

Towards an Anthropology of Gravity: Emotion and Embodiment in Microgravity environments

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Abstract:

Human space travel has largely been understood through a physiological and psychological lens but rarely sociologically or anthropologically. Drawing on astronaut testimony, experiences of microgravity environments, laboratory experiments and art practice this paper argues that gravity, or rather its absence, offers a unique vantage point through which to consider the human relationship to emotion, cognition, and the curation of social relations via experiences of the body in different gravitational environments. The analysis draws attention to the contextual, embodied and contingent moments of social relations through using a holistic materialist position with theories of affect and work on the anthropology of the body. An anthropology of gravity recognises the ethno-physical conditions of space-living by showing that microgravity environments disturb the habitual affective landscapes of human interaction. It suggests that body, emotion, social relations and environment can be better understood when they are contextualised by the underlying forces that operate subtly throughout them; forces that are more fully understood once they are no longer present.

Key Words: The Body, Gravity, Anthropology, Movement, Affect, Outerspace

“Sich verlieben ist gar nicht das Dummste, was der Mensch tut - die Gravitation kann aber nicht dafür verantwortlich gemacht werden.”

- “Falling in love is not at all the most stupid thing that people do — but gravitation cannot be held responsible for that”

The above quote was scribbled by Albert Einstein on the margins of a letter unreturned to a student. The student, confused about the mechanics of Gravity on Earth, wrote to the theoretical physicist, asking if it was due to these forces that spin people around, and turn them upside-down, that people fell in love or committed other foolishness (Dukas and Hoffman, 1981; 51). Einstein’s musing on the matter is a poetic one. He argues that human emotions, such as love, are unaffected by physical forces such as gravity. However, this paper, using examples from experiences and experiments with weightlessness, primarily via spaceflight, argues that emotions, but more specifically their ability to be communicated, are subject to the material conditions in which they manifest. We argue that social relations can then be better understood through attention to their contingent and material context. In this sense, Einstein may have been overly swift in dismissing the role gravity plays in the development and communication of human emotion.

Drawing on theorisations of affect and emotion, the force of gravity is examined as a potential nexus of social relations. The paper argues that the normative material conditions of expressing emotions are a vital element in the processes of effective communication. Experiences of weightlessness offer a moment through which these normative conditions are no longer present, and as such, the usual coordinates of how to feel and be human are disturbed. Moments of microgravity expose what we didn’t know we knew - an unknown-known. All bodies feel the force of the Earth's gravity. Usually our relation to gravity is firmly in the background until often surprising moments bring this force to the foreground of lived conscious

experience. A fall, a leap, or perhaps a sudden realisation of how one's body¹ is changing over time, can make one suddenly more aware of their relation to gravity. However, this relation is brought into sharp focus in low-Earth orbit due to the radical difference in the way one's body and everyday experiences relate to the gravity of the environment. Gravity, or the lack of it, affords one the opportunity to consider again the normative assumptions of human experience, communication and social relations, or as Valentine has written, it grounds "the problem of space through which to fix arguments about humanness, relations of equivalence and difference" (2017:189). If our sense of being is contingent and contextual to particular moments where the material conditions and bodily interactions of social relations matter, then the ways in which such radically different material conditions (microgravity, radiation, different bio-rhythms and so on) that would be experienced via living on Mars, the moon, or any home outside the confines of Earth matter. They would lead to radically different experiences of life and social relations (Valentine, 2017). Attentiveness to the social implications of these radically different material conditions can provide lessons for anthropological analysis of social relations where relations to the material world are very different.

The paper begins by outlining an approach to theories of affect which emphasise the 'intra-relatedness' (following Barad 2007) of bodies, movements and material environments in the experience of being and social communication. We then discuss the ways in which anthropologists have been increasingly engaging with space, and how they have paid particular attention to the changing conception of what human bodies are in space. The paper draws on the authors' long-term experiences working with NASA funded neuroscience and cognition laboratories, space artists, and space architects, as well as secondary evidence of astronaut narratives aboard space stations. Selected evidence of social relations in space, from rumoured

¹ The authors recognise that the term 'body' is a contingent category. The individual body as socially legitimated is shaped by physics, biology, social relations, politics and each individual's unique experiences in the world. The use of the term 'body' and 'bodies' in this paper is used to situate the human form broadly within the unique environment of microgravity to highlight the affective potential of its material conditions.

fist fights to attempts to hug in weightlessness is then considered with regard to the anthropology of the body, notably extending the work of Brenda Farnell in order to emphasise a materialist position.

Farnell, in her ethnography of Native American Nakota tribes, describes her experience of receiving directions from a young woman whose gestures were cardinally orientated in a way that differed in important ways from a European tradition. She writes, “Instead of the four directions as lines moving outward from a given point, the Nakota terms denote a general direction from which certain things come towards a person” (2000:399). Farnell (2000:399). argues that semantically rich spaces “cannot be understood without attention to the active persons moving in such spaces”. In other words, the context in which the bodies move matter, and actions that may be thought to be universal (a smile, a bipedal stride, giving directions), may be open to cross cultural misrecognition. While Farnell’s argument emphasises the cultural aspects of misrecognition, this paper draws attention to how alternative gravitational environments provide one such context where it is the *material conditions* of semantically rich space that lead to misrecognition. The failure of communication is not just cultural. By linking Farnell’s approach to bodies in movement, with the concepts of affect and material intra-actions, this paper shows how individuals are neither able to properly produce, nor interpret, emotional communication in unfamiliar material conditions. As such, if emotion is communicated through dynamically embodied action, then not only does the cultural ability to produce and read those signs need to be present, but the material conditions for bodies to both experience and communicate also needs to be present. Farnell’s theories of bodies in movement explain how people fail to effectively communicate when they do not have a strong grasp of how their movement works in alternative contexts. Within the confines of living in low-Earth orbit, even if residents have a deep understanding of the cultural contexts in which their bodies move, gravity presents a radical challenge by altering the material form of the body itself, impacting on the ability of the body to produce meaningful affect.

Because micro-gravity provides a radically different environment to Earth, the role of the body, emotion, and affect operate in profoundly foreign ways and can therefore provide a unique opportunity to further evaluate the role of the body. Living in micro-gravity in low-Earth orbit, like living on Earth, has its own particular gravitational context, with its own affective potentials and semantic environments. To understand this context, gravity must be taken seriously as a force upon the body that generates affect. It is easy to take for granted the physics of planet Earth that, for the majority of history of human philosophy, has lain subconsciously assumed. The emergence of long periods of human experience in microgravity environments, via living in space, offers a chance to give a new importance to the contingency of the universals that undergird understanding of human relations. Finally, the paper ruminates on what such a perspective affords in a consideration of the forms of analysis extended to understand human experience.

Affect, Emotion and the body.

This paper builds on previous theorisations of affect, emotion and the anthropology of the body. Following from Spinoza (part III, p II, 2001 [1677]), affect refers to ways “the active power of the body is increased or diminished”. It is pre-emotion, pre-representation or pre-expression (see Pile 2010) and refers to the ability to affect the state of being. Affect, as used here, is approached as pre-semantic. Gregg and Seigworth (2002:2) state that

“affect can be understood then as a gradient of bodily capacity – a supple incrementalism of ever-modulating force-relations – that rises and falls not only along various rhythms and modalities of encounter but also through the troughs and sieves of sensation and sensibility, an incrementalism that coincides with belonging to compartments of matter of virtually any and every sort”.

Key, here, is the emphasis on the affective capacity of all matter and the central location of the body within this nexus of relations. Theorists have used affect to explain how a wide range of abstract forces precipitate onto the lived experience of being human through the way they affect the rhythms, temporalities and embodied experiences of being. This affect has frequently been used in considering the different embodied ways of experiencing place. For example, Yael Navaro-Yashin’s (2012:21) ethnography of experiences of political subjectivity in Northern Cyprus shows how conditions of international recognition are experienced through the affective qualities of place, emphasising the way materials and bodies interact to produce atmospheres of place. Similarly, Kathleen Stewart’s (1996) exploration of marginality and precarity in a declining coal town in West Virginia shows attentiveness to the rhythms, temporal frames, and habits of her informants in order to examine the relationship between capitalism and daily lived experience.

Consideration of affect has drawn attention to the relationship between the materiality of the world and embodied experience. Theorists of new materialisms, such as Timothy Morton (see 2013) and Karen Barad (see 2007) have challenged normative subject/object distinctions – foregrounding a more performative reading of the world, thereby troubling stable normative categories such as ‘place’ or ‘the body’. Neither the body nor place are considered a priori stable or coherent entities. Rather, they co-emerge through their ‘intra-action’ (Barad 2007:141).

Much affect theory has focused on the ways in which the subject is constituted through their embodied sensory experience of a material world. However, we emphasise how the communication of emotions vital to social relations *between* different bodies are also affected by

material conditions. Micro-gravity affords an exciting context to think through affective material conditions because of its totalising force on the human body.

As Atkinson & Duffy (2019) assert in their analysis of dancing bodies, not only do bodies and place co-emerge through movement, the observer of the dance also senses the relations between body and place in a new way. They state: “When we observe any corporeal movement, even inattentively, it is embedded in a particular sensual environment, but one that is configured with respect to our own capacity to move” (Atkinson & Duffy, 2019:20). They push beyond a traditional phenomenological analysis to assert that inhabiting a body is more than experiencing a place. Rather, it co-constitutes place by producing what Ben Anderson (2009: 77) would call “affective atmospheres”. Melissa Joy Wolfe (2017) notes, in her work on feelings of belonging in Australian schoolgirls, that some are more likely to remove themselves from educational pathways if they feel they don’t fit into the ‘atmospheres’ of a place. Wolfe uses Baradian terms to think through the ‘spacetimematterings’ of making certain places for certain types of subjects. In these formulations, neither place nor person are foregrounded as the phenomena under investigation, rather they are understood as contingent and particular to happenings in which their solidness is understood within a momentary and fluid nexus of relations.

Our focus of analysis on micro-gravity takes these ideas further. We show how environments of microgravity lead to unique experiences of the embodied self, but also how such environments and embodiments lead to issues of emotional communication and thus affect social relations. The next section considers how anthropologists have dealt with experiences of space travel, and it relates our analysis to work in the anthropology of the body that calls for attentiveness to bodily motion and its role in communication and embodiment.

An Anthropology of Micro-gravity and embodied action

Anthropology has a long history of studying the material culture of extra-terrestrial environments. Anthropological analysis has traced the ways in which cosmos, place, bodies and social relations are linked. Rivière (1995:195) for example has noted how traditional dwellings of the Ye'cuana, on the North-East Brazil/Venezuela border, serve as analogues for the celestial sphere as they mark “an exact replica of the universe”. Similarly, Blier (1987) has noted how Batammaliba dwellings in NorthWestern Benin and Eastern Togo track the passage of celestial ancestors through various light apertures, bringing the cosmic and terrestrial into contact. More recently, Lisa Messari has analyzed how through Google's digital mapping of Mars, space scientists create intimate visual experiences of other worlds. The experiments and technical innovations of space science simulate future socio-technical configurations and generate and expand existing social relations and values, such as democracy, in new ways. The expansion of relations between entities, such as bodies and the cosmos, relate to Heidegger's (1933 [1927]) neologism of ‘worlding’. Here the linking of abstract and intimate concepts where contingent and contextual experiences of bodies, place, materials and social conventions intra-act, is, following Heidegger, how worlds are made.

Debbora Battaglia uses the diary of cosmonaut Valentin Lebedev to argue that environments of “zero gravity” can be generative of new forms of human condition. Lebedev's diary demonstrates how “in space things become weird”. He outlines how, on entering the space station for the first time, he “came in at an unusual angle”, the walls had suddenly become the floor and he walked on what he once considered side panels (Battaglia 2012:1092). Battaglia (2012:1094) writes;

“Zero-G is the agent in bricolage that is the invisible undoing of culture in its relation to nature [...] and operationalizing a kind of reverse tinkering which is beyond known or hypothetical consequences in the material world [...] Suspending without releasing the hold of context (cf. Dilley 1999), it thus invites engagement with hypothesis-making and gives the proposition place of privilege over claims to certain knowledge and totalizing paradigms.”

For Battaglia the diary of Lebedev opens a space for the “value of surprises of translation and for off-normal experiences” (Battaglia, 2012:1100) where the body and its material surroundings are configured in radically different relations. The “zero-G” environments act as a form of limit, an extreme that is understood not as another world but rather as a way to make the world (See Valentine *et al.* 2012; Latour 2002) through novel configurations and experiences. Valentine *et al.* (2012) argue that there has been a shift from viewing extreme environments such as space as a human ‘limit’ - to an environment of open potential; what Valentine calls a ‘horizon’ (Valentine, 2012:1014). As such, space and zero-G environments afford an opportunity to open and explore the parameters of being human; as Valentine (2017:191) argues, these parameters challenge “human commonality and difference by fixing terrestrial conditions ... in non-terrestrial places.” However, if the very form of being human, in both an experiential phenomenological sense and in the social sense, is understood to be contingent to a material-affective moment, then these universals become unstable. Battaglia’s idea that zero-G is the ‘invisible undoing of culture’ alludes to the ways in which the material and affective forces within culture emerge as unknown-knowns, only to be exposed at such times of surprise.

Valerie Olson, in her ethnography of NASA, coins the term “ecobiopolitics” (2010:130) to draw attention to the ways in which “ecology and cosmology are co-constituting in American astronautics” (Olson, 2010:2). Olson advances the biopolitical claims of Paul Rabinow and

Michel Foucault to consider the human body with the environmental context centre stage. Olsen notes how NASA creates and uses the category “space normal” (Olson, 2010:134) to indicate the ways in which pathological boundaries are redefined in microgravity. This terminology re-contextualises the ‘normal’ parameters of a human body. Humans as environmental hybrids, affected by the conditions of space living, may not necessarily be considered ‘sick’ or pathological when experiencing bodily changes in space. Rather, astronauts experiencing nausea and other symptoms are considered ‘space normal’ within the context of gravitational alterity. Forms of human ‘being’ (following Heidegger, 1993) emerge from constellations of bodies, technology, architecture and data, and extreme or zero gravity environments, to offer new ways of constituting humanness.

However, this paper relates less to the physiology of the body, or experience of the body alone, but more to what Farnell and Varela (2008:215) term a bio-psycho-social “paradigm of dynamic embodiment” whereby the “semiotic can be the somatic”. That is, while still attentive to bodily experience, this paper foregrounds how the material-affective aspects of experience feed into effective communication and, thereby, the management of social relations. Farnell and Varela (2008) assert that the role of the body, specifically the role of kinaesthesia, has been underplayed in terms of perception and communication. They call for a “second somatic revolution” (Farnell and Varela, 2008), arguing that a number of theoretical omissions have led to the moving body being side-lined. Specifically, Farnell (2000) asserts that Bourdieu's conception of habitus lacks an ontological – and we add a material – grounding. She argues that habitus holds a Durkheimian and Cartesian bias because social action is explained through both transcendent forces on a social level and through a bifurcation of mind and body on an individual level. For Farnell (2000:397), habitus lacks an adequate conception of “the nature and location of human agency”, and she calls for a greater emphasis on the performative and bodily aspects of communication. In re-asserting the body as a prime meaning maker, Farnell (2002) relieves ‘meaning’ from being fixed to a referential or representational function and adds

malleability to the indexical aspects of sign functions. The malleability of the index, that emerges from its contextual basis, allows the body to reassert itself as a key aspect of the generation of meaning in moments of human experience and, crucially, communication. The problem, states Farnell, is that the bifurcation of body and mind has led to the mind being understood as the location of language to the exclusion of other meaning making practices, whereas personhood is rooted in the realms of body and mind together. Evoking James Gibson's (1965, 1979) "anti-Cartesian ecological approach to perception", Farnell and Varela (2008:223) explain that instead of "thinking of perception as the computational activity of a mind within a body, we should think of it as the exploratory activity of the whole organism within its environmental setting in active participation through practical bodily engagement".

Farnell's call for attentiveness to dynamically embodied action is particularly relevant to micro-gravity environments as it requires attentiveness to both the role of the body and its environmental context, not only in a consideration of experiencing and making place, but also in its role in communication and perception.

Edmund Husserl noted on an envelope which contained his essay *Overthrow of the Copernican Theory in Usual Interpretation of a Worldview*, "the original art, Earth, does not move" (Oliver 2015:20). It is, rather, that to which everything else moves in relation. As Oliver (2015:21) notes "speaking phenomenologically, we do not directly experience the spinning of the earth on its axis as movement". But, Oliver outlines how Husserl draws attention to how even those forces, which appear universal to all human experience, are in fact contingent and contextual:

"Although for us it is the experiential basis for all bodies in the experiential genesis of our idea of the world. This 'basis' is not experienced at first as body but becomes a basis-body at higher levels of constitution of the world by virtue of experience"

(Husserl 1981a:222-223 Cited in Oliver 2015:21)

The Earth and its forces of gravity are the normative parameters through which social relations are played out. Space living affords us the opportunity to think through socially embodied action via conditions of microgravity, which may lead to surprises via the radically new contexts they provide. In doing so, we no longer assume Earth's gravitational pull as a base constant of analysis but rather bring this into a position as one context amongst other possible contexts for social interaction. We therefore require a re-examination of our assumed universals in human communication. To understand the ways in which human experience is co-constituted through bodily interactions in weightless environments, a consideration of how social relations work in alternative environments is needed. This analysis has been lacking from studies of the human, and their bodily capacities, in space.

Understanding Humans and Spaceflight.

At the time of writing, just over 550 people have left the Earth's atmosphere to travel in space orbit. Scientific knowledge about the effects of space flights are increasing constantly, with much research focused on both the physiological and psychological aspects of microgravity. Gravity is still present in low Earth orbit with around 10% reduced force (Phillips 2012:54), but the feeling of weightlessness comes from constant falling.

Whilst the physiological effects of microgravity are still being uncovered, many, such as the stretching of the spine; the slowing of the heartbeat; and the deterioration of bone and muscle tissue are well known. One's senses of touch change as the skin receives different forms of pressure during contact. The inner ear sends erroneous and garbled information to the brain, and the sense of spatial disorientation is increased through the incongruous visual stimulation of one's surroundings. As Phillips (2012:129) notes of an astronaut's experience:

"...a colleague reported after his shuttle mission that he had been doing very well with minimal problems and had started to eat an apple. Just at that time, one of his crewmates floated by. He was upside down and moving backwards. There were too many conflicting inputs. My friend began to feel upset, discarded the apple, and got out a 'barf' bag."

This anecdote demonstrates that physiological effects, such as nausea, are brought about not only through the different relation to physics, but how materials, orientations and orders of things are radically different. The challenges and disruptions to the astronaut's normative orientations of everyday life are impactful to the point of inducing nausea. This impact is caused not only through the physics of physiology, but through uncanniness of the relations between things.

Psychological effects of spaceflight can come from the experience of isolation, the distance from loved ones, or boredom. As David Urbina reports from his diary of the European Space Agency's Mars 500 program, where he spent 520 days in isolation to simulate a Mars flight, "simple things such as blue sky, going dancing in the evening, ... in general I miss the randomness of the world" (ESA, 2011). Routines are micro-managed and monotony is a major psychological challenge. Urbina's narratives mirror other anthropological studies on science in extreme environments such as Antarctic research outposts (O'Reilly, 2017) or Mars simulations in the Utah Desert (Messerli 2016) where the affective potential of the material surroundings and landscapes need to be managed.

People living in microgravity environments experience a bone loss of about 2% every month, leading to osteoporosis (Orwoll, 2013). One of the solutions to combating muscle and bone degradation in long-term space flight is the creation of artificial gravitational environments. For example, a rotating spacecraft generates rotational centrifugal forces (see Valentine 2017) - in

which travellers reside along the edge of a ring-like structure that, through spinning around a central axis, maintains a constant force equal to that of gravity on Earth, roughly 9.8m/s^2 . In addition to centrifugal forces, residents of the rotating spacecraft would experience Coriolis forces that operate throughout the body of rotation.

The Ashton Graybiel Spatial Orientation Laboratory at Brandeis University in Massachusetts is devoted to the study of all these forces on the human body. Established in 1982, the lab specialises in research into the psychological and physiological effects of space flights. [AUTHOR] worked in the laboratory as a research technician for 2.5 years creating databases of microgravity and parabolic flight body experiments, and assisting in the laboratory's testing facilities. The researchers there are interested in how the brain functions, and how locomotion and behaviour are altered in alternative gravitational environments. Among their equipment is a round 'slow-rotation room', 22 foot in diameter, and 8 feet tall. The room has a single entrance, and the floors and walls are cluttered with testing equipment, treadmills, video cameras, and other technological paraphernalia. The Graybiel Laboratory has devoted its resources to understanding how 'artificial gravity', necessary for space living by preventing body decay and disease, impacts upon the brain and cognition. Human motor control and function is also affected. As people experience kinaesthetic changes they may become dizzy, tired, or nauseous, and reaction times are slowed or altered (Piantadosi 2002). Tests in the slow-rotation room may be as short as an hour, or be extended over several weeks at one time. The room is capable of spinning at up to 60 rotations per minute (rpm); at 25rpm it is possible to sit or stand on the walls. The windowless laboratory prevents research participants from being influenced by visual frames of reference as they spin in the chamber.

The laboratory researches motor function and movement under different gravities, crucial to future space exploration. However, the research belies a larger framework for study. If robust research recognises that cognition is radically impacted by different gravitational states experienced by the body, as the Graybiel lab has demonstrated for decades, then emotion itself,

or the facility to generate emotion, may be subject to gravitational influence as well. Mood is altered through drowsiness or nausea. The physical experience of the body translates into emotion, an example of the somatic relationships between mind and body long researched in medical anthropology where ethnographers have shown how physical and emotional states become linked in complex ways (see Kleinman, 1982; Littlewood, 1980; So, 2008). The researchers at the Graybiel lab, then, work not only to mitigate the effects of gravity on the human body to create an atmosphere in which people's bodies remain sustainable, but also to create an atmosphere where people can operate cognitively in strange physical conditions. The laboratory works with human motor function, orientation, and somatosensory effects on wellbeing, including different forms of space sickness (see Lackner, 2014), recognising the links between physical experiences of gravity, motion sickness, and anxiety. Their work hints towards the ways that gravity impacts upon emotion within an individual, but it does not address how the physical effects of gravity on the body impact upon the relational understandings of emotion.

The lived experience of microgravity aboard the Mir space station provides evidence of how to think through this problem. The psychological health of astronauts and cosmonauts has been a concern of space programmes from the start of human space flights, even when psychiatric diagnosis was not officially part of medical screening regimes. Douglas Vakoch (2011) showed how psychiatric warnings were systematically ignored to promote traits of machismo and nationalism that embody the ideals of American character. Space psychiatrists had been frustrated with the ways astronaut psychiatric data was systematically ignored or underutilized long before American collaboration with the Russian space programme aboard MIR (Helmreich, 1983; Harris, 1989). American Astronauts historically have held a culture of extreme negativity towards psychiatry which they viewed as a deterrent of progress. Astronaut Joe Kerwin tellingly claimed, "you gotta understand, the crews won't be happy until the last psychologist has been strangled on the entrails of the last flight surgeon" (Burroughs, 1998:180). Narratives and archives of astronaut and cosmonaut experiences with training and living aboard MIR

demonstrate ground control's concern of deteriorating mental health and emotional instability aboard the craft, though these concerns often come too late. Bryan Burrough's accounts of the MIR space station show how these states were contested and negotiated. American astronaut Jerry Linenger, cleared for space travel by American health screenings, initially failed Russian medical scrutiny. The Russian space programme, and their board of medical professionals had, arguably, far more experience with the psychological needs of those aboard the MIR spacecraft, though political clashes and cultural misunderstandings made communications of these concerns opaque, and Linenger was eventually cleared for travel (Burroughs, 1998; 14-15). Still, mission control from both the United States and from Moscow increasingly began to worry over the psychiatric well-being of both astronauts and cosmonauts.

Burroughs outlines the many acts of micro-aggression that developed aboard the station. For example, after a nearly catastrophic collision with a spacecraft in 1997, Cosmonaut Commander Tsibliyev's colleagues began to believe that he was exhibiting traits of paranoia and that he "is sure Mission Control wants them to come back as dead heroes. It's very far from the truth" (Burroughs, 1998:163). The Russian Cosmonauts began working at strange hours, and Linenger becomes increasingly frustrated as Commander Tsibliyev begins taking afternoon naps (Burroughs, 1998:165). Linenger, after a series of events, becomes irate and wants to cut off all voice communications with Earth to improve efficiency and discipline on board the station and on ground control. Russian psychologists believe his temper is a result of stress after dealing with hardships and crisis management (Burroughs, 1998:168). Linenger begins to completely isolate himself from his peers, and eventually NASA's ground team begins to believe Linenger is also showing signs of paranoia (Burroughs, 1998:179).

These concerns prompted NASA to take psychiatry more seriously, allowing professionals to properly scrutinise astronaut behaviour. It was the first time that psychiatrists were able to concretely address the environmental effects on behaviour in the space-station, though the emphasis remained on the problems and stresses of isolation and communication,

specifically between MIR and Earth. However, it became clear that social relations aboard the craft were also at risk. The relationship between Linenger and Tsibliyev became especially strained, and degraded to the point of constant hostility, sometimes in physical ways. Russian psychiatrists believed Tsibliyev developed neuroses due to exhaustion. Linenger began to privately think that it is time for all on board to wrap up work and abandon the craft (Burroughs, 1998:195). During Linenger's only extravehicular activity (EVA) (a 5-hour spacewalk outside of MIR), a lack of communication is striking. Linenger and Tsibliyev eventually abandon each other in the darkness of space, both disoriented and heading in opposite directions. Months later, Cosmonaut flight director Solovyov claimed that, in interviewing Tsibliyev on what went wrong during the EVA, Tsibliyev reported that the two had gotten into a fist fight in the darkness of space, and that Linenger had stricken him on the helmet, though both the astronaut and the cosmonaut denied it at the time.

There are numerous other acts of micro-aggression and emotional 'failures' within narratives of MIR. Psychological explanations for these failures could be found in a range of explanations, from cultural misunderstandings, isolation, overwork, living within cramped spaces, or just two people not liking each other. This paper offers an additional approach to understanding these failures in which the body and the forces of gravity are made prominent. The work at the Graybiel laboratory takes the relationship between gravity and the brain seriously, but is unable to address psychiatry and social relations. The narratives aboard MIR highlight the seriousness of psychiatry aboard long-term spaceflight, but neglect the body as a material form that serves as a medium of social relations. An anthropology of gravity, then, makes explicit the links between these perspectives to demonstrate gravity's role in modifying and informing the body's long-recognised potential as a communicative device and a nexus of relations. Environments of microgravity alter the material conditions through which human communication occurs, leading to difficulties in communication and preventing people from relating to the speech acts of others.

Space artists Rachel Rose and Nahum Mantra have also considered the role of the body, communication and emotion within novel material context of space. In her video and sound piece *Everything and More* (2015), Rose considers the limits of the human body and feelings of detachment and disembodiment in space flight. Through interviewing astronaut David Wolfe (Rose, 2018), her work aims to evoke a sense of a “thing released from humanness, but still human” stating “someone who has been to space and come back has experienced the brink of nothingness”. Whilst discussing the effects of gravity on the human body on returning to earth Wolfe notes (Rose, 2015);

"...when I first come back to earth after 128 days I thought I had ruined my life. Just walking, I took a few steps of the spacecraft then I decided to go ahead and use the, lay down on the stretcher and be carried away because gravity felt so heavy my wristwatch felt like a bowling bowl on my arm, the weight of your body is overwhelming even my ears felt heavy on my head. But some senses are increased for example... when you're in space the air cleaning systems are so effective that there are very few odours, the filters are so good. And when the spacecraft door is opened you're overwhelmed with the smell of grass and the air and it must be like a dog feels when you can smell bushes when you walk by them, your sensitivities are so increased because erm.... they've been absent for so many months."

Rose draws attention to the sensual aspects of spaceflight, or rather the stark differences of sensual experiences between spaceflight and being on Earth, from the overpowering smells to the different experience of the weight of the body. These lead Wolfe to have deeply emotional responses to these affective experiences. Wolfe (2015) claimed that he thought that this ‘had ruined his life’; that one form of life may have been switched for another through radically different bodily experiences.

Nahum Mantra’s work also confronts the emotional aspects of spaceflight, in particular “the creation of wonder and feelings of magic” (per coms, 2017), that the idea of spaceflight

evokes. A renowned space artist, Nahum has worked extensively with the space agencies of NASA, the ESA and Roscosmos. He teamed up with artist and designer Alejandra de la Puente, via the Arts Catalyst 'Zero Gravity Program' to work with the European Space Agency and the Gagarin Cosmonaut Training Centre in Russia to coordinate artists and scientists in collaborative work conducted aboard parabolic flights. These flights simulated microgravity environments via the rapid loss of elevation, thereby producing weightlessness for those inside. Nahum's artwork, *Holding Air* (2015), a sound and video installation, documents the awkward attempts of those on the flight trying to hug in microgravity. Bodies flow in and out of frame at a range of different speeds and zoom lengths. An ambient sound track plays at a high volume while floating human bodies are portrayed in a seemingly dream-like way. Nahum asks the viewer not only what it means to be intimate in space, but further, what aspects of intimacy we may take for granted, such as its background material conditions, co-presence and gravity. Like Rose's work, the piece has an abstract yet relatable quality to it. He explains

“When you have two bodies in zero gravity that try to touch each other and have that human physical contact, it also becomes a different thing because first you are floating and it's like, how do I get there? You cannot swim, so you really struggle to grab the other person. And someone is upside down and another is in a funny position, so a hug becomes something else. And once you manage to grab someone, you notice that the body of the other person does not have any weight. It's like holding onto air. You get very anxious about that, and you try to hold on more. And this becomes a beautiful action” (Paterson, 2015).

The above anecdote draws attention to how changes in gravity highlight normative material conditions for human life. When gravity is absent, these conditions become all the more apparent. Nahum's work draws important attention to both the experience of trying to

communicate and to 'feeling' the communication and intimacy of others in weightlessness. While the physiological effects of long term weightlessness and the psychological effects of spaceflight are under intense scrutiny and research, the ways in which gravity affects the conditions of human emotion and communication require further consideration. In microgravity, emotional communication that on earth would be fully understood, often fails. The hug becomes difficult and awkward, bodies do not align, and skin fails to receive pressure. The failure to communicate emotion could result in tensions among flight crew with potentially dangerous consequences, as seen in the case of Linenger and Tsibliyev aboard MIR.

To unpack the implications of this argument for anthropology, the next section briefly engages with theories of failure, and brings these discussions of communicative failure back to the work of Brenda Farnell. It is the failure to communicate that exposes the difference between the experience and habit of using affect to communicate.

Failure and Context.

An anthropology of gravity asserts the material and bodily aspects of human communication inspired by those who have been seeking to develop semiotic theory through performative thinking. In (Carroll et al. (2017) the action of failing is described as being "...when objectification ceases to adhere. This is to suggest that in the individual subject's (or collective societal) project of inscribing themselves in the world, failure happens when the material and social stuff of that inscription behaves in ways other than intended." (Carroll et al., 2017:2)

In the cases outlined above, the effect of gravity means that a bodily action, such as the application of pressure to another person's skin, is unable to take place. The person hugging lacks the adequate skills to be fully able to enact pressure under the conditions of microgravity;

the hug fails. Further, whilst the intent to communicate intimacy may be present, the person receiving the hug, or hug attempt, may not be able to fully comprehend the action as a hug as it was intended, due to the unrelatable material conditions of the action. That is, it feels different. Failure happens in the gap between the articulation and the interpretation of the sign.

Gravity provides the usual conditions for a hug, or other dynamically embodied actions, to work. In conditions of microgravity, the eyes bulge, facial features sit differently upon one's face and water is retained differently throughout the body, creating puffy features. Blood accumulates in the body's extremities, especially in the face, creating constant swelling. The hair on a person's head, if it isn't cut short or fastened tightly, flails in all directions. Body mechanics as simple and automatic as a blinking eye become distorted from what we recognise as normal. As a material form, the body ceases, as Carroll et al. suggests, to 'align to the convention' and a hug fails. The 'body in movement' ceases to cohere in a manner in which people are accustomed. That is not to say that the body ceases to communicate, rather gravitational alterity creates conditions where the body fails to behave socially in the ways a person intends or can recognize. The ability to both create and respond through habitual and recognizable affective registers is compromised or, to say it another way, hugs are hard in space, and therefore, intimacy can be hard in space.

Gravity is a key material condition of social relations. The disruption of material conditions help to explain how the failure described above occurs. Farnell (2012:7) argues that "dynamically embodied acts thus belong at the heart of social theory". She positions the body in movement as "dynamically embodied signifying acts in semantically rich spaces as the [...] means by which persons, social institutions and cultural knowledge are socially constructed, historically transmitted and revised." (Farnell, 2012:7). What we show in this paper is how these semantically rich spaces are more than cultural. Dynamically embodied action requires a recognition of cultural semantics, but understanding and communicating emotion also requires a

deep familiarity with the physical affordances of the material ecologies where we learn to be social beings.

Conclusion

Anthropologist Clifford Geertz (1964:47) has argued that “Without the guiding patterns of human culture, ... intellectual life would be [...] buzzing, booming confusion [...] without the guidance of the public images of sentiment found in ritual, myth, and art we would, quite literally, not know how to feel”. Later, taking cues from phenomenological perspectives, anthropologists understood emotional constructs as informed from dynamics beyond these cultural mechanisms, recognising the role of the body in facilitating and creating social relations. As Farnell and others have shown, without the body in movement, people would often, quite literally, not know how to feel. Gravity, or the lack of it, radically changes all of the subtle movements and queues by which people have come to ‘know how to feel’; to recognise instinctively when another is frustrated, happy, impatient, cynical, or – to contradict Einstein from the intro to this paper – enamoured. In alternative gravities, the body betrays its owner’s intentions. As the paper briefly demonstrates, research in neuropsychology has taken the body and gravity seriously, though the construction of emotion is systematically neglected. Within anthropology and geography, the body-in-space has received some excellent attention where the body is understood to be dynamically and dialogically constituted through its environment, where the affective qualities of both the body and the spaces it inhabits work in partnership to create hybrid forms of meaning. An anthropology of gravity brings attention to how the body is functions as a meaning maker in environments with unfamiliar material conditions. Critiques of behaviour aboard MIR highlight why the psychology of astronauts must be taken seriously, but

these critiques ignore the role of the body, gravity and material contexts. This paper offers an additional approach that recognises the current ethno-physical conditions of living in outer space. It suggests that body, emotion, social relations and environment can be better understood when they are contextualised by the underlying forces that operate subtly throughout them. The radical context of microgravity helps focus attention on the otherwise everyday, namely the material effect of Earth's gravity on the body and its role in social relations.

David Valentine's (2017) paper 'Gravity Fixes' considers the possible futures of human habits and experiences from the perspective of living on Mars or Island Three, a proposed rotating space colony. Valentine asserts that on Mars "being 'human' would matter differently... To be 'human' on Mars could not be settled ahead of time through any assemblage of terrestrial accounts—Indigenous, Black, or settler because it would require different embodied habits and accounts in relation to different conditions than those in which these histories took shape" (Valentine, 2017:196). Valentine's assertions align with this paper – the experience of being human, and the forms of relations that bring our experience into being, are both contingent and contextual on the material conditions and embodied experiences of the moment. It is through this consideration of the contingency of relationality that Valentine comes to challenge the anthropological understanding of difference. Such an anthropology is forced to ask questions on the framing of what difference is; "Moves to the multiple places of outer space—in removing one-G as a coordinate... permanently defer any reaching for a *universal* universal, including a capacity to frame what forms "difference" takes." (Valentine, 2017:196). Valentine's contexts are hypothetical, but scientists working on the International Space Station live through this reconvened relationality and embodiment now. Future research will take these theories further to challenge other contexts considered by anthropologists to be the 'fabric of society'. Issues of gender, race and bodily difference exist off-world, but in altered ways that may, as Battaglia suggests, 'surprise' us. Living in these different material landscapes may indeed shape constructs of sexuality, ethnicity, or even, as Hass (2019) suggests, spirituality. In this regard, an

anthropology of gravity offers a unique opportunity to reflect upon the subtle but powerful forces that inform the relationships people make on Earth, as well as challenge the theories of what universal human experience is.

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References

1. Anderson, B. (2009) '*Affective atmospheres!*', *Emotion, Space and Society*, 2 (2). pp. 77-81.
2. Atkinson, P., & Duffy, M. (2019). Seeing movement: Dancing bodies and the sensuality of place. *Emotion, Space and Society*, 30, 20-26.
3. Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
4. Battaglia, D. (2014) *Diary of a Space Zucchini: Ventriloquizing the Future in Outer Space*. Platypus, July 14.

5. Blier, S. P. (1987) *The Anatomy of Architecture: Ontology and Metaphor in Batammaliba*. Architectural Expression, Cambridge: Cambridge University Press
6. Burrough, B. (1998). *Dragonfly. NASA and the Crisis aboard MIR*. Fourth Estate. London
7. Carroll, Timothy, Jeevendrampillai, David, Parkhurst, Aaron, 2017. Introduction: Towards a General Theory of Failure. In: Carroll, Timothy, Jeevendrampillai, David, Parkhurst, Aaron, Shackelford, Julie (Eds.), *The Material Culture of Failure*. Bloomsbury, London, pp. 1–20.
8. Dukas, H and Hoffmann, B. (1981). *Albert Einstein, the Human Side: New Glimpses from His Archives*. Princeton University Press, New Jersey
8. ESA. (2011) Mars 500: one year inside. May 30, 2011. European Space Agency. http://www.esa.int/spaceinvideos/Videos/2011/05/Mars_500_one_year_inside?fbclid=IwAR0IRV_g6CH2ps12KvksMNO567-JoJOfKCxMk5Z7n0oez3gRezgWRlSiZsU
9. Farnell, B. (1999) "Moving Bodies, Acting Selves." *Annual Review of Anthropology* 28: 341-73.
10. Farnell, B. (2000) "Getting Out of the Habitus: An Alternative Model of Dynamically Embodied Social Action." *Journal of the Royal Anthropological Institute* 6 (2000): 397-418.
11. Farnell, B. (2012) *Dynamic Embodiment for Social Theory: "I move therefore I am"* Routledge. London.
12. Farnell, B, and C Varela. (2008) "The Second Somatic Revolution." *Journal for the Theory of Social Behavior* 38.3 (2008): 215-240.
13. Geertz, C. (1964) *Ideology as a Cultural System*. In 'Ideology and Discontent'. Ed. David Apter. pp. 47–76. New York: Free Press.
14. Harris, P. R. (1989). Behavioral science space contributions. *Behavioral science*, 34(3), 207-227.
15. Hass, A. W. (2019). *The Gravity of Mystical Ascent*. Space and Culture. <https://doi.org/10.1177/1206331219864274>

16. Heidegger, M. (1993) *Basic Writings from 'Being in Time' (1927) to 'The Task of Thinking' (1964)*, London: Routledge
17. Helmreich, R. L. (1983). Applying psychology in outer space: Unfilled promises revisited. *American Psychologist*, 38(4), 445.
18. Kleinman, A., 1982. Neurasthenia and depression: a study of somatization and culture in China. *Culture, medicine and psychiatry*, 6(2), pp.117-190.
19. Lackner, J.R. *Exp Brain Res* (2014) 232: 2493. <https://doi.org/10.1007/s00221-014-4008-8>
20. Latour, B 2002 "Morality and Technology: The End of the Means." *Theory, Culture & Society* 19, nos. 5–6: 247–60. <http://dx.doi.org/10.1177/026327602761899246>
21. Littlewood, R., 1980. Anthropology and psychiatry—An alternative approach. *Psychology and Psychotherapy: Theory, Research and Practice*, 53(3), pp.213-225.
22. Messeri, L., (2016). *Placing Outer Space: An Earthly Ethnography of Other Worlds*. Duke University Press.
23. Morton, T. (2013). *Hyperobjects: Philosophy and Ecology after the End of the World*. U of Minnesota Press.
24. Navaro, Y. (2012). *The make-believe space: affective geography in a postwar polity*. Duke University Press.
25. Oliver, K., 2015. *Earth and world: Philosophy after the apollo missions*. Columbia University Press.
26. Olson, V. A. (2010). *American Extreme: An Ethnography of Astronautical Visions and Ecologies*. Rice University.
27. O'Reilly, J. (2017) *The Technocratic Antarctic: An Ethnography of Scientific Expertise and Environmental Governance*. Cornell University Press. Ithaca, NY.
28. Orwoll, E. S., Adler, R. A., Amin, S., Binkley, N., Lewiecki, E. M., Petak, S. M., Shapses, S. A., Sinaki, M., Watts, N. B. and Sibonga, J. D. (2013), Skeletal health in long-duration

- astronauts: Nature, assessment, and management recommendations from the NASA bone summit. *J Bone Miner Res*, 28: 1243–1255. doi:10.1002/jbmr.1948
29. Paterson, C (2015) *Turning Art Upside Down: An Interview with Mexican Space Artist Nabum*. Artillery Magazine, Los Angeles. <https://artillerymag.com/turning-art-upside/> Retrieved 02/03/2020
30. Phillips, R. W. (2012). *Grappling with Gravity: How Will Life Adapt to Living in Space?* New York: Springer. <http://doi.org/10.1007/978-1-4614-1332->
31. Piantadosi, C. A. (2002). *Mankind Beyond Earth*. New York: Columbia University Press.
32. Pile, S. (2010). Emotions and affect in recent human geography. *Transactions of the Institute of British Geographers*, 35(1), 5-20.
33. Rivière, P. (1995) Houses, places and people: Community and Continuity in Guiana. In J. Carsten and S. Hugh-Jones (eds) *About the House: Lévi-Strauss and Beyond*, Cambridge: Cambridge University Press
34. Rose, R (2015) *Everything and More*. Whitney Museum of American Art. High-definition video, color, sound, with mylar, PVC, and carpet
35. Rose, R (2018) Rachel Rose Interview: A Space Travel Into Mortality. YouTube. Louisiana Channel. Sep 25, 2018. <https://www.youtube.com/watch?v=Wfv79WwdFGQ>
36. Gregg, M., & Seigworth, G. J. (Eds.). (2010). *The affect theory reader*. Duke University Press.
37. So, J.K., 2008. Somatization as cultural idiom of distress: rethinking mind and body in a multicultural society. *Counselling Psychology Quarterly*, 21(2), pp.167-174.
38. Spinoza, B. De. (2001[1677]) *Trans Elwes*, R.H.M. Ethics. Blackmask online: Blackmask.
39. Stewart, K. (1996). *A space on the side of the road: cultural poetics in an " other" America* (p. 17). Princeton, NJ: Princeton University Press.
40. Vakoch, Douglas. (2011). *Psychology of Space Exploration: Contemporary Research in Historical Perspective*. NASA, Washington, DC

41. Valentine, D. (2017). Gravity fixes: Habituating to the human on Mars and Island Three. *Journal of Ethnographic Theory*, 7(3), 185-209.
42. Valentine, D, V. A. Olson, and D Battaglia. (2012) “Extreme: Limits and Horizons of the Once and Future Cosmos.” In “Extreme: Humans at Home in the Cosmos,” edited by Debbora Battaglia, David Valentine, and Valerie A. Olson, special issue, *Anthropological Quarterly*. 85, no. 4: 1007–
43. Wolfe, M. J. (2017). Affective schoolgirl assemblages making school spaces of non/belonging. *Emotion, space and society*, 25, 63-70.

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