of health and performance: an ethnographic investigation of an exercise physiology laboratory

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ABSTRACT

Critical scholars of sport and physical culture have devoted significant attention to developing critiques of epistemological hierarchies and the discursive power of biomedical knowledge in sport, exercise and physical activity. However, such work has largely failed to engage in an empirically grounded fashion with the processes of knowledge production. Furthermore, relative to its importance in the creation of knowledge, the laboratory is conspicuous in its absence from both critical discussions and as a site for empirical research. By way of response, this study draws on data collected from over 1000 h of participant observation and 53 semi-structured interviews to explore how underlying political and social values are articulated through relationships between knowledge creation, transfer and claims-making, and specific social frames in exercise physiology, a cornerstone of sports science. Rather than rehearse methodological challenges and critiques, the analysis presented demonstrates, contrary to critical analyses of scientific research that charge biomedical sciences with producing de-contextualised knowledge, laboratory-based sports science is thoroughly contextualised, albeit in specific and nuanced ways. Specifically, exercise physiology knowledge production is characterised by dehumanization and rehumanization processes. The relationship between these processes is not unilinear or sequential, but reciprocal and recursive. Nonetheless, dehumanization is the basis upon which exercise physiology knowledge is made applicable. Rehumanization is how it becomes desirable.

Introduction

Social scientists studying the relationship between science and technology, and sport and physical culture have devoted much attention to challenging the ontological and epistemological proclivities of the 'hard science' approach of sports scientists (Maguire 2004; Andrews et al. 2013), questioning epistemological divisions (Vertinsky 2009; Pringle and Falcous 2016), and critiquing the discursive power of biomedical definitions of health (Fusco 2006; Rail and Jette 2015; Thorpe 2016), the body (Pronger 2002; Hargreaves and Vertinsky 2007; Markula 2014), and obesity science (Gard and Wright 2006; Gard 2011; Rail 2012). Similarly, following Brohm's (1978) ground-breaking vituperation, scholars have critically examined sports science and sports medicine (Hoberman 1992; Malcolm 2017) emphasizing doping (Miah 2004; Beamish and Ritchie 2006; Moller, Waddington, and Hoberman 2015) and athlete classification regarding gender (Cooky and Dworkin 2013; Wells and Darnell 2014; Kidd 2017) and disability (Purdue and Howe 2013; Schalk 2016). Most recently, assumptions, claims and impacts of health surveillance technologies have been examined (Lupton 2012; Millington 2016, 2018; Rich and Miah 2017).

Despite the importance of biomedical knowledge to the aforementioned critical scholarship, such work has largely failed to engage in an empirically grounded fashion with the processes of knowledge production. In short, critiques address either epistemological hierarchies (e.g. Andrews et al. 2013), or manifestation of knowledge in, for example, schools (e.g. Evans et al. 2008), fitness clubs (e.g. Wiest, Andrews, and Giardina 2015), clinics (e.g. Jette 2011), and fitness technology (e.g. Millington 2018). Studies of knowledge production are predominantly from historical perspectives. For example, the formation and development of exercise physiology (Svensson 2013; Schantz 2016; Tipton 2011), and activities, in influence, and importance of the Harvard

Fatigue Laboratory (Johnson 2015; Oakes 2015; Scherer 2015) have received attention. Moreover, Heggie (2013), Park (2007), and Vertinsky (2017) identify antecedents for contemporary debates regarding health, exercise, physical education, and the body in the emergence of sports medicine and physical education. Knowledge creation processes per se, however, receive limited attention.

Furthermore, relative to its importance in the creation of knowledge, the laboratory is conspicuous in its absence from both critical discussions and a site for empirical research. That said, the laboratory has not been entirely overlooked. Jonasson (2014) juxtaposes the dynamics of ‘purity’ and ‘hybridity’ in and through experimental research and sport. Johnson (2013a) conceptualises the athlete as a model organism for sports science, and examines geopolitical influences on resources and prestige shaping exercise physiology (Johnson 2013b). The purpose of this study is to explore how social values, cultural practices, aspects of everyday life, *and* physiological processes manifest in questions, answers and styles of thought in exercise physiology, as a cornerstone of sports science (Ji, Di ee, and Schrage 2008). Simply put, critical scholars have been adept at studying scientific knowledge down-stream at point of use, but overlook the creation of knowledge upstream and subsequent journey. Addressing this oversight is a central impetus for this paper.

Methodology

Studying laboratories: setting and philosophical underpinnings

Stephens and Lewis (2017, 204) identify the fundamental purpose and strength of laboratory ethnographies as exploration of ‘knowledge production as situated within new technical domains, and new political contexts’. Although ethnography is not the only way to develop such understanding (cf. Merton 1973), the methodological foundation of this research follows Geertz (1973, 5), who avers those studying science as a social practice should ‘look in the first instance not at its theories or its findings, and certainly not at what its apologists say about it: you should look at what the practitioners of it do’. Drawing on direct, sustained and extensive participant observation (O’Reilly 2012), and semi-structured interviews, this study is designed to examine ‘what the practitioners do’ and in doing so go beyond extant recounting of empirical, theoretical, and technological developments, and ‘great men’ of the field (cf. Tipton 2011).

As a scientific practice, exercise physiology is relatively unique as a non-clinical research environment using ‘whole people’ as participants (Johnson 2013a). Indeed, in a faculty research seminar the presenter, a Professor of molecular biology, discussed how visiting exercise physiology laboratories was especially interesting because, compared to laboratories in their field: ‘humans are your lab rats’. Underlying this observation is the explicit aim of scientific exploration of physiological processes through sports science is documenting and changing people’s bodies. Consequently, cultural and moral judgements of values, behaviours, and valued behaviours are made implicitly. The connection of the explicit practice and implicit values makes exercise physiology laboratories important sites for ethnographic investigation. The specific laboratory for this research was selected due to its explicitly stated mandate of research-informed

intervention into high-performance and recreational sport, exercise, and healthcare contexts; and advocacy of performance-enhancement research to contribute to health-enhancement practices. Therefore, this research not only addresses a new technical domain (Johnson 2013b; Stephens and Lewis 2017) but also connects the technical domain of exercise physiology to the political contexts of modern achievement sport (Maguire 2004), health and fitness technologies (Millington 2016) and the politics of the academy (Andrews 2008).

The study design is underpinned by interpretivist philosophical assumptions. Therefore, this research adopts a symmetrical perspective on laboratory work (Bloor 1976) and does not assess the reliability or validity of laboratory research. Instead it holds people's experiences and understandings of events and practices (in the laboratory and of sport and physical activity) are inherently multiple (i.e. ontological relativism). Furthermore, that knowledge creation is subject to different interpretations, mediated by values, and changes in relation to time and place (i.e. epistemological constructionism). From such a perspective, rather than rehearse methodological challenges and critiques of laboratory science, such as those outlined above, the analysis presented here demonstrates how underlying political and social values are articulated through relationships between knowledge creation, transfer, and claims-making and specific social frames (Jasano 2012). Not evaluating validity or reliability of methodologies, or truth-value of laboratory research.

Data collection

Data were collected through prolonged interaction in the field: over a thousand hours of participant observation in the lab, at conferences and seminars, in gyms and training facilities; and semi-structured interviews with conveniently and purposefully sampled (Miles, Huberman, and Saldana 2014) participants ($N = 53$).

Entrée was granted after receiving institutional ethical approval, and provided I contributed to laboratory work as a lab assistant. My duties, however, were never formally defined. Generally, I would assist researchers with logistical and practical issues setting up experiments (often as a pilot participant) and data collection and analysis procedures during and after experiments. Like Latour, I found it 'necessary to be a technician, and an incompetent one at that' in order to more fully appreciate technical and social processes in the laboratory and 'the practical "miracle" of completing an experiment' (Latour and Woolgar 1986, 245). I was a participant in the numerous experiments where I met inclusion criteria (cf. Costello, Bieuzen, and Bleakley 2014), and involved in the general aspects of daily life in the laboratory including coffee-breaks, lab events and parties, and 'baked-goods Wednesdays'. Following best practice principles (Emerson, Fretz, and Shaw 2011; Atkinson 2015), participant observation data were recorded in observational fieldnotes taken as soon as practically possible after any event, and at the conclusion of each day.

Semi-structured interviews began after three months of participant observation. Interview participants were invited to participate in the research based on ability to provide particular insights, perspectives, and in response to findings of initial analyses (Miles,

Huberman, and Saldana 2014). Interviews were conducted with: those most responsible for ‘actual’ lab work, namely graduate students, post-doctoral researchers and laboratory technicians; permanent faculty members; senior staff researchers; applied practitioners working for sporting organizations and elite athletes working with them; and those who, like me, participated in laboratory research projects.

Interviews guides were created to explore findings from initial analysis of participant observation data. Participants were invited to talk about: their research biography, interests and activities; contextual aspects of research, including political, technological, and procedural factors, with particular reference to opportunities, barriers and challenges for their field; and my readings of data, findings and arguments. Interviews, then, were designed to enable member reflection (Smith and McGannon 2017) and encourage guided theoretical dialogue (Stebbins 2001). Iterative findings were presented to participants, in both inter-views and ethnographic conversations, as my contingent, theorized understandings, rather than theory-free knowledge, which reflect interpretivist ontological and epistemological assumptions. Interviews ranged from 30 min to 2 h, were transcribed, and supplemented with observation notes for analysis. All quotations and have been de-identified to protect participant identity.

Analysis and rigor

Following foundational ethnographic tenets (O’Reilly 2012) and best practice qualitative analysis techniques, prolonged interaction and observation (Atkinson 2015, 2017; Morse 2018), and iterative analysis (Miles et al. 2014; Saldana 2016) enabled better understanding of practices, actions, conversations, phrases, behaviours and processes. Observational field notes were reviewed each day (Emerson, Fretz, and Shaw 2011) where memoing (Saldana 2016), with reference to sensitising concepts (Blumer 1969) and *in vivo* codes (Saldana 2016), supporting initial analysis. My responses to fieldwork, experiences and participants, personal standpoint, dilemmas, potential mistakes and initial analysis were identified in reflective field notes (Emerson, Fretz, and Shaw 2011; Atkinson 2017).

The craft of qualitative analysis and theory generation followed recommendations of Becker (1998, 2015). Integrative and selective coding developed *in vivo* codes into concepts through connection to memos and reflective field notes, and supplementation with ‘so data’ (Pool 2017). Dominant ideas were clustered into themes demonstrating conceptual family resemblance (Becker 1998; Saldana 2016). As data collection and analysis progressed, developing patterns of repetition and variation in dominant ideas were explored and refined through iterative review of codes and concepts (Becker 1998; Saldana 2016) and shifts between deductive and indicative reasoning (Becker 2015), which informed further data collection (Morse 2018).

Member reflections (Smith and McGannon 2017) generated additional insight as findings were directly explored with, challenged and reinforced by, participants. Not simply verifying recording and/or transcript accuracy. This approach enabled participants to inform interpretive analysis by reviewing, confirming or clarifying both their narratives and my analyses directly, which has been identified as useful for theoretical development

(Morse 2018). Through member reflections, participants generally acknowledged findings as recognizable, although not necessarily sanctioned. In this regard, this research demonstrated theoretical validity (Maxwell 1992) for participants acknowledged that even though specific events, practices or examples (i.e. data) may not directly reflect their personal experiences, abstractions from data (i.e. concepts) were recognizable as fluid ideas (Atkinson 2017) – even though some struggled with perceived pejorative conceptual terminology – that could enable new understandings (Smith 2018). Rather than rejecting findings – and in acknowledgement of the inability to produce ‘quantified proof’ per their paradigmatic assumptions – participants accentuated structural and rational-choice determinants of findings. As such, participants, especially those in the lab, challenged me to find solutions to the problems I identified. A task beyond the scope of this paper.

Findings

Given the prolonged and sustained nature of this study, unsurprisingly, a number of findings developed of which two are presented here: *dehumanization* and *rehumanization* processes. Dehumanization is characterized by particular ways of thinking, speaking and acting that remove social issues *and* other dimensions of human experience in knowledge generation processes. Conceptually, dehumanization draws on sociological understandings of rationalization processes (Ellul 1964, 1990; Weber 1991; Ritzer 2013) and instrumentalization of reason (Adorno and Horkheimer 2010). As such, dehumanization accentuates methodical ways of life. It is not targeted stigmatizing (cf. Haslam 2006). Said differently, dehumanization in the laboratory is legitimized systemic forms of thinking and acting that entail ‘denial of full humanness’ (Haslam 2006, 252), but as a general social process, not inter-group (symbolic) violence. Dehumanization necessarily occurs in the construction of sports science facts because to claim knowledge is universally applicable contextual details of participants lives must be controlled and removed. Rehumanization is the rhetorical process of re-infusing or re-inscribing values back into accounts of the place, purpose, and potential of knowledge. Importantly, rehumanization draws on values unknowable within the paradigm. The relationship between these processes is not unilinear or sequential, but reciprocal and recursive. Nonetheless, the former is the basis upon which sports science knowledge is made applicable. The latter is how it becomes desirable.

Dehumanization

Methodologically laboratory work establishes facts by removing social, historical, political and personal factors. Thus, ‘scientific facts are formulated in the denial and obliteration of *their own* historicity’ (Latour and Woolgar 1986, 277 emphasis added). Such obliteration and denial entails a twofold process; first, removal of external factors in knowledge production; secondly, omission of external contingencies in communication. This is particularly important given the aforementioned unique use of ‘whole’ people in exercise physiology (Johnson 2013a). Thus, laboratory knowledge becomes positioned as inherently independent of human values. For example:

Our research examines the effects of aerobic training, resistance training, and

their combination on cardiometabolic risk factors in obese adolescents. What we've shown is that the combination of aerobic and resistance training is the most beneficial for pretty much everything: reducing in percentage body fat as well as abdominal fat, lowering BMI, smaller waist circumference, and improving fitness. The best part about this is all these benefits are realised without any change in cardiometabolic risk markers.

Assumptions made of experimental design objectivity, namely the ability to remove bias (as understood from a particular ontological perspective) through good research design, are integral because removing social, historical, political and personal factors from laboratory research is deliberate, conscious and desirable. Usually by 'gold standard' testing protocols and procedures, adherence to which may open be counter-productive.

For example, I was a participant in a study assessing various cold water immersion protocols for recovery from high-intensity exercise. Double-blinding was deemed methodologically desirable. Practically, though, it was very easy to identify the experimental condition by how long you were in the bath and how cold the water was. Even more obvious was the control condition: sitting on a chair. Further, technical challenges of water temperature maintenance meant the lead researcher was often required to adjust and calibrate equipment. Ultimately, during one session a lab member derided the blinding process as 'wearing sunglasses'. The researcher responded they were acutely aware of the tenuous blinding, but were compelled to attempt a blinded study even though it compromised tight controlling of conditions. Even allowing the proposition that aforementioned biases can be controlled there is no possibility for addressing the highly subjective underlying assumptions, social values, and cultural preferences at play in the generation of research questions, interpretation of data, and avenues for the practical application of laboratory knowledge. Dehumanization concatenates knowledge production such that documented epistemological hierarchies between (Andrews et al. 2013) *and* exploitive hierarchies within knowledge production are reinforced.

The cornerstone of knowledge generation, and therefore dehumanization, in the laboratory is the production of 'inscriptions', which, for Latour (2010, 75) are at 'the heart of scientific life'. Indeed, without inscription devices an object cannot be said to exist:

It is not simply that phenomena *depend on* certain material instrumentation; rather, the phenomena *are thoroughly constituted by* the material setting of the laboratory. The artificial reality, which participants describe in terms of an objective entity, has in fact been constructed by the use of inscription devices (Latour and Woolgar 1986, 64 emphasis in original).

Devices producing inscriptions in exercise physiology laboratories include blood lactate assay devices, VO₂max testing equipment, blood plasma refraction measures, bioelectric impedance tools, and various scales (for mass and Perceived Rate of Exertion, for example). Therefore, the focus of researchers is not really participants but graphs, tables and results qua naturalised representations of participants'. Therefore, laboratory

equipment constitutes practically what can and should be studied within a given laboratory:

The equipment we have available really dictates what kind of studies you can do. That is part of the reason why I am working here [in an exercise physiology laboratory]. My lab doesn't have the treadmill or the ability to measure VO_2max and I don't have any experience with those things. In fact, in many ways, the things people do here which are routine to them would be quite exotic to people in my other lab. Exercise isn't a major focus in my department so it's also nice to be around people who are also interested in exercise. Really, coming here means that I am able to do a study that would simply not happen otherwise.

Equipment facilitates certain kinds of research and therefore defines laboratories. For example, when a new laboratory received its treadmill a researcher commented 'we are finally a real lab now'. Sophistication of laboratory equipment facilitates researcher training, formulating connections between different laboratories, funding generation, and attracting athletes to the laboratory for testing. It also facilitates dehumanization processes.

Dehumanization of researchers: McDonaldized labs

Andrews et al. (2013) commentary on McKinesiology rightly challenges practices embedded in audit cultures, business logics, market principles, and the politics of epistemology shaping higher education generally and sports science, as McKinesiology, specifically. However, the privileging of laboratory epistemologies does not unproblematically advantage sports science laboratories. They can only be said to be doing less-worse. Dehumanization processes manifest as the production and reification of inscriptions precipitates dehumanized assembly line production replete with naturalised, depoliticised exploitive hierarchies (Gramsci 1971).

Exercise physiology labs are veritable dehumanizing McDonaldized prototypes (Ritzer 2013). Combined, the streamlining of production processes and simplification of lab services (efficiency); pursuit of and faith in (only) quantitative measurement (calculability); standardization of equipment and protocols (control by non-human actors); and metric measurements of output, impact, and recommendation for activity (predictability) are clearly evident within the laboratory. Further, much laboratory work involves mundane and/or repetitive tasks that reduce the need for 'workers' to think (cf. Gramsci 1971, 309). People are reduced into the most easily learned body parts. Technical procedures are then applied. And assembly line production of knowledge by relatively cheap academic labour is formed. Resultantly, as Ioannidis (2016, 84) observes, 'it is sometimes difficult to tell whether a superb CV with a lengthy publication list reflects hard work and brilliant leadership or the composite product of dexterous power game networking, gift authorship, and excellence in the slave trade of younger researchers'. One participant recounted a peculiarity of a laboratory:

In one of the labs I used to work in the person who had the most publications was,

believe it or not, one of the technicians. They had been there for a pretty long time and were responsible for ordering, maintaining, and calibrating all the equipment. They would also do a fair amount of data collection, or at least help the grad students and research fellows do the data collection. So, their name went on almost every single publication out of that lab. I mean, they had like 300 publications or something.

A hallmark of dehumanized, McDonaldized exercise physiology research is assembly-line-produced, bland, uninspiring, standardised knowledge: the answer is *always* exercise is good for you. One researcher who found a negative effect of exercise on occupational injury prevention told me they were unsure whether they should attempt to publish because 'I don't want people to think exercise is not a good thing.'

Dehumanization also exploits, naturalises and essentialises power differentials. Ioannidis (2016) would likely recognise this participant's experience:

My supervisor didn't really do anything for that [publication] other than proofing it a few times and helping me respond to reviewer comments. That's ne; they were obviously pretty influential in the study that publication comes from. I'm happy that their name is on it. It's my first publication so no one really knows who I am so having their name on it makes it more likely the someone else will read it and, if I'm honest, probably increased the likelihood of it being sent for review at a better journal in the first place.

The analysis presented shows, contra dominant sociocultural critiques of epistemological hierarchies, that while laboratory researchers are certainly in a position to benefit more in the contemporary academic climate than others in sports science, significant potential costs still exist. This is not to suggest that exploitation of academic hierarchies is confined to laboratory research. Nor that laboratory researchers, as individuals, are predisposed to exploiting each other. Rather, physical and technological organization, and social values of the laboratory create potential for exploitation to be naturalised. For example, laboratory research may be more likely to attract external funding (Ji et al. 2008). However, recall sophisticated equipment is essential to laboratory research. Researchers unsuccessful in gaining funding, therefore, often have to engineer their own equipment, or make (oftentimes expensive) out-of-pocket purchases and/or 'exchange' equipment:

Researcher 1: I had a strange conversation with another researcher the other day. I was using a piece of equipment and they came in and said 'that's my piece of equipment.' Nothing else, just 'that's mine.' What does that mean?

Researcher 2: They probably just want some appreciation.

Researcher 1: I do appreciate it, but we all use that piece of equipment. Am I supposed to write a thank you note every time I use it? Or, if I see them using my piece of equipment should I be like 'get away, that's mine.' Besides, it wouldn't make sense for us all to go and buy our own. We don't have room for ten of these and even if we had the

money it would be a huge waste of it. It makes sense for consumables, but for bigger equipment; I mean should we all have our own treadmills too?

Researcher 2: No, they want some *appreciation*.

Researcher 1: What?

Researcher 2: You know, put their name on something. Another researcher has been using my equipment quite a lot and I totally expect my name to be on the papers.

Researcher 1: Well, what about that piece of equipment? It belongs to another researcher and that piece to another researcher.

Researcher 2: That's a good point, I really need to talk to them about that and get their name on something.¹

Dehumanization: calibrating people to machines

Calibration, for sports scientists, reliably translates abstract inscriptions into *the* phenomena thereby reifying functioning of human bodies: the wave on the electrocardiogram *is* the electrical activity of the heart, for example. From this perspective, during fieldwork an amusing incident (for me, at least) was being fitted with the mask for a VO₂max test. Necessary set up processes were completed methodically and rigorously. However, two lines which should have been inscribing peaks and troughs of respiratory volume, and oxygen inspired vs. expired were at. My breathing produced no inscriptions because, unbeknownst to the researcher, I was holding my breath. Thus, no matter how much they readjusted the mask and/or machine no reading was possible until I breathed again. Upon discovering my trick, the relief of the researcher was palpable.

Calibration processes within exercise physiology involve not calibration of the equipment to the body (clean signals from electrodes, for example) but rather calibration of the participants to the lab. Therefore, calibration, in dehumanization, goes beyond familiarization. Like Johnson (2013a), this study found athletes to be 'model organisms' because of practical considerations including (learned) ability to reproduce specific exercise intensities, visible and accessible veins and muscles, and familiarity with equipment, but only in part. Athletes are not only physiologically amenable to the research (Heggie 2013; Johnson 2013a; Svensson 2013) but also ideologically. As devices reify theories, laboratory research calibrates physical activity to dominant ideologies. A fundamental aspect of sports science, then, is the calibration of people (Ellul 1964). The means of measurement to answer a particular question may be the explicit purpose, but the implicit function is to dehumanize. As such, dehumanization in the laboratory is not just associated with the production of data, but an entire and orchestrated technical process that works to ensure reproducibility of measurements *and* performances. Dehumanization is marked by reciprocal and recursive reinforcement of dominant cultural assumptions of modern achievement sport (Perelman 2012) and rationalised fitness practices (Millington 2018).

From such a perspective, having laboratories with equipment commonly found outside the laboratory contributes to the (perceived or otherwise) denigration of sports science by other scientific disciplines and field-wide need to assert scientific legitimacy (Maguire 2004). However, exercise physiology does not gain power over people by the difference of its equipment (even though access to specialised measurements such as VO_2max tests are attractive to many participants), but its similarity and recognition:

Researcher: Have you used one of these machines [a treadmill] before?

Participant: Yeah, my gym has about twenty. Although I don't use them very often and this one looks a little more technical.

Researcher: Great, well, everything works probably just the way you are used to except the computer will control the work rate and will measure how hard you are working. All you need to do is run. When it gets to the point you can't keep up just stand on the side.

Participant: I suppose this is much more accurate than our gym treadmills then?

Researcher: It's not so much the treadmill as the computer controlling it. Treadmills are treadmills more or less, but the MetaMax which is measuring your gas exchange, and we're also collecting heart rate data from your heart rate monitor, and we'll take some blood; that is the real difference. It is not so much the accuracy of the input in terms of the speed of the treadmill that is important, but the accuracy with which we measure your output.

Participant: So this would make my workouts more effective then?

Researcher: Yeah, but it's a little overkill to have a really expensive piece of equipment in the gym. Measuring your output accurately is really important if you want to get the most out of your workout. For most of us a heart rate monitor is more than enough to ensure you're working at the right intensity for your particular goals.

Furthermore, for example, heart rate monitors were familiar to nearly all participants in studies with inclusion criteria requiring 'more than recreationally active' and/or 'well-trained' participants. Across several such studies participants had their own heart rate monitors (one of which caused confusion when leaving their monitor behind and mistakenly taking one belonging to the lab) and would compare and contrast the functionality of their monitors, including fitness trackers, with the lab's. Many of the participants I had ethnographic conversations with as part of their trials articulated how essential heart rate monitors were to training regimes uniformly noting monitors maximised efficiency of training. References to feeling naked when training without a heart rate monitor were made frequently. Of central importance across such conversations was not the equipment, nor concept under investigation or even inscriptions, but the framework under and through which measurement is taken. Here, we see that the laboratory firmly underpins the socio-technical networks and data intensiveness in contemporary exercise and fitness practices identified by Millington (2016, 2018). In this way, people are calibrated to a framework accentuating a rationale that requires

‘whatever cannot be expressed numerically to be eliminated from the ensemble’ (Ellul 1964, 168) and reinforces the dehumanization of sport, physical activity and exercise (Brohm 1978; Perelman 2012). The production of reified inscriptions as dehumanizing processes in sports science, then, are not descriptive, but algorithmic. They remove subject-object dialectics.

Rehumanization

Dehumanization entails removal of both social issues and other dimensions of the human condition from the construction of sports science facts. This necessarily, and purposely, frames exercise physiology as value-less, which resonates with romanticized expressions of science as a politically and culturally neutral endeavour. Rehumanization involves values of humanity being re-infused into accounts of the place, purpose, and potential of sports science. Simply put, the removal of values enables the introduction of different values once the fact is established. Exercise physiologists rehumanize knowledge with specific reference to individual ability, and improving quality of life through increased functioning and aesthetic appeal, which finds willing audiences among the already converted (cf. Evans et al. 2016).

Rehumanization is not cynical or entirely planned. Rehumanization is partly, however, rational, purposeful and understandable response to increasingly competitive research environments where understating complexities and overstating research impact is incentivised (Vinkers, Tjink, and Otte 2015; Chubb and Watermeyer 2017). Nonetheless, rehumanization frames physical endeavour as primarily a means-oriented activity where physical performance and functioning are the paramount ends: the better the performance; the better the life. Thus, achievement of an endeavour is morally praiseworthy because it is demonstrative of a particular understanding of the human condition. However, rehumanized accounts are devoid of aspects of the human condition such as empathy, compassion, or creativity. Such denuding inherently limits the utility of sports science knowledge to realize its avowed ambitions because it discounts progressive change. Partly because of the sheer audacity of rehumanized rhetoric. Partly because it fails to comprehend inequities in sport and physical activity (Coen 2017).

Rehumanization: a technodiscourse

Just as Pronger (2002) highlighted his initial forays into exercise afforded him greater access to sexual encounters courtesy of a more desirable body, sports science highlights under-taking exercise (with specific reference and adherence to the technical logic of exercise physiology) unlocks your greatest desires. Consider the following account:

I get to spend most of my time with world-class, international level athletes, as a sports scientist and physiologist, or at a hospital for children with chronic diseases. What I learn at the extremes of the human condition can inform all of us how to live better, happier, more exciting lives and perform at a higher level in no matter what we are trying to do.

In this sense, rehumanization works along a particular version of humanity and comes

very close to what Ellul (1990, 125) identified as technodiscourse:

All technodiscourse either is or seeks to be a discourse about humanity, about human primacy and objectives. It does not merely seek to assure us of happiness, nor does it discuss power. (There is never any question of power in this pious talk.) Its theme is true human fulfillment, which it rates very highly. Nothing is more important than the human race.

The importance to the human race is articulated by one sports scientist as follows:

An amazing thing happened at the Vancouver Olympics. For the first time in history, or at least since the 1970s, there were no positive drug tests. Doesn't mean that no one is doping, but there were no positive tests. I believe that it is because of the amazing new information we have about training and nutrition that allows athletes to perform at the highest levels without resorting to cheating. Now we have kids training well and eating well which may enable them, one day, to win. With this new knowledge, we can eat better, sleep better, and move better and by being inspired by Olympic athletes we can all really live a world-class life. There really are no more limits to what humans can achieve.

Theatrical and poetic flourishes notwithstanding, such accounts are extremely typical of both participant observation and interview data. The central message remains clear: sports science enables people to undertake a particular form of physical endeavour more efficiently and that makes everything better. Consider the following, more modest, accounts about research impact:

Exercise really is the key to health. I'm sure you are familiar with all the benefits of exercise as related to cardiovascular functioning, chronic diseases, and all that. It is more than that though, if you are active your body responds and you feel better. This is especially important in modern societies when we are inactive during the day at our desks in front of the computer but also as our societies age. We've shown that three bouts of aerobic training and two bouts of resistance training a week is all it takes for people to stay healthy and stay active. It just improves every aspect of your life and our research continues to both show why it is so important and furnish people with ways to maximize the benefits so they can experience them in their own lives.

People have an innate desire to challenge themselves, to want to climb mountains, cross deserts and oceans and the work we do enables them to do that with as much crossover into their daily work lives as well.

The pursuit of efficiency in physiological functioning and concomitant instrumental use and functioning of human bodies is articulated as a marker of an improved, good life. However, such rehumanized appeals cannot necessarily or inherently beget a fulfilling, multi-dimensional life. First, rehumanization confuses life with biology (Henry 2002). Secondly, similar to Loland's (2002) application of eudaimonia, rehumanized technodiscourse provides limited experiential and moral possibilities outside rational justifications

for activity. Thirdly, as Ellul (1964, 365) notes:

when the technical problem is well in hand, the professional humanists look at the situation and dub it humanist'. This procedure suits the literati, moralists, and philosophers who are concerned about the human situation. What is more natural than for philosophers to say: 'See how we are concerned with Man?' and for their literary admirers to echo: 'At last, a humanism which is not confined to playing with ideas but which penetrates the facts!' Unfortunately, it is a historical fact that this shouting of humanism always comes *after* the technicians have intervened; for a true humanism, it ought to have occurred *before*. This is nothing more than the traditional psychological manoeuvre called rationalising.

Harvey's (2007, 5) focus on human dignity and individual freedom as inherent to the political economy of contemporary society provides an eloquent and succinct definition of the hegemony of rehumanization rationalising in sports science, he states:

For any way of thought to become dominant, a conceptual apparatus has to be advanced that appeals to our intuitions and instincts, to our values and our desires, as well as to the possibilities inherent in the social world we inhabit. If successful, this conceptual apparatus becomes so embedded in common sense as to be taken for granted and not open to question.

Within sport and physical culture, the dominant conceptual apparatus of sports science rehumanizes bodies as collectively hallucinated, fantasized, imagined and individually experienced as an object, an instrument, a technical means to an end, a reified factor of output and productivity, in short as a machine with the job of producing the maximum work and energy (Brohm 1978, 5). Within incentivized academic audit cultures the specialised knowledge of sports science works to provide appealing results from its research that reflect ideologically dominant conceptual apparatus (Althusser 2014) to reinforce focusing on productivity and reducing humanity to efficiently functioning individuals as indicative of enhanced humanity. All the while 'man [*sic*] becomes nothing more than the imprint of his [*sic*] occupation or of his [*sic*] specialised knowledge' (Schiller 1995, 100).

Rehumanized units of measurement

Methodologically dehumanization aggregates and collates, yet rehumanization appeals directly to the individual as the central unit of measurement. It presents a neat alignment between exercise physiologists' scientific paradigm, and a political paradigm dominated by ideologies of individual sovereignty and responsibility. Therefore, rehumanization processes speak to individuals (as the unit of analysis) while seeking methodologically to function to the contrary. At its most simple, per dominant critiques, sports science overemphasizes agency and choice and understates environmental and social opportunities shaping sport, exercise and physical culture. Some acknowledgement of the various social challenges people face is made, however, overcoming these challenges is down to individual choice and action. For example:

We're generating new knowledge about the dangers of inactivity itself and not just lack of physical activity. That means we have to find ways of rationalising physical activity into every part of our day. Workplaces should provide standing and walking desks, stand up meetings are another good idea. The problem is that we live in an obesogenic environment where being sedentary and making poor nutritional choices are encouraged. From a physiological perspective these things are no good and people need to be aware of the choices they have and armed with the knowledge to make the right ones. People are confused and we need to help them understand.

One exercise physiologist explained their field as having a 'general mission to base patterns of behaviour on physiological evidence. From that rationale we can make better choices about what we put into our bodies and how we use our bodies'. Here, then, rehumanization of sports science knowledge appeals to free will as a politico-social endeavour, and exhorts individual choice of fate. The evidence base, as Ellul (1964) identified, has particular impact on the narrowing of choice. Fatalistic exhortation is particularly bitter when the stressing of choices denies disparities in opportunities.

In the context of the exercise physiology lab rehumanized knowledge reflects and reinforces dominant Western political and economic theories through a 'perceptual bias' whereby social and cultural mores are mutually constituted and supported through the conceptual apparatus of scientific paradigms 'not because it is easier to model, but because it is what we expect' (Keller 1992, 211). Thus, dehumanized research processes are rehumanized to enhance the individual (i.e. you). In doing so, rehumanization exhibits feminist Philosophers' of science compelling demonstration that units of analysis are not neutral. The success of rationally driven approaches to exercise and our bodies that imbues this approach with an undeniable power (Pronger 2002). And, posits choice as a rational, technical process whereby failure to adhere to the (dehumanized) evidence base becomes indicative of a moral failing (Ellul 1964, 1990).

Importantly, the analysis presented here posits rehumanization as a general social process. It does not intimate exercise physiologists rehumanize knowledge with any deep, perverse intention. The underlying thrust of rehumanization, however, is a humanism based 'on the assumption that the human being in question is, above all, meant for technology, and that the sole great problem is adjustment' (Ellul 1990, 315). Assuming general patterns of behaviour should be based on physiological rationale concomitantly reduces focus to assisting individual's, rather than comprehending possibilities for structural, change and reduces how sport and physical activity can be experienced and are valued.

As mentioned above, quantitative reduction of experience is necessary given paradigmatic assumptions and methodological practices of laboratory research are unable to understand other aspects of humanity such as compassion or empathy. In this sense, the knowledge sports science produces is meaningless (i.e. dehumanized). Meaning is only made through (rehumanized) appeals to values incommensurate with both laboratory science and modern achievement sport. Regardless of the empirical precision or technical genius of laboratory research, sports scientists are bereft of the ability to tell us what to

think of our bodies generally and our experiences in sport, exercise and physical culture specifically. There is no possible way for gold-standard methodological protocols to evaluate these values; nor can these approaches accept other knowledge generation methods as they would undermine paradigmatic authority of laboratory science and epistemological hierarchies (Silk, Bush, and Andrews 2010; Jasano 2012). As such, claiming improvement in life through activity informed by sports science rationale is unsubstantiated and unknowable within the paradigm. A telling and articulate example of this came from a highly respected and renowned scientist recounting and reciting various percentage improvements in morbidity achieved through exercise, as illuminated by their research, as well as reductions in mortality and ‘preventable deaths’. After stating 15-min of exercise reduced mortality by about 14%, which equates to roughly 3 years longer life.

Kass: What should we die from?

Researcher: You’re asking me what should we die from not how we should die, right?

Kass: Yes. If these deaths are preventable then what should we die from?

Researcher: Well that’s obviously a hard question to answer. I would say that we should die in the comfort of our own home away from all the medicine, the white rooms, and buzzing technology. Ideally peacefully in our sleep after a nice meal and a walk outside with your family. It will differ for every person.

What has continued to strike me about this conversation is that after clarifying the exact nature of the question they answered the question I was not asking. Naturally, this will not come as a great surprise to anyone who has conducted interviews. However, it typifies that adhering to the advice of exercise physiologists’ may well extend lifespan and improve health (leaving aside the oftentimes tautological conceptualizations and operationalizations of health and implicit healthism). However, within the laboratory there is no possibility to demonstrate improvement of life. Nonetheless, these are the exact claims made:

What our research shows, time and again, is that by incorporating physical activity into your day you are healthier, better able to do the things you want to do, and will live a better life.

The need to exercise is well known. Most people realise that exercise lowers the risk of heart disease, stroke, diabetes, and several forms of cancer. That alone shows how important the knowledge we produce is for living an active life. Exercise improves mood, strengthens bones to mitigate osteoporosis, provides strength and stability which lessens falls and, of course, helps manage body composition. We know all of this because of sports science research. The changes at cellular level and the relevant molecules related to specific chronic conditions are only just being understood. Everyone knows they *should* exercise, few realise that exercise is the single most important thing you can do to maintain and improve health. Exercise changes and improves your body and your life.

Recently, studies coming out of Europe have shown that exercise actually changes

DNA expression. You can see changes to body shape and composition from exercise. You can feel changes in mood and cardiovascular functioning. Now we are showing that exercise can literally keep you young by changing your DNA. Sports science shows all this and shows that exercise will impact, and by that I mean improve, every part of your life.

One interviewee, a former Olympic champion, rejects such sentiments. In doing so, they bring into stark relief the failure of sports science to promote happiness and compassion and undercuts rehumanization:

I wouldn't give back my athletic career at all, but I know that where I am today is a matter of finding out what makes me a person and not an athlete. My career reduced me to a sack of chemicals and forces in order to get me and my teammates into the best possible condition in order for us to win. That came at the cost of other parts of my life, which I was only able to hang onto through the help of people outside that system. I have seen many other athletes – in my sport and others – that were not able to do that. There are a variety of reasons, of course. Although a lack of interest and support in athletes as people from the system is a common denominator. I take my son for walks in the very same park that we would run through as part of our training now. I can tell you in all honesty, and I know it sounds cheesy but it's absolutely true, I get so much more satisfaction and fulfillment walking through that park with my kids now, at a fraction of the pace that I used to, than I ever did busting a gut there in training. You can't quantify it, but it counts more than anything.

Conclusion

Exercise physiologists are the vanguard of sports scientists seeking to establish themselves as culturally and scientifically legitimate informants on not only sport and exercise performance, but also physical activity as a health care practice (Ji et al. 2008). A charge frequently levelled against sports scientists is the production of de-contextualised knowledge. The sentiments of Hargreaves (1987, 139) where 'scientific discourse and common sense combine to naturalize the 'truth' about the body so that its historicity and its significance in the constitution of social relations is obscured' neatly summarises such critiques. The findings of this research demonstrate, contrary to such longstanding critiques, laboratory-based sports science is thoroughly contextualised, albeit in specific and nuanced ways. The findings document how, and why, the 'obscuring' identified by Hargreaves (1987) occurs, and adds empirically grounded specificity to Carlsson and Hedenborg's (2014, 1225) observation that 'advocates of sport seem obliged to add values in order to support and strengthen its importance'.

The analysis presented here posits dehumanization reinforces exercise physiology knowledge as universal by mechanical reduction of human experience to immutable physiological laws. In doing so not only is the utility and power of facts established by a formation of technical complexity and obliteration of historicity (Latour and Woolgar 1986) but also standardization of assembly line knowledge production replete with essentialized exploitive hierarchies. Rehumanization seeks to reconnect this knowledge

with broader, and individualizable, components of human experience through ideological framing of physical activity that legitimizes rationalized, data intensive, socio-technical networks (Millington 2016). In this regard, exercise physiologists present the consequences of knowledge deployment as the product of human choice thereby making failure to choose an individual failure to acknowledge the ‘immutable laws’ of corporeal materiality they posit as determining how and why we should engage in physical activity. The results of this study, then, provide a foundation for future investigation and consideration of the place and potential of sports science knowledge. Findings indicate the dehumanization processes may trap sport science in an irreconcilable relationship between the logics of modern achievement sport and rationalized exercise, and physical activity and health because consonance is achieved through rehumanization yet more fervent and production of yet more dehumanized knowledge.

Dehumanization and rehumanization process should not necessarily undermine confidence in the scientific approach of sports science, or provoke charges of deliberate iniquitousness, or superciliousness. The processes articulate how knowledge generation processes are determined by not only the realities of the work and body, but also an inherent rearranging of work in terms of technical progress, institutional pressures, procedures and processes of the contemporary academy. Nor should this paper provide cause for increased confidence in other forms of knowledge generation, or propose an ‘essential’ or natural account and thus chastise sports scientists for transgressing essential or natural components of humanity. Rather, without careful attention to dehumanization and rehumanization processes, exercise physiology fails to comprehend predictable negative outcomes of its decisions, actions, and knowledge including reproduced health inequalities (Williams and Gibson 2017), doping (Moller, Waddington, and Hoberman 2015) or sports injuries (Malcolm 2017). Simply put, further dehumanized demonstrations of physiological rationale and outcomes of physical activity are not necessary; knowledge production sensitive to contextual aspects in which physical activity occurs, or not, is much more pressing. Continued production of dehumanized and rehumanized knowledge may well see the field fail to realize its potential to be legitimate, valued informants on physical activity beyond the performance aims of a select few.

Note

1. When confirming the veracity of my record of the conversation, Researcher 1 stressed that this particular conversation did not result in a researcher (besides Researcher 2) being named as an author on any published manuscripts because of equipment use. Nonetheless, they also stressed it was clear being a named author did not always denote intellectual contribution to research papers.

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