EXPLORING DIGITAL METHODS & THE AFFECTIVE EXPERIENCES OF MUSEUM VISITORS: AN AFFECTIVE PRACTICE AND CRITICAL DATA STUDIES VIEW ON THE USE OF ELECTRODERMAL ACTIVITY DATA IN SOCIAL RESEARCH.

Jessica Leigh Hoare

A thesis submitted in accordance with the conditions governing candidates for the degree of

Doctor of Philosophy

Cardiff University

2021

I, Jessica Leigh Hoare, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

22/10/2021

ABSTRACT (300 words)

This thesis addresses the challenges of researching affect and emotion. It wrangles with the debates and definitions that accompany these terms and adopts an affective practice approach informed by Margaret Wetherell's work. The thesis extends this approach by considering the role of digital technologies in affect research. It asks what technologies might offer the researcher, specifically in developing the tools currently available to understand museum affective visitor experience. The thesis draws on critical data studies to provide a necessary and critical investigation of technologies that monitor physiological response and questions whether such technology reveals the affective relationships enacted between museums and their visitors.

It had three formal aims. First, to understand the embodied and social organisation of emotion and affect. Second, to engage with the debates and methodological approaches that are associated with these pervasive concepts. And third, explore the value of using wearable physiological monitoring in such a study. These aims were addressed via two comparative case studies and engagement with primary self-report and physiological data, collected in Summer 2019. These cases studies were: *Snakes*, National Museum Cardiff's summer exhibition in 2019 and *Museum ExplorAR*, an Augmented Reality (AR), trilingual, self-led mobile experience providing visitors with an immersive experience of the museum's permanent exhibitions. An analysis of physiological and self-report survey data is presented. The results are discussed within the context of Wetherell's theory of affective practices and Leach's cognitive tools model (Wetherell, 2012; Leach, 2009).

The thesis validates the cognitive tools model and the visitors' use of its associated practices to relay their affective experience. Second, the thesis interrogates links between such practices and physiological response. It examines the value of electrodermal data in understanding visitor emotion and subjects this data to analysis at group and individual levels. Based on the study's evidence and informed by its critical approach to data, methodological and ethical caveats for physiological data are established. The result is a comprehensive interdisciplinary thesis that explores visitors' affective processes and the value of electrodermal activity data.

Acknowledgements

I am grateful to a number of people who made this thesis possible. First, Josh, thank you for being loving, patient, and kind. More than anything, thank you also for keeping me well-fed in the latter stages. Mum, Nick, Alice, Victoria, and Mildred, you each provided advice, respite, and laughs in your own ways. Thank you for sending seeds, ideas, knitting advice, and for providing continual reminders of the importance of rest.

Thank you to the attendees of Digital Heritage, San Francisco, 2018, Museum Next Conference, Portland, 2017 and Researching Digital Cultural Heritage, University of Manchester, 2017. Thank you for listening with interest to the early versions of this work. Your enthusiasm was so encouraging and has remained a valuable resource. I am grateful to my peer reviewers at the International Journal of Heritage Studies. I am grateful to have benefited from your insights, criticisms, and challenges - they have immensely improved the quality of this work. To my supervisors, Chris Taylor and Jon Anderson, thank you for your continued support, guidance and perseverance.

The thesis is dedicated to the memory of Casper Flag and Fran Byron-Chance, whose affecting insight, tenacity, and wit is deeply missed. My gratitude to you both is incomprehensible.

Contents

List of tables

List of figures

INTRODUCTION

This thesis investigates theoretical and methodological approaches to affect and emotion; it sets out an approach to physiology, emotion and affect drawing on the work of social psychologist Margaret Wetherell. It supports and contextualises this position with reference to debates in physiology, psychology and neuroscience. It offers a necessary, empirical investigation of a wearable technology that monitors physiological response and investigates whether such technology reveals the affective relationships enacted between museums and their visitors. As a result, the thesis also discusses the challenges and ethics of researching visitor emotion and makes critical methodological points on the value of the technology used in the study.

A mixed methods study was run in collaboration with National Museums Wales. This thesis presents visitor data from two displays at National Museums Wales' Cardiff site. It includes an analysis of physiological and self-report survey data collected in Summer 2019, from visitors to *Snakes*, National Museum Cardiff's summer exhibition in 2019 and *Museum ExplorAR*, an Augmented Reality (AR), self-led mobile experience providing visitors with an immersive experience of the museum's permanent exhibitions. In this thesis, five research questions are addressed:

1. How do visitors describe and recall their experience of *Museum ExplorAR* and *Snakes*?

2. Does visitors' response vary between different displays?

3. How do open and closed survey questions contribute to understanding affective experience?

4. In the cases considered, is the analysis of aggregated electrodermal data a valid and useful methodological approach to investigating visitor experience in museums?
    a. When standardised and grouped by exhibit and sub-divided by demographics, how is physiological response distributed and do distribution differences exist between groups?

5. In the cases considered, is the analysis of individual participants electrodermal data a valid and useful methodological approach to investigating museum visitor experience?
    a. Do relationships exist between visitors' self-reported emotion data collected via surveys and the electrodermal data collected from the Empatica E4?

These questions and the rationale underlying them are foregrounded in parts one and two of the thesis.

This introduction details the context of this thesis and the research landscape in which the study is located. It achieves this by first paying attention to affect and emotion; it then discusses the gap in methods and the context of the museum before introducing the values inherent in work across affect, museum, and physiological studies. Finally, it outlines the organisation of the thesis.

Affect and Emotion

Chapter 1 discusses scholarship that has sought to tackle definitions of and approaches to emotion and affect. That chapter outlines a coherent, pragmatic understanding of emotion and affect, which draws on an interdisciplinary body of literature. Investigations of emotion and affect are a stimulating yet challenging field of social inquiry. There is no shortage of approaches to each topic, and affect in particular has been subject to increased attention in previous years (Ahmed, 2004a; Hemmings, 2005; Blackman and Cromby, 2007; Blackman *et al.*, 2008; Thrift, 2008; Blackman and Venn, 2010; Gregg and Seigworth, 2010; Leys, 2011; Blackman, 2012; Wetherell, 2012, 2013, 2014). Chapter 1 discusses three dominant approaches in social and cultural research on affect – those that draw on affect as a direction of travel towards establishing emotion categories (Sedgwick and Frank, 1995, 2003; Sedgwick, Frank and Gullickson, 1996), the claims for a theory of non-representation put forth by Nigel Thrift in social geography (Thrift, 2000, 2004, 2008); and Sara Ahmed's work on the cultural politics of emotion and the 'affective economy' (Ahmed, 2004b). Each of these approaches to affect is unpacked in the next chapter.

For the sake of clarity, it is helpful to offer the definitions of emotion, feeling, and affect contested by Smith, Campbell, and Wetherell, who write:

> Traditionally, affect is the more generic term, highlighting the embodied state and the initial registering of events in bodies and minds. Feeling refers to qualia and the subjective phenomenological experience, while emotion refers to the processing and packaging of affect in familiar cultural categories such as anger, grief, schadenfreude, etc. (Smith, Wetherell and Campbell, 2018, p. 1)

Of particular use to this thesis is that the authors question the clear distinctions between affect as the initial state, internal subjective reflection (the 'qualia') as the next progression leading to categorisation within established emotion terms. Smith, Wetherell, and Campbell assert that approaches based on such definitions 'suggest a kind of dubious chronology' (Smith, Wetherell and Campbell, 2018, p. 1). Instead, the authors claim affect as 'embodied meaning-making – a view which works through affect, feeling and emotion processes, seeing them not as neat packageable progressions but dynamic and flowing configurations where emotion is 'action-orientated (Smith, Wetherell and Campbell, 2018, p. 1). In particular, Smith, Wetherell and Campbell acknowledge their debt to Margaret Archer and Andrew Sayer's work on creating understandings of emotion that avoid the binaries of emotion vs reason and instead view emotion as forms of reason and commentary on personal values (Archer, 2000; Sayer, 2005). In this approach, affect and emotion form and are formed affective practices – a term put forth by Wetherell to suggest a way of thinking about affect as embodied meaning-making that resists chronology and makes space for dynamic affective experiences.

Drawing on Wetherell, this thesis approaches affect as a dimensional, potentially looping and non-linear, embodied cognitive process that, through its involvement with emotion, enables meaning-making on individual and collective levels and drives evaluative judgments. This is not to say there is no chronology between affect, feeling, and emotion. Instead, any chronology that exists is likely not to be linear or reproducible and is in relation with multiple affective practices. This understanding of affect and emotion situates this thesis within a defined and well-established social psychological approach. This view of affect as embodied meaning-making understands it as a driver of the relational aspects of human experiences and the production of personal and social meanings.

This concern with meaning-making presents itself within the study's concern with *how* visitors described their visit, in addition to what they described. Such an investigation draws on Wetherell's formulation of affective practice as a strategic move that rehabilitates discourse

within affect studies. In response, this study demonstrates how affective experiences in the museum may be researched and how this can be evidenced and understood through subjective self-report visitor data codified within Leinhardt et al.'s cognitive tools framework (Leinhardt, Tittle and Knutson, 2002). Chapter 1 elaborates on this approach, discusses other approaches to affect in more detail, and makes a clear case for the route taken in this thesis.

The Methods Gap

This thesis was funded by an ESRC collaborative doctoral award and was developed as a partnership between Cardiff University and National Museums Wales. The project intended to investigate visitors emotional experiences in tandem with physiological monitoring.

This thesis investigates a novel technological tool within an established, evidenced-based approach to affective experience; it takes a pragmatic approach to the relationship between exploratory research and novel technology. Chapter 2 covers a significant body of research on the relationship between affect, emotion and physiological arousal. As we shall see, while there is an abundance of lab-specific methodological approaches and experimental procedures, no well-established methodological protocols for ambulatory monitoring exist (Dawson, Schell and Filion, 2001; Boucsein *et al.*, 2012). Furthermore, a lack of agreement on the validity of physiological measures means there are still serious methodological issues to be considered in any research design seeking to include data from ambulatory participants in real-world settings (Mauss et al. 2005; Mauss and Robinson 2009; Friedman and Kreibig 2010; Kreibig 2010; Levenson 2014). Chapter 2 covers these issues in detail and lays the groundwork for an exploratory and methodology focused investigation. As the forthcoming chapters will establish, its methodology is informed by interdisciplinary literature on affect, emotion and physiology. This is a departure from epistemological approaches in affective computing and seeks to retain a vital concern for relational social processes within the investigation through Wetherell's understanding of affect. This thesis is concerned with the embodiment and social organisation of emotion and affect and the methodological approaches that can be practically enacted within the collaborative doctoral award's remit. It is important to note that this thesis's work does not seek to create before and after comparisons of the museum visitor's state of mind. There are both practical and political reasons for this: objections to this stem from the limited number of precedents for carrying out physiological monitoring in museums and the unproven reliability of such devices. Given the evidence discussed in chapters 1 and 2, this thesis represents a stage before such an

endeavour. The researcher was well aware of the methodological issues in physiological monitoring when applying for the studentship position and was drawn to the project out of a desire to interrogate the validity of wearable technology and to explore meaningful ways to access and understand affective visitor experiences.

This study is necessarily exploratory. The research undertaken in this thesis sought to develop a sound methodology to explore what museum visitors self-report and how this contributed to their experience, whether this was accompanied by physiological patterns in the body, and the methodological constraints inherent in such an investigation. It examines electrodermal activity (EDA) data, which has become synonymous with emotion and affect research; Cacioppo et al. write that EDA has been closely linked with the psychological concepts of emotion, arousal, and attention (2007). Heart rate measures are discussed at the outset but later discounted.[1] As there are only a few precedents for the inclusion of physiology data in museum-based research (e.g., Tschacher et al. 2012; Kirchberg and Tröndle 2015; Tröndle et al. 2012). The investigation furthers understanding of the affective relationship between museums and its visitors through a fundamental exploratory approach to the novel application of technology in culture and heritage emotion research. In its findings, this thesis is a modest but dedicated endeavour that centres on methodological validity. It reports on a novel investigation of a wearable technology that can monitor ambulatory museum visitors' physiological response; it is concerned with questions related to meaning-making, the affective and emotional aspects of these processes, and whether these experiences create physiological patterns in the physical body. It operates with an awareness of debates pertaining to cultural value and wellbeing extant in museums studies. Related, it is cautious of how physiological research may seem to be an appealing way of substantiating wellbeing claims. These debates are framed within the context of critical data studies – which enables the thesis to wrangle a variety of complex theoretical and methodological issues in a critically engaged manner. This thesis is engaged in the praxis of critical data studies, and as such, the approach to physiological data is shaped by the provocations set out by Dalton and Thatcher (Dalton and Thatcher 2014). This thesis contends that before physiological measures are used to support any social scientific insight, we much first understand the fundamental contexts that shape the interpretation of these particular forms of data.

[1] This decision is discussed in the methodology chapter.

The thesis is a methodological investigation in the research gap located between affective practices, critical data studies and physiological monitoring. This study extends the concept of affective practices and reveals the extent to which emotion-driven affective practices shape the meanings visitors construct during a museum visit. It examines and critiques a form of personal, technological enabled biological metric as a means of understanding human experience. It is driven by a strong desire to interrogate these tools and the novel data they produce. It takes the view that museums stimulate affective relationships that activate forms of subjective meaning-making. From this perspective, the thesis presents an exploratory methodological investigation that explores new and extant methodological presents for investigation visitor experience and emotion in the museum. As well as addressing methods for how visitors report their subjective emotional experience, these research questions seek to establish the value of physiological monitoring and ask whether it has a valuable contribution to make to such an investigation. Here the thesis draws on the wealth of social sciences scholarship, which theorises and interrogates data and technological tools.

As a result, this thesis brings together sources from a range of disciplines to understand affect, emotion, the methods for investigating them, and the presumed authority of the physiological metrics. It is in this interdisciplinary space that the warrant for this thesis lies. Working within this novel, mixed methods space presents several issues: managing interdisciplinarity, resources, and the social and ethical considerations of an emergent data form. Critical scrutiny comes via an exploration of the validity and reliability of the technology, social and ethical considerations, and finally, reflections on the technological construction of human experiences. These issues run through the thesis and are reflected on routinely throughout.

The Museum as an Emotive Environment.

Interest in the emotive potential of the cultural heritage sector has expanded in the last twenty years and has generated a substantive amount of literature (e.g. Smith 2016; Witcomb 2013; Cunningham 2004; De Leur et al. 2017; Endacott and Sturtz 2015; Savenije and de Bruijn 2017; Kohlmeier 2006). Chapter 4 discusses Smith's Registers of Engagement, Witcomb's pedagogy of feeling, and Falk's work on learning and emotion (Falk and Gillespie, 2009; Smith, 2010, 2011; Witcomb, 2013, 2015; Smith and Campbell, 2015b; Falk and Dierking, 2018; Witcomb and Mulcahy, 2018). What these approaches have in common and their connection to this thesis is that they seek to address and understand the internal affective

and emotional processes of visitors to museums and heritage sites. The implication here is that whatever is happening must be of value or interesting somehow and that it requires further understanding. This section sets out, albeit briefly, the museum's position today and its role as a site associated with affective meaning-making. The thesis follows by discussing the forms of value involved in this study.

Writing in 1995, Silverman described the process of a museum visit as one of making meaning through the 'constant process of remembering and connecting' (Silverman 1995). Since Silverman, cultural policy and museum practice has drawn on the paradigm of meaning-making to illustrate and explore the visitors' active role in their museum experience (Bennett 2011; Bennett 2005; Message 2009). Value has been ascribed to this process - Perry claims that connection to the past has 'the power to enchant, and… stand as seedbeds for human generosity' where affective response can 'motivate us to act back on the world in constructive, ethically-minded ways' (Perry 2019, page 344). This notion of the self's transformation in a museum can be traced right back to the museum's enlightenment origins.[2] Lewis refers to museums as 'civic engines' enlisted in the 19th Century to assist with managing and educating a newly enfranchised mass male citizenry (Lewis 1989). In response, the museum developed as a public educational institution, where their educational impulse might be best described as 'civilizing' those that attended.

Historical context is not irrelevant detail in establishing the concerns of this thesis. The transformational power of museums upon the populace remains central to the work done in museums. Silverman claimed the future role of museums 'lies in realizing how museums can meet a variety of human needs and learning how best to do so' (Silverman 1995, p.169). Post-colonial and post-structural theory have offered new understandings of museum

[2] The museum finds its roots in the 17th and 18th century collecting practices: fuelled by the grand tour and resulting Wunderkammer, many public museums were founded in the middle and later decades of the 19th century. These institutions were primarily municipal centres for city dwellers growing in number during industrialisation. The growth of museums in the 19th century is often linked to a desire to provide to the new industrial working classes opportunities to extend their knowledge, thereby to 'encourage responsible citizenry' (Fleming 2008) and is a common argument in museum studies (Duncan 1995; Bennett 2005; Bennett 2011; Thomas 2016).

collections and modes of display. These approaches have addressed and reshaped museum practice through museums practice approaches that prioritise social justice and diversity, often through participation, community engagement, and co-creation.[3] For Bennett, museums' function as civic spaces in the 21st century is contingent on these types of practices re-socializing museums and the objects they contain so that they might function as the operators of new kinds of action on the social. (Bennett 2005). However, historical precedents run deep, from sculptural depictions of dominant races and genders carved in the very architecture of many museums to the ongoing issue of repatriating looted collections. This thesis and much contemporary research on visitors' affective experiences find itself today somewhere between two places; the analysis of identity, particularly of cultural and racial identities, is still fully realised within the pedagogic impulse of a 19th-century organisation (Bennett, 2005, 2011). Central to the changes in museum practice and Bennett's idea of resocialisation, I argue, is the act of meaning-making - an affective practice inextricable, as this thesis will argue, from any attempt to understand emotive visitor experiences in museums.

Engagement focused practices in the last twenty years have been said to have reconfigured production and consumption in the museum (Simon, 2010). Conceptions of the visitor as a consumer of curatorially produced displays have been contested and now often provoke discomfort for museum professionals who argue for forms of values outside the museum's traditionally didactic educationist values (Simon, 2010). While participatory and discursive forms of museum practice have laid the foundations for visitor emotion research, these practices are also implicated in a large and still growing body of museums, and heritage scholarship makes a case for the civic and social role of museums (Sandell, 1998; Silverman, 2009; Sandell and Nightingale, 2013; Lynch, 2017). The question of whether the heritage and cultural sector can address a wide range of issues with the intentions of leading to health, social and political change remains open. As Lynch writes: 'through the gift of "access" and "engagement" museums make efforts to 'humanise the world … by making it a place that is

[3] A cornerstone of these changes was the move towards participatory practices most notably explored and categorised in Nina Simon's now infamous 2010 treatise *The Participatory Museum* (Simon, 2010). Simon directly responded to the practical 'how' of participation rather than the much covered 'why', this practical approach toward engaging museum visitors radically reframed what museum education could look and feel like.

more socially cohesive and hospitable' (Lynch 2017, page 12), but despite 'announcing their social justice credentials, museums and galleries have yet to make convincing arguments regarding their useful civic role' (Lynch 2017, page 23). Lynch's critique indicates how social and civic value is conceived in the context of public museums, with years of public policy centred on engagement and participation where museums have increasingly been asked to perform social and civic roles under the banner of 'engagement' (Bennett 2011). This has specific relevance to this thesis as the terms of value when engaged in understanding emotion, and physiological data might readily turn towards the potential for evidencing wellbeing.

In this thesis, the museum is the lens through which an investigation of affect and method is conducted. Understanding the values (and baggage) that shapes that lens is vital. Value in the museum can take many forms - financial, social, political, emotional, creative, democratic, but arguably, each represents a form of attention. This speaks to seminal research in museum studies and understands the museum as a 'cultural organisation with a contradictory and unequal social framework' (Hooper-Greenhill 1999, page 3) or as Dicks puts it: 'Museums comprise a 'field' of institutionalized judgments of value' (Dicks, 2016, 2). These unequal, contradictory, institutionalized judgments are dynamic and affective where emotion is 'action-orientated – in this case towards judgements of value - is the basic conceptual claim at the heart of this thesis. While this is by no means a neutral stance, taking this approach to the role of affect and emotion in the museum, this thesis is cautious of approaches that speak to self-improvement. I have previously described considerations of emotion and affect, specifically in culture and heritage studies, as broadly corresponding to two strands of inquiry: the first, those primarily interested in the role of emotion in meaning-making and critical evaluation and the second focused on the involvement of emotion in health and wellbeing outcomes (Hoare 2020). In proposing these (by no means exclusive) categories, I argued that often a drive to understand the role of emotion in the museum is concerned with the role of emotion in the visitors' 'thinking better' or 'feeling better' – arguably both of which might in some definitions be associated with wellbeing and its associated values. This thesis avoids these categorisations and associated judgements on the value of emotion. This thesis is cautious of claiming or assuming relationships between visitors' affective experiences and grand yet slippery social outcomes – be it wellbeing effects or otherwise. Chapter 4 unpacks these issues in more detail.

Organisation of the thesis

This thesis contains an introduction, 8 chapters in its main body, and a conclusion. This introduction provides an overview of the study and set a warrant for the thesis. It identifies the thesis's concerns and indicates the current research landscape associated with that context within relevance to emotion and affect. In locating a research gap, it demonstrates a need to understand visitor emotion and physiological monitoring as social phenomena, each in their own right but also proposes that in combination, they may have significant methodological implications for social science and museum studies. The remainder of the thesis is broken into four parts. This structure enables the vast range of cross-disciplinary literature and discussion to be presented in a concise and reader-friendly manner, where necessary, concluding sections after given for these parts which summarise the main points before progressing.

Part one is comprised of two chapters. Chapter 1 summarises the relevant literature on emotion and affect. It establishes a thesis that is driven by an awareness of the interdisciplinary relationships involved in this research. It discusses various approaches to affect and emotion and makes a case for an affective practice approach. It argues that such a route is commensurate with the methodological challenges and is based on psychological evidence. Chapter 2 discusses physiological monitoring with attention to electrodermal activity and heart rate measures, longstanding methodological issues, and critical approaches to data. Part one concludes by discussing the overlap between chapters 1 and 2.

Part two focuses on research precedents – it examines several ambulatory studies from across disciplines that collect physiological data and employ it in their analysis. In chapter 3, particular attention is paid to eMotion, a study which represents one of the most significant uses of physiological data recorded in a museum environment. Chapter 4 engages with the museum visitor emotion research and the specific context activated by conducting emotion research in museums.

Part three presents the study’s methodology and discusses both the research paradigm and the mixed methods analysis structure. Chapter 5 attends to the relationships between the study development and its practical considerations. It outlines the research paradigm, case study approach, pilot study and the partnership with Amgueddfa Cymru – National Museum Wales and the two displays chosen for data collection are introduced. Chapter 6 establish the

study’s research questions and details the design of the study. Chapter 6 also tackles reliability and validity issues in terms of each of the data forms and discusses ethical issues.

Part four contains three analysis chapters. Each of these chapters tackles a different form of data analysis. First, Chapter 7 summarises the results of the study’s survey. This chapter includes both quantitative and qualitative data. It is divided into sections so that each of the survey questions is approached in turn, and this is followed by a discussion of each of the relevant research questions. This chapter uses the idea of affective practice and the cognitive tools framework to explore visitor experience. Chapter 7 presents the results of an aggregated group-level analysis of visitors EDA data. The data in this chapter is wholly quantitative. The research questions central to this chapter are concerned with whether EDA data could offer a greater understanding of visitor emotional response if analysed at the group-level. Chapter 8 presents an individual-level analysis of visitors' EDA data held in conversation with their survey responses. This chapter responds to research questions concerned with the relationships between individual EDA responses and self-reported experience.

Finally, Chapter 10 offers conclusions. It summarises the main findings in the context of the study’s aims and research question. It engages with key debates on physiological monitoring, including critical data studies perspectives and methodological challenges revealed in the extant literature. It describes the challenges of working with EDA data shows and new directions for research into museum visitor experience, affect, and physiological monitoring.

Part One: Emotion & Affect: Concepts, Theories and Method

Introduction

The first part of thesis is made up of two chapters. Chapter 1 critically examines prominent understandings of emotion and affect. It establishes the approach to emotion and affect deployed in this thesis. Chapter 2 turns to the role of physiological monitoring and the value of such data in an investigation of affect and emotion. Part one ends with a conclusion that knits the two chapter together and informs the thesis' methodology.

Chapter 1 considers approaches to emotion and affect drawing on psychology, social psychology and neuroscience to establish the evidence for an affective practice approach to affect. Through interdisciplinary discussions, the chapter establishes a foundation for the thesis which is psychologically coherent and plausible given the empirical evidence available. The thesis navigates a route through the contested debates of emotion research to emphasise the importance of psychologically evidenced approaches to affect. Chapter 1 gives an overview of emotion that introduces two well-established understanding of emotion: discrete and dimensional theories. The evidence for, methods associated with, and complications of each camp are discussed. A third approach is introduced – that of psychological constructivism (Barrett, 2006). The chapter details how this particular approach is well-evidenced and compatible with the affective practice approach to affect put forward by Wetherell (Wetherell, 2012). From this standpoint, the thesis claims that emotion and affect are central to the physical, cognitive, embodied, and social aspects of a museum experience.

Chapter 2 looks in detail at physiological monitoring. It begins with a brief overview of physiological response and the autonomic nervous system. It goes on to explain the nature of electrodermal and heart rate measures. It then tackles a number of methodological issues including the lack of support for indexed relationships between physiological response and self-reported emotion, dispute over baseline procedures, lack of clarity over analysis protocols, and the problems presented by ambulatory recording. Subsequently, it turns to the concept of critical data studies to establish a necessary, critical approach to physiological data. This is developed in the conclusion to part one which demonstrates how the two chapters in this section relate to one another. In this final section, the value and coherence of working through an affective practices and critical data studies is laid out ahead of part two.

Chapter 1. Emotion and Affect

Introduction

Emotion evolved primarily as a survival mechanism (LeDoux, 2000). Today research has shown that emotion should be understood as a complex component of human experience which plays a key role in cognitive processes, such as memory and learning (Picard *et al.*, 2004; Immordino-Yang, 2015). However, social and cultural understandings of emotion – in particular those with roots in classical philosophy have shaped western culture. We find tendrils in Plato's three parts of the soul: reason, emotion and desire. In this trifactor categorisation, emotion and reason are seen as two horses pulling us in opposite directions. It is this idea which forms the basis of dualistic models of judgment and decision-making, systems which are Platonic in the way that they present antagonism between reason and emotion (Annas 2000). More commonly, this might be perceived as that familiar battle between heart and head. This notion underwrites understandings of emotions as primal reflexes which one might seek to overcome with rationality (Annas 2000; Barrett 2017). We can find it reproduced in popular entertainment, with the Pixar movie *Inside Out* providing a neat example of cartoon emotions as separate entities within us which fire up and cause feelings and behaviours (Docter, 2015; Keltner and Ekman, 2015). This view is often embedded in our interpersonal relationships, recruitment processes, and the legal system. For instance when we look to criminals to show remorse in their facial expressions or describe an offence as a crime of passion. The question here is whether this view is correct – a question that has caused consternation for a great number of people: from psychologists, sociologists, and neurologists, to philosophers, geographers and critical theorists.

In terms of definitions of 'emotion', Scherer claims that the number of scientific definitions now proposed is immeasurable (Scherer, 2005). Elsewhere attempts to collate the vast number of definitions resulted in one hundred divergent claims to a definition (Kleinginna and Kleinginna, 1981). Rather than attempt a meta-analysis of the term, this section summarizes two main approaches and presents a recent third discourse challenging views on emotion. This is vital to this thesis - epistemological and ontological assumptions give rise to methodological considerations and in turn determine elements of research design. Therefore, one must be clear about the approach to emotion in this study before progressing to a research design. For this reason, chapter 1 is dedicated to theories of emotion, conceptualising disagreements in the field and understanding the implications for methods.

Discrete Emotion

Discrete emotion models, most linked to the model of basic emotion and universalist models discussed previously, suggests that each emotion (e.g., anger, sadness, happiness) has a unique experiential, physiological, and behavioural footprint. William James proposed that 'emotional brain-processes not only resemble the ordinary sensorial brain-processes but in very truth are nothing but such processes variously combined' (James 1884 p.188). James, in his seminal paper, *What is an emotion?*, James proposed to consider only emotions with a 'distinct bodily expression' by which he means those that we might understand to be universal responses:

> Common sense says we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike. The hypothesis here to be defended says that this order of sequence is incorrect, that the one mental state is not immediately induced by the other, that the bodily manifestations must first be interposed between, and that the more rational statement is that we feel sorry because we cry, angry because we strike, afraid because we tremble, and not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be. Without the bodily states following on the perception, the latter would be purely cognitive in form, pale, colourless, destitute of emotional warmth. We might then see the bear, and judge it best to run, receive the insult and deem it right to strike, but we could not actually feel, afraid or angry. (James 1884 p.190)

James' essential claim is that upon perception, bodily states enact a categorisable group of things called emotions. Discrete, materialist theories of emotion, such as James, differ significantly in their view of how emotions become manifest. Still, they share a common assumption that any explanation of emotion can be understood as a relationship of effect and cause, where emotion results from stimuli uniformly (Ekman 1992). It is this thinking and its reliance on causal relationships and categorisation, which led to beliefs that certain emotions are universally recognisable, have particular neural paths, neurochemical systems and can be recognised in facial expressions (Tomkins 1962; Ekman and Friesen 1971; Izard 1971; Matsumoto et al. 2008; Gendron et al. 2014).

This understanding of emotion has been referred to as the ‘natural-kind model’ or more specifically in relation to the work of Tomkins and Ekman as the theory of basic emotions (Tomkins 1962; Ekman 1992; Collet et al. 1997; Panksepp 2000; Barrett 2006; Barrett et al. 2007; Widen et al. 2011). These views hold that we have particular circuits of emotion in our brains that correspond to distinct physiological responses (Scherer 2005; Barrett 2006; Scherer 2009; Barrett 2017b p.x). The basic emotion model claims that there are six basic, uniquely identifiable emotions. It has been argued that these six emotions have a distinct, identifiable, reproducible patterning along our corporeal, neurological and physiological selves (James 1884; Kleinginna and Kleinginna 1981; Scherer 2005; Barrett 2006; Barrett et al. 2007; Gendron et al. 2014; Barrett 2017b).

In the discrete approach, nominal, ordinal, or interval scales are prevalent (Scherer, 2005). These take the form of closed-choice questions underpinned by a discrete theory of emotions. Commonly, researchers present participants with a list of emotion terms to choose from and scale to rate the intensity of feeling. In this situation, the participant can select only the most prominent emotion or multiple to indicate possible blends of feeling. There are a number of standardised instruments for this. For instance, Izard’s Differential Emotion Scale (DES), formulated around a thirty-item adjective checklist, with three adjectives corresponding to each of the ten emotions Izard considers universal. Each of the items on the list is scored on a 5-point scale (Izard, 1991). Crucially, this method is based on a standardised and shared understanding of each of the ten universal emotions. There are some further difficulties in such an approach. First, it produces many zero values, which some argue complicates the statistical analysis (Scherer, 2005). Second, its function is contingent on all assumptions that have caused the discrete approach to be questioned. As was previously stated, these are the issue of a lack of evidence for the type of emotional labelling and the universality of labels that discrete emotion theory relies on (Russell, 2003; Barrett, 2006; Mauss and Robinson, 2009).

Furthermore, these methods are complicated by the labels chosen for studies and the variation within these. Scherer writes that many researchers ‘prefer to create ad-hoc lists of emotion categories that seem relevant in a specific research context’ (Scherer, 2005, p. 718). This, of course, creates problems. One of the major ones is whether preselected responses can ‘prime’ participants, i.e., manipulate responses depending on the researcher chosen categories. Additionally, a participant may wish to respond with a category that does not

feature, thus ‘forcing the person to respond with the closest alternative, or, if provided, with a residual category such as ‘‘other’’, with the specificity and accuracy of the data suffering in both cases’ (Scherer, 2005, p. 712). Selecting relevant emotions introduces bias, and an ad-hoc selection produces research that might not be widely comparable to studies in the same field. Scherer writes that both issues may create ‘serious problems of comparability of results across different studies in which widely different sets of emotion labels are used’ (Scherer, 2005, p. 718). Suppose one wishes to use closed-choice methods that take emotion to have universal properties. In that case, it is difficult to ignore that such questionnaires and rating scales of emotion ‘rely, directly or indirectly, on such everyday English words as anger, fear, happiness, anxiety, or stress’ (Russell, 1989, p. 83). This may not be a considerable problem should, for instance, one wish to actively solicit and study the presentation of a specific emotion under lab conditions; there are some emotions for which empirical evidence support their universal properties, e.g. happy or amused (Gendron *et al.*, 2014).

Just as easily as this discussion can make its way from Plato to Pixar, the study of emotion has journeyed across disciplinary lines. Psychologists, neuroscientists, philosophers, computer scientists, geographers, sociologists, and anthropologists have all tackled the study of emotion. Despite this, less is known about emotion than other comparable human traits, memory and attention (Barrett 2006). Some argue that the lack of progress in a scientific understanding of emotion results from unresolved disagreements over the fundamental question of how emotion is to be defined (Ekman and Davidson 1995; Solomon 2003; Barrett 2006). Barrett’s argues that progress is limited by:

> the wide acceptance of assumptions that are not warranted by the available empirical evidence and these assumptions can be summarised by one core idea: Certain emotions (at least those referred to in Western cultures by the words ‘‘anger,’’ ‘‘sadness,’’ ‘‘fear,’’ ‘‘disgust,’’ and ‘‘happiness’’) are given to us by nature. (Barrett 2006 p.29).

Here, one can see Barrett bring the socialised aspects of affect and emotion into the debate – and rightly claim that cultural assumptions cannot be taken for granted. We will return to this point below.

The lure of discrete models is that they suggest a biological basis which one can objectively identify, measure and link to definable forms of emotion response. Yet, when Barrett claims

that this view can no longer be sustained, they do so because no emotion has been shown to have reproducible traits in either psychological and physiological understandings of emotion (Barrett 2017b). The field of psychophysiology has demonstrated that different discrete emotion categories are not distinguished by distinct patterns of peripheral physiology (Cacioppo et al. 2000), nor facial muscle movements (Cacioppo et al. 2000; Russell et al. 2003) or vocal traits (Bachorowski and Owren 1995; Russell et al. 2003; Barrett 2006). Research on facial expression and emotion has failed to reproduce findings that attempted to make a case for pan-cultural facial expressions in particular emotions. Recent research which sought to determine the validity of basic emotions and universal expression (Widen et al. 2011; Gendron et al. 2014), found that claims made that evidence for universality appears to be 'conditional on the experimental methods being used' (Gendron et al. 2014 p.3). Given the lack of evidence, few researchers remain confident that evidence will be found for discrete emotion theories (J. T. Cacioppo *et al.*, 2000; Barrett *et al.*, 2007; Daum, Markowitsch and Vandekerckhove, 2009). This lack of evidence has profound implications for this thesis and any psychobiological organisation of affect and emotion. With such strong evidence against determinate biological emotions, the question remains: what can physiological monitoring offer an investigation of affect and emotion in museum visitors? The answer can be found in exploring other approaches to emotion and affect and in interrogating the technology itself. In this chapter, we are concerned with the first of those points. The second will be addressed in the next chapter.

Dimensional Emotion

Dimensional models emphasise not core emotional categories but dimensions of emotion: valence and arousal or approach-avoidance (J. A. Russell and Barrett, 1999; Posner, Russell and Peterson, 2005; Mauss and Robinson, 2009). Such approaches draw on the idea of emotional variability and posit that not all mental state categories placed under one named emotion (e.g. fear) are identical in feeling or neurophysiological signature (Barrett, 2009). Valence is the degree to which something is pleasant or unpleasant, and arousal is the continuum between sleepiness and alertness. In comparison, approach indicates a tendency to approach stimuli and avoidance motivation the propensity to avoid stimuli. By adding a dimensional element, researchers have sought to add nuance to emotion research that basic emotion theory excluded (J. Russell and Barrett, 1999).

Dimensional methods ask participants to structure their subjective feelings in a dimensional space formed by valence (positive-negative) and arousal (low–high). Many dimensional theorists use a circular map, known as the Affect Grid, to plot emotion in two-dimensional space. This tool is based on Russell's circumplex model of affect (Russell, 1980). Scherer finds this method of obtaining self-report 'simple and straightforward and generally quite reliable', readily compatible with statistical analysis and applicable in a variety of environments (Scherer, 2005, p. 718). Indeed, as the next part of this thesis will detail in chapter 4, the Affect Grid was used by Falk to study the emotions of science centre visitors (Falk and Gillespie, 2009).

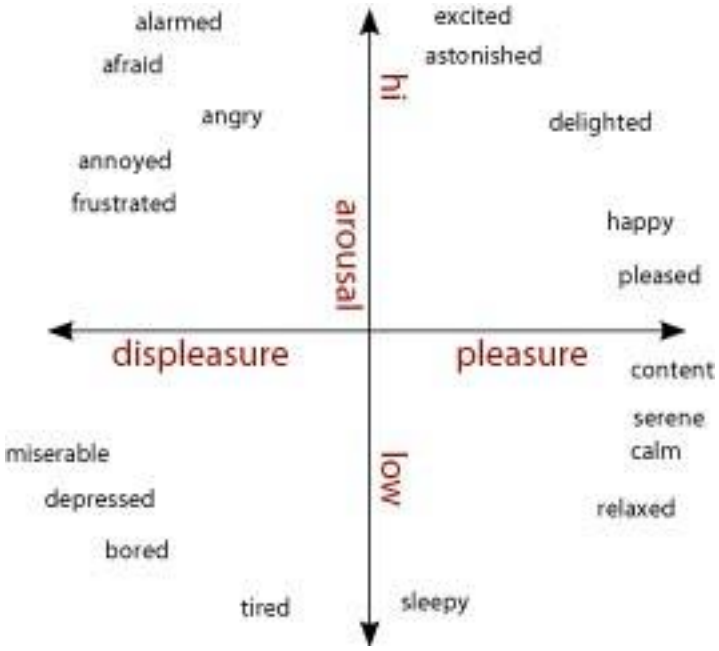


Figure 1: Russell’s Circumplex Model of Affect

The Affect Grid results are restricted to positive or negative feelings and the participants' perceived arousal level. Some argue that labelling experience via a list of presented emotions words is less complex than asking a participant to understand and acknowledge both intensity and arousal (Scherer, 2005; Bermond *et al.*, 2007; Pollatos and Schandry, 2008). Whilst Russell's circumplex model calls for a participant to respond to both the intensity and qualities of emotion, the result is somewhat opaque. Scherer argues it is harder to understand participants' feelings when reduced to a singular dimensional point in space and that comparisons between individuals are difficult to support (Scherer 2005). Scherer asks

the question: 'which are more comparable: two individuals who share the same point in valence-arousal space or two individuals who use the same word to describe their feelings?'. Scherer argues that those who use the same verbal description are likely to have similar experiences, but those with the same valence pattern and arousal might be less likely (Scherer, 2005, p. 719). For instance, both fear and anger have negative valence and high arousal.

One of the shortcomings of dimensional approaches is that emotion terms plotted dimensionally can be inconsistent with cultural differences. This is supported by the linguist Wierzbicka, who argues that a key complication in understanding emotion comes from 'treating English emotion terms as valid analytical tools' across the various cultures and experiences (Wierzbicka, 2009, p. 3). This is an issue for the discrete models too, but the problem of dimensionality complicates this issue further. For example, "sadness" is more akin to physical pain in Russian but more keenly associated with the experience of loss in the USA (Barrett 2009; Wierzbicka 2009). It has been shown that anger involves 'psychological distance from others in the USA but increasing proximity and closeness in Japan' (Barrett 2009). Even within cultures and similar forms of socialisation, interpersonal differences can be striking. At the extreme, one can find cases of alexithymia, which, more than a difficulty putting emotions into words, includes difficulties in 'recognising, describing, and distinguishing feelings from bodily sensations of emotional arousal, and affective deficits'. (Taylor and Bagby, 2004; Bermond *et al.*, 2007; Samur *et al.*, 2013, p. 1). These forms of personal and cultural emotion variability are problems for emotion researchers.

Psychological Constructivism

In response to criticisms outlined above, the dimensional model has been expanded by emphasising sociocultural considerations and posing that emotions are variable cultural constructs governed by social norms and an individual's previous experiences (Scherer, 2005; Barrett, 2006, 2017; Barrett *et al.*, 2007). This particular model has been termed psychological constructivism by its leading proponent, Barrett (Barrett, 2009). One of Barrett's psychological constructivism's key differentiators is that it aims to acknowledge and attempts to understand variability (Barrett, 2006, 2009). Barrett makes clear the approach of psychological constructivism:

> As socially constituted artefacts of learning and culture, no emotion category is assumed to be biologically basic. Most notably, and perhaps more than any other approach to understanding emotion, psychological constructionist models predict variability in emotional life and assume that this diversity must be a central feature in any explanation of what emotions are and how they work. (Barrett 2009 p.1286)

Importantly, Barrett does not disregard categorisation but calls upon William James' comment to support their approach: 'The trouble with the emotions in psychology is that they are regarded too much as absolutely individual things' (James, 1890, p. 449). Barrett argues that the urge to divide and separate emotion activation into discrete categories should be understood as:

> a natural consequence of the way the brain works. Human brains categorise—continuously, effortlessly, relentlessly... From birth, the human brain captures statistical regularities in sensorimotor patterns and stores them as internal representations. Words are then applied to these categories later in development… For these categories, words act like the glue that holds a category together. Without words, these categories would not exist...The brain then draws from its vast repository of stored representations in the blink of an eye, to associatively recombine what it has learned in the past. This allows the brain to continuously and unintentionally categorise what sensory stimulation means in the present, to make the present state meaningful. (Barrett, 2009, p. 6)

Barrett claims categorisation is the brain's way of interpreting sensory stimulation, which then creates meaning and enables us to communicate our state to others. Rather than see categorisation as indicative of a form of basic emotion or articular psychological profile, psychological constructivism sees categorisation arising from external stimuli, embodied somatics, and prior experience. From this position, emotions are seen as diverse 'mental events' or 'states of mind' assembled from a combination of stimuli. Barrett argues that their variable combination and weighting produce the 'myriad of mental events that people give common-sense names to, like perception, cognition, and emotion'. (Barrett, 2009, p. 1292). This model is founded upon the idea that emotion categories exist because there exists a tacit cultural agreement that this is a practical method for parsing and sharing mental activity.

The hypothesis that relationships between stimuli and any single emotion category are highly variable has several implications. It suggests that emotion concepts are not amodal but are personal and embodied (Barrett, 2009, p. 1295). It also aims to work with an awareness of the issues introduced by culturally dominant forms (i.e. English language and western culture understanding of emotion terms) identified by Wierzbicka (Wierzbicka, 2009).

Instead, emotions present in personal, cultural and context specific blends arising from 'ingredients' that can be used to 'make any number of different recipes (which make the mental states that people experience and give names to)' (Barrett, 2009, p. 1295). As a result, it is not enough to identify what the ingredients are. Instead, true value comes from exploring how they 'coordinate, and shape one another, during the process of construction'. (Barrett, 2009, p. 1298) The implication of an ingredient and recipe process rather than a purely biomechanical one is that the application of the broader categories of emotion, perception and cognition become more diffuse, and we may begin to see:

> how certain aspects of emotion play an intrinsic role in what people consider to be non-emotional events… This idea extends the variety of emotional life even further because it means that even "cognitions" and "perceptions" are, in a sense, emotional in nature. (Barrett, 2009, p. 1298)

In thinking about how one might understand and study emotion as a social researcher, this premise opens an interesting space in which to consider how and to what extent emotion continually and dynamically shapes experiences.

Affect

So far, in this chapter, we have seen how psychologists and neurologists conceptualise emotion. This thesis draws from this evidence to form a coherent and evidenced route forward for critical social research into emotion and affect, where affect is a component in the subjective appraisal of emotion. In recent years, interest in affect has steadily grown; this 'turn to affect' has produced a growing interdisciplinary body of literature, which calls attention to 'feeling' 'emotion', 'affect' and 'embodiment' in matters of human experience (Massumi, 2002; Sedgwick, 2003; Ahmed, 2004; Thrift, 2004, 2008a; Clough with Halley, 2007; Greco and Stenner, 2008; Seigworth and Gregg, 2010; Blackman, 2012). As with emotion, a significant number of positions on affect exist, and these vary considerably. Rather than address each in

detail, this thesis teases out three traits common in approaches to affect to makes a case for Wetherell's form of affective practice. The three issues at play are understandings of affect which draw on basic emotion theory and are underpinned by assumptions that see emotions as natural and uniform psychobiological processes, the idea of non-representation and what that may conceal, and finally affect as a form of excess. These three issues are not mutually exclusive and occur across a spectrum of approaches to affect. This section takes these issues and discusses each in relation to its key proponents; it draws on supporting evidence in chapter 1 and establishes an argument for the affective practices approach in this thesis.

First, let us look at views of affect as a pre-personal and pre-conscious force (Massumi, 1995, 2002). Scholars such as Thrift via Massumi view affect as 'non-representational', an idea that 'values the pre-cognitive as something more than an addendum to the cognitive' (Thrift, 2008, p. 6). In this view of affect, Blackman has described affect as bypassing 'reason and criticality and seizing the body at the level of neural circuits, the nervous system, the endocrine system or other systems assumed to work independently of cognition' (Blackman, 2012, p. 11). There are a number of issues with these approaches that have caused them to be described as 'psychologically implausible' (Wetherell, 2014, p. 149). Leys systematically takes apart the psychological studies on which Massumi's argument is based (Leys 2011). The main concern is that Massumi relies heavily on Tomkins and Ekman's theory of basic emotions, the lack of evidence for which has already been discussed in chapter 1. Leys argues that 'differently from Tomkins and Ekman but to the same end, Massumi conceptualises affect as inherently independent of meaning and intention' (Leys 2011 p.450). In this approach to affect:

> the body not only "senses" and performs a kind of "thinking" below the threshold of conscious recognition and meaning but—as we shall see in a moment— because of the speed with which the autonomic, affective processes are said to occur, it does all this before the mind has time to intervene. (Leys 2011 p.450).

Furthering their critique of affect in the social sciences, Leys cites Barrett's 'impressive series of reviews ... as empirical evidence inconsistent with the idea that there are six, or seven, basic emotions in nature' and suggests this is evidence of the need for 'a new scientific paradigm for research on the emotions' (Leys 2011 p.440). The psychology constructivist model has been cited in the evidence against non-representation approaches to affect (Wetherell, 2012). Wetherell's case against non-representation is twofold. First, its suggestion

of chronology - the notion that affect comes first and doesn't interact reflectively with the personal. Second, chronology often leads to forms of categorisations that demonstrate an overreliance on and assumptions about the validity of twentieth-century psychology. Theories based on the theory of basic emotions – this unstable foundation erodes the basis of any approach– whether this is a non-representational approach or otherwise.

In the article *Trends in the Turn to Affect: A Social Psychological Critique*, Wetherell dismantles the idea that affect and emotion can be considered non-representational. In response to Thrift's arguments that 'emotions are largely non-representational' (Thrift, 2004, p. 60) and 'affect is in large part a biological phenomenon' (Thrift, 2008, p. 236), Wetherell makes it clear that this understanding of emotion and the presume precursor, affect, are untenable. First, because this reduces bodies to processes outside cultural representation, where:

> People feature in terms of their body parts. These body parts are assailed by events, by smells, the social relations organising spaces, material objects and global economic forces. The person becomes a kind of semi-intelligent, hormonal ape. (Wetherell, 2014, p. 149)

And second, because such understandings of affect as a pre-conscious process divorces affect from 'everyday talk, discourse and meaning-making…and makes little social psychological sense' (Wetherell, 2014, p. 151). Finally, rendering the object of research mute and unknowable sets up methodological challenges and impedes empirical research (Laurier and Philo, 2006; Pile, 2010; Wetherell, 2013).

Approaches to affect that argue for a split between body activities and meaning-making stake a value in focusing on the former. The appeal of this is the divorce with social and textual discourse rooted in a belief that description neuters affect through its attempts to codify it. This approach to affect has been extensively criticised (Anderson and Smith, 2001; Hemmings, 2005; Laurier and Philo, 2006; Pile, 2010; Leys, 2011; Wetherell, 2012, 2014). Crucially, as Hemmings believes, such an approach to affect 'flattens out poststructuralist inquiry by ignoring the counter-hegemonic contributions of postcolonial and feminist theorists' (Hemmings, 2005, p. 458). Which is to say that to take nothing of the social and meaning-making into an engagement with affect and emotion ignores powerful personal and historical

circumstance. As Pile claims, it is possible to go beyond the representational to work from a perspective that seeks to understand 'emotions as ways of knowing, being and doing' (Pile, 2010). This perspective speaks to a model of affective practices as put forward by Margaret Wetherell. Affective practices offer a theoretical frame that acknowledges the affective and embodied aspect of emotion and its central role in personal and collective forms of meaning-making without drawing on dubious and dated psychobiology or positing unfounded chronologies of affect. Crucially, affect does not unfold in an orderly manner and complete itself as we 'do', 'be' or 'know' - it is a dynamic, continually reconfiguring process where the being, doing and knowing are enmeshed. This point will become more apparent throughout the rest of this chapter.

There is one remaining characteristic of affect research to address before establishing the approach taken in this thesis. In some formations, affect is seen to accumulate and circulate with attachments to cultural signifiers or signs. Sara Ahmed draws on Marxists notion of surplus value to propose a way of thinking about affect in this vein (Ahmed, 2004a, 2004b). This approach attempts to build a useful and much needed bridge between psychology and cultural studies to understand how affect and emotion operate in the cultural landscape. In this model, emotion and affect are neither wholly within or outside the body. Neither biological and owned by the individual nor externally activated and internalised as a script. Wetherell agrees these points are 'unarguable' and 'affect is distributed' (Wetherell, 2014, p. 158). Yet, it is in their moves to avoid the 'inside' or 'outside' binary that Wetherell believes Ahmed is wrong-footed. The result focuses on emotion as a form of movement between emoter and objects where affect 'is produced only as an effect of its circulation' (Ahmed, 2004b, p. 45). This approach mystifies affect and renders it 'deeply enigmatic' (Wetherell, 2014, p. 158). Human actors fade from view; the focus is on traditional emotion categories (e.g. drawing on the basic theory of emotion) – hate, shame, joy and associated instances of episodic enaction between subject and objects. Affect isn't live and unstable. Instead, it is accumulating between cultural signs be they object or otherwise. While useful for cultural studies, this approach hinders any attempt to conduct social research into affect as it does not translate into a pragmatic route for empirical social research.

This section addresses why, even though some are creative and interesting ways to think about bodily affect, many approaches are not founded on sound evidence. In this interdisciplinary field, not all approaches translate across disciplinary boundaries. In this

empirical thesis, the psychological evidence forms the basis for a more discursive approach. Reliance on basic emotion theory is a stumbling block for many theories of affect – a point underpinned by the arguments above and in the preceding section. Where the sections of this chapter meet is in Wetherell's interpretation of Barrett's research which posits that affect is a 'contingent, plastic and flexible, constructive feedback process' where affects are 'simultaneously perceived, organised, categorised, labelled and communicated becoming socially recognisable ''emotions''' (Wetherell, 2013, p. 355). This position seeks to reconcile the somatic and cognitive; in attending to this divide, it presents a generative direction of travel for the current study. Therefore, this study proceeds under Barrett idea of psychological constructivism and Wetherell's concept of affective practices.

Wetherell's approach aligns with Barrett's social constructionist approach to emotion. For both Barrett and Wetherell emphasis is placed on the social and action-orientated aspects of emotion. For Wetherell, this is vital in social research as it sees affect as:

> a stimulus to expand the scope of social investigation. It leads to a focus on embodiment, to attempts to understand how people are moved, and what attracts them, to an emphasis on repetitions, pains and pleasures, feelings and memories. (Wetherell 2012 p.2)

This approach understands affect and emotion as capable of being simultaneously in relation to entwined unmediated bodily response and mediated cognitive ones. Wetherell argues that this view 'opens up crucial questions about meaning-making practices', claiming that acknowledging somatic experience within meaning-making practices, researchers must acknowledge 'issues about how the speaking subject makes sense of and communicates affect' (Wetherell, 2013, p. 353). This is compatible with this thesis, which sees the inclusion of the subject's experience and how they recall experience as vital.

How a museum visitor expresses and communicates their affective experience should not be muted or undervalued. Wetherell offers a way of thinking about visitor experience that is not bound to categorising it into neat formations. This speaks to the issues heritage scholars Smith and Campbell identified emerging from their work concerning 'range of emotional responses... and a range of intensities in those responses' (Smith and Campbell, 2015b, p. 445). They argue that whilst such an observation might appear 'prosaic', it remains the case

that an engagement with visitors' felt experience 'reveals the limitations of much of the heritage and museum interpretation literature that draws on educational studies' (Smith and Campbell, 2015b, p. 444)[4]. Wetherell's conception of affect offers museum and heritage scholars an understanding of affect and emotion compatible with their field of investigation. It provides space for visitor experiences beyond the metric of what distinct emotion can be identified and tagged, where banal, complex, or 'thin' visitor responses can be acknowledged (Smith and Campbell, 2015b).

Wetherell offers a pragmatic approach to affect and emotion, which extends Archer's claim that emotions are felt reflections of our experiences, knowledge, values and judgements (Archer, 2000). Emotions are commentaries on what is important to us. The concept of affective practices makes space for such an understanding and remains open to the plural, coterminous, blurred, and entangled nature of our experiences and emotional lives. Therefore, it follows that Wetherell's concept of affective practice does not offer a clear and complete explanation of either emotion or affect. Instead, it is a particular framing, or as Wetherell puts it 'a way of thinking', which keeps a keen eye on evidence and understands these processes as mobile, fluid, social and relational. It doesn't deny either the cognitive or embodied aspects while also making space for discursive practices. As Smith et al write:

> the kinds of discourse activities (formulating, accounting, narrating) that are the unavoidable and inevitable focus of most qualitative research offer a way into important features of affective practices such a retrospectively sense-making around emotion episodes… but also potentially through more fine grained qualitative work, to the stitching together to embodied states and meaning-making in flows of affect (Smith, Wetherell and Campbell, 2018, p. 5).

In this sense, what affective practice offers is a way of thinking about affect that enables the researcher to engage with the diverse perspectives and responses visitors may have to a museum site. In this approach, the social relations inherent in a study of affect and emotion are better able to come to the fore. As Wetherell, Smith and Campbell contend, in their claims for affective practices in heritage studies, this approach accommodates more fragmented forms of individuality and intersectionality while moving 'outwards from the subjective, the

[4] Part two discusses studies of museums visitors in more detail.

phenomenological, the experiential and the psychological to the social organisation of heritage relations, episode, and the whole assemblage' (Smith, Wetherell and Campbell, 2018, p. 6).

This thesis sets out to achieve the outwards movement described by Smith, Wetherell and Campbell. In seeks to do this through drawing on the affective practice and psychological constructivist modalities. In part, this means the stitching of embodiment and personal accounts of meaning-making, which Chapter 6 does directly. However, the thesis also aims to work out what physiological monitoring can and cannot do. Crucially, this is not just about methodological validity but also about what is at stake in affect and emotion research when it meets with affective computing forms. The next chapter looks at physiological monitoring and affective computing in detail. Chapter 3 problematises much of the promise of affective technologies not with the intension of their wholesale dismissal – but with a sense of curiosity of what 'stitching' can occur when technological produced data' thread' is available.

Conclusion

This chapter works to establish a sound basis for an affective practice understanding of affect and emotion. It does this by starting with the psychological evidence relating to emotion and then interrogating inquiries into affect. Within Wetherell's concept of affective practices, this chapter finds an approach to affect that rejects the schema of basic emotions, a theory precipitated on the claim that all bodies produce discrete packages of emotions, each with distinct names corresponding neatly to conventional Western emotion descriptors (J. Russell and Barrett, 1999; Wierzbicka, 1999; Barrett, 2006; Barrett *et al.*, 2007; Lindquist *et al.*, 2012; Gendron *et al.*, 2014). Given that the evidence for any basic or biological basis for emotion is flawed or cannot be reproduced, research that can be traced back to basic emotion assumptions can and should be called into question. Barrett claims the basic emotion view sustained itself as a 'result of an error of arbitrary aggregation' whereby 'our perceptual processes lead us to aggregate emotional processing into categories that do not necessarily reveal the causal structure of the emotional processing' (Barrett 2006 p.29). Simply put, the socialisation and categorisation of emotion generated categories that have been presumed to be biological. Correspondingly, I contend that the basic emotion model has become a circular self-sustaining limit on our understanding of and our potential to understand affect and emotion.

Instead, it is possible to proceed from a more spacious understanding of affect through affective practices. The affective practices approach is not a methodological dictate. Although it does rehabilitate discourse within affect studies; it is instead a way of thinking about distributed social relations involved in experiences that are affective and affecting. It is rooted in understandings of emotion and effect that are not always neat or easy to contain. Wetherell argues that this attends to the reality of the psychological evidence and the human act of meaning-making (Wetherell, 2014). Affective practice locates feeling social actors and the past experience bring within a broader assemblage of place, time, culture(s), and affiliations. In pursuing a concern for the human practice of meaning-making within such a context, affective practice creates the space for understanding a range of affective experiences which are ‘socially consequential and bound up with ongoing social relations’ (Smith, Wetherell and Campbell, 2018, p. 5)

Chapter 2. Physiological Monitoring

Introduction

This chapter discusses the use of physiological monitoring in affect and emotion research. Whether social, cultural, political, or ethical, the implications of wearable monitoring technologies are still to be fully understood. Therefore, the chapter begins with an overview of physiology evidence and debates in the field. It then describes specific physiological metrics under consideration in this thesis - electrodermal activity (EDA) and heart rate (HR) measures. The chapter also considers the methodological challenges, as well as the ethical and social aspects of physiological data. Finally, it concludes by looking in detail at a number of research precedents.

Psychophysiology

Over a century of study has generated many positions on the role of physiological response in affect and emotion. Wilhelm Wundt introduced such measures to investigate psychological activity in *Principles of Physiological Psychology,* first published in 1873 (Wundt, 2009). In 1888, the French neurologist Féré demonstrated that the skin's electrical conductivity changed with emotional stimulation (Boucsein, 2012). In the early 1900s, Carl Jung included Electrodermal activity (EDA) measurements in word association experiments, reporting that EDA deviated in response to emotion arousal (Neumann and Blanton, 1970). Half a century later, Woodworth and Skoldberg supported this indexing relationship by noting lower EDA during sleep and higher levels during emotionally charged activities or mental work (Woodworth and Schlosberg, 1954). Investigations of heart rate and heart rate variability have been underway since the nineteenth-century, and in more recent years, interest has grown as links between cardio activity and emotional experience have been demonstrated (Tsunetsugu *et al.*, 2007; Lane *et al.*, 2009; Nakahara *et al.*, 2009; Wallentin *et al.*, 2011; Quintana *et al.*, 2012; Laundav *et al.*, 2014; Sung-Nien Yu and Shu-Feng Chen, 2015; Ernst, 2017). Interest in these measures is by no means new. Yet, as this chapter will demonstrate, interest has not translated into clear, undisputable positions on physiological data's value and meaning. Indeed, as we will see later in the chapter, new technologies have brought additional complications.

Physiological response originates in the nervous system and is grouped into those controlled by the Central Nervous System (CNS) or the Autonomic Nervous System (ANS). The CNS controls the brain and the spinal cord, whilst the ANS corresponds to the electrodermal, cardiovascular and respiratory systems. The ANS is further broken down into parasympathetic and sympathetic divisions. ANS over CNS presents more opportunity for observation, Pijeira- Diaz et al. write:

> ANS responses offer great potential for research and physiological computing since their measurement mechanisms are cheaper, faster and more unobtrusive than those of the CNS responses. (Pijeira-Díaz *et al.*, 2016, p. 65)

Two commonly considered aspects of the ANS are electrodermal (i.e., sweat gland) or cardiovascular (i.e., circulatory system) responses. Electrodermal activity (EDA), an Autonomic Nervous System (ANS) response, is one of the most widely studied response systems in psychophysiology.[5] The next section describes each in turn.

Heart Rate (HR) and Heart Rate Variability (HRV)

Measures of heart rate are common in studies of ANS specificity in emotion (Kreibig, 2010). HR is a measure of beats per minute, and HRV measures the variation in time between each heartbeat. HR has been shown to increase for both negative (e.g., anger, anxiety, disgust, fear) and positive emotions (e.g., pleasure, happiness, joy) (Kreibig, 2010). Decreased HR has shown in instances of fear, sadness, contentment, visual anticipatory pleasure, and suspense (Porges, 1995, 2001; Vingerhoets, 1985). Increased HRV has been linked to self-reported amusement and joy, whereas HRV was decreased in instances of reported happiness and visual anticipatory pleasure (Kreibig, 2010). While Cacioppo and Kreibig make a case for HR and HRV's potential involvement in emotion response, they argued that this is complicated by the fact that the autonomic nervous system has multiple roles to play in HR and HRV. The sympathetic and parasympathetic nervous systems dually innervate the heart; this is further complicated by the influence of metabolism and physical activity (Cacioppo, Tassinary and Berntson, 2007; Kreibig, 2010).

---

[5] Elsewhere, Electrodermal activity is also referred to Galvanic Skin Response (GSR), or Skin Conductance (SC). This thesis uses Electrodermal activity (EDA) throughout.

Electrodermal Activity

Electrodermal activity (EDA) indicates the level of electro conductance at the skin's surface via a measurement of sweat gland activation. EDA signal consists of two parts: the tonic and the phasic signals. Changes in tonic signal are slow and indicate the background level of skin conductance. The phasic component indicates a response to specific external stimuli such as sounds, noises, changes in light condition (Cacioppo, Tassinary and Berntson, 2007; Boucsein, 2012). EDA data itself does not indicate valence; it does not describe the qualities or category of an emotional state. EDA's relationship to emotion and affect cannot be understood without the researcher undertaking interpretation in combination with participant self-report data (Taylor, Jaques, Weixuan Chen, *et al.*, 2015; Xia *et al.*, 2015). Across the literature, the term 'arousal' is used as a deliberately non-specific descriptor of response because EDA may be driven by several different affective experiences (Cacioppo, Tassinary and Berntson, 2007; Boucsein, 2012). EDA magnitude depends on individual bodily and psychological response. A small percentage of the general population do not have a demonstrable electrodermal response (Boucsein, 2012). These individuals, persons with little electrodermal lability, are non-responders and are identified by the absence of EDA peaks in their data. This can be due to a number of factors, such as medical conditions and medications that suppress the ANS (Empatica, 2019).

Cacioppo asserts that EDA is influenced primarily in response ' to punishment, to passive avoidance, or frustrative non-reward (Cacioppo, Tassinary and Berntson, 2007, p. 167). In a meta-analysis of 134 experimental investigations on the relationship between emotion and ANS response, Kreibig found that decreases in electrodermal activity were present only in a few emotions, namely 'non-crying sadness, acute sadness, contentment, and relief' (Kreibig, 2010, p. 409). In contrast, all other examined emotions were accompanied by increased EDA (Kreibig, 2010). Kreibig's review points to the activation of EDA in many forms of emotion. Reviews of the literature indicate that categories such as anger, fear, sadness, disgust, and happiness cannot be differentiated by autonomic activity alone (Cacioppo *et al.*, 1997; John T. Cacioppo *et al.*, 2000). As a result, Kreibig proposes EDA arousal reflects motor preparation where arousal is a precursor to action. Accordingly, decreases in electrodermal activity may be understood as a decrease in motivation to act. (Fredrikson *et al.*, 1998; Kreibig, 2010). This is consistent with arguments that claim emotional response reflect an individual's values and motivation towards action (Archer, 2000; Perry, 2019).

In relation to the positions set out in chapter 1, Kreibig's findings do not support discrete approaches to emotion, affect, or physiological response. There are grounds for a significantly more generalised approach to EDA that views it as a modal response rather than a measure correlated with specific, definable emotions. However, within this position, there are still are numerous methodological issues for physiological research to overcome. It is to these that we now turn.

Methodological Issues

Kreibig's review is the most exhaustive and recent review of empirical studies exploring links between emotion and physiology. (Kreibig, 2010). As a meta-analysis, it does not tackle the challenges of conducting such research in detail other than to indicate exclusion criteria and how particular methodologies exclude studies from the analysis. While it suggests general modal relationships between reported experience and some physiological measures. It is worth understanding this review in the context of the broad issues in physiological research. In their 2014 paper *The Autonomic Nervous System and Emotion*, Levenson discussed the 'significant methodological obstacles' to be overcome before empirical studies can adequately test theories linking physiological response and emotion (Levenson, 2014, p. 100). This section highlights areas of concern in this thesis – the verification of emotional states and ANS relationships together, baseline procedures, analytical protocols, and physiological data's social and cultural contexts.

As chapter 1 detailed, positions on affect and emotion range from those that align with distinct emotions complete with specific patterns of arousal to argue for a more constructivist understanding of emotion (Scherer, 2000, 2005; Barrett, 2006; Mauss and Robinson, 2009; Kreibig, 2010). As stated in chapter 1, Mauss and Robinson found evidence for the distinct emotion model lacking (Mauss and Robinson, 2009). This finding agrees with two further meta-analyses, which find links between physiological activation and specific emotion labelling to be empirically inconsistent (John T. Cacioppo *et al.*, 2000; Lindquist *et al.*, 2012). Kreibig's meta-analysis provides some evidence for general modal relationships between reported experience and some autonomic responses (Kreibig, 2010). However, in all cases, identifying any relationship is dependent on qualitative self-reported data collected from participants (Barrett, 2006; Cacioppo, Tassinary and Berntson, 2007; Mauss and Robinson, 2009; Kreibig, 2010; Lindquist *et al.*, 2012). A physiological measure cannot be assumed to

be in a causal relationship with a specific emotion. Put simply, there are no physiological blueprints or signatures for specific emotions, i.e., fear, joy, amusement.

Kreibig's meta-analysis included empirical publications in which emotions were manipulated and physiological measures were assessed. Kreibig acknowledges the limitations of the review and describes it not as conclusive but rather as providing 'an instructive guide for future research of specific emotion contrasts and autonomic parameters that demand further empirical study' (Kreibig, 2010, p. 408). Indeed, the comprehensive review is instructive. It is worth noting that only direction (not magnitude of the response) was examined because comparisons of magnitude ultimately depend on comparative baseline procedures. Kreibig notes that establishing baseline varies dramatically across studies, making magnitude comparisons untenable (baselining will be addressed in the next section) (Kreibig et al., 2005). Instead, a modal response pattern was favoured and the direction of ANS response is used to make the assessment. The overall analysis includes various studies – discrete and dimensional approaches to emotion, studies undertaken in both lab and real-world environments. There is no analysis or comment made on these differences. Kreibig does not outline how the emotion categories used across the different studies were compiled in the meta-analysis. One wonders about the differences between joy and happiness in different studies; how distinct are the differences between each emotion in the studies considered? This highlights a core issue in physiological measurement. How can one ever presume to be measuring the same thing in different participants?

Levenson reminds us that before stringent ethical protections were in place, participants were typically placed in extreme situations thought to, unequivocally produce presumed basic emotion categories (Levenson, 2014). Given the lack of evidence for' unique and invariant' relationships between physiology and emotion (Barrett, 2006, p. 40), experiments concerned with eliciting predetermined and presumed emotion categories attempt to neaten a messy problem. Such approaches are at odds with the psychological constructivist approach in this thesis – which acknowledges multiple, overlapping affective experiences. Furthermore, in the affective practices model of affect, the emphasis is on the description and narration of experience. Identifying and labelling emotions is a necessary condition for communicating and categorising emotion. Given the evidence, working with physiological data is an interpretative process, not one of validating specific emotions. Interpretation takes place within the context of the participant's subjective experience. This is an important distinction as

such an approach does not place the digitally derived data on a quantitative pedestal. As this chapter argues, there is limited evidence to support such authority.

In addition to meta-level analyses, individual studies also reveal issues in assuming relationships between emotion states and ANS arousal. Levenson notes that little evidence has been created by either between-subject or within-subject studies to suggest that research has reached the point where comparisons between participants can be built upon a solid foundation of knowledge (Levenson, 2014). This is a vital point – Levenson claims that there is no evidence to support comparisons between participants. In citing supporting studies, Levenson draws on Mauss et al.'s comparison of perceived physiological activation and actual physiological activation. This study found that in 50 participants scored with low levels & 50 with high levels of social anxiety, the two groups did not differ in actual physiological response (Mauss, Wilhelm and Gross, 2004). The analysis found that anxiety experience was associated with perceived physiological activation for both participant groups but not with actual physiological responding. Levenson cites Buck et al. (1974) and his study with Notarius (1979) as further inter-subject studies demonstrating a lack of association between subjects. (Buck, Miller and Caul, 1974; Notarius and Levenson, 1979). This causes one to question the validity of working with physiological data in affect and emotion research.

Others have shown how participant self-report can be manipulated without changes in physiology (Valins 1966). The phenomena, first observed by Valins, has been reproduced with studies providing participants with false heart rate feedback and observing how this influences cognitive and subjective appraisal (Hirschman and Clark 1983; Crucian et al. 2000). Parkinson and Manstead found that participants rated images as significantly more unpleasant when associated with falsely accelerated pulse sound (Parkinson and Manstead 1981). More recently, Weibel et al. had participants watch horror movies and supplied them with real-time heart rate feedback (either true, lower or higher readings). In the case of those whose heart rate feedback was manipulated, participants reported stronger feelings of presence and enjoyment when they wrongly believed that their heart rate had been higher (Weibel et al. 2011). These studies demonstrate that participants can be led to discount their subjective appraisal and believe that they have had stronger emotional experiences based on manipulated physiological feedback. This issue is included here and is revisited in the methodology chapter to illustrate the degree to which participants have been shown to invest authority in physiological data. This is a point of particular interest and fascination to this

author and it serves this thesis to engage with this issue and research that has sought to intervene in the social relationships between technology and people in more detail.

Several researchers have confirmed that various stimuli can produce the same physiological response (John T. Cacioppo *et al.*, 2000; Conati, Chabbal and Maclaren, 2003; Mauss and Robinson, 2009; Pijeira-Díaz *et al.*, 2016; Sedenberg, Wong and Chuang, 2017). Studies have reported issues with signal noise, indeterminate emotional valence, and questioned the value of physiological data (Conati, Chabbal and Maclaren, 2003; Swan, 2012; Resch *et al.*, 2015; Sara Ann Taylor, 2016). While studying the use of biometric sensors for monitoring user emotions during educational games, Conati et al. concluded that it is 'not clear how effectively the sensors can detect emotions that may be expressed more subtly' (Conati, Chabbal and Maclaren, 2003, p. 1). Biosensor data has been described as 'precise yet ambiguous' by BioSENSE, the socio-physiological computing research centre at UC Berkeley. The authors continue: 'a single emotion may have different associations or spectrums for one individual compared to others' (Sedenberg, Wong and Chuang, 2017, p. 4). The implications of this for the current thesis are unavoidable. It suggests that the value of physiological measures is limited and research that presumes finite relationships between embodied affective experience and that which is cognitively parsed as emotion is unfounded. However, this is a fruitful conclusion to draw so early in this thesis. It illustrates how evidence is stacked against certain approaches and indicates that validity in pursuing a psychological constructive and affective practices model may be of value. Two questions arise here: Can an affective practices approach be reconciled with physiological measures? And, given the evidence against, why are physiological measure so pervasive? These questions are central to this thesis. With respect to the first, determining whether this is possible and how it might be achieved is central to this thesis. The second question is addressed through a critical data studies approach that shall be returned to later in this chapter.

Another essential consideration in this thesis is the establishment of participant baselines. Establishing a baseline condition is a prerequisite for making statements about the direction of ANS changes during any period under study. Most common is the 'rest' period, which at first glance seems to be a practical way to establish a participant's baseline. Many investigators adopt baseline procedures in which the subject is asked to do 'nothing' for a period preceding the experiment. Levenson questions whether a subject can comply with this instruction, and claims that for some it might provoke anxiety (Levenson, 1988). Instead,

Levenson claims that the most useful baseline for 'any biological system is representative of the modal level of activation for that system, taking into account its normal range of functioning' (Levenson, 1988, p. 24). They argue that in investigating ANS responses, we should consider baseline procedures that produce moderate levels of ANS response:

> There are both methodological virtues associated with using a baseline activity that produces a moderate level of ANS activation. From the standpoint of methodology, starting with the ANS in the middle of its range of activation opens the possibility for change in both the increase and decrease directions, without immediately running into biological floor and ceiling limits (Levenson, 1988, p. 24).

As Kreibig shows, incompatible baselining methods can limit comparisons between studies (Kreibig, 2010). To understand physiological response, a baseline that avoids a fabricated 'rest' period and enables bidirectional observation seems more useful. This is relevant to this thesis, as its participants are located within a dynamic public museum space. They also come with their own previous experiences and preconceptions of that space that influence their initial state. A rest period baseline may create a false lull in their ANS. On the other hand, the anxiety of 'rest' may increase ANS activity. Baselining based on a 'rest period' is itself an intervention. As Levenson suggests, it may be more beneficial to undertake baselining that is more aligned with normal functioning in an environment. In a museum, this might be walking towards and between galleries.

Futhermore, there exists a solid foundation of research that outlines clinical HR and HRV analysis procedures (Lane *et al.*, 2009; Laundav *et al.*, 2014; Ernst, 2017; Shaffer and Ginsberg, 2017; Massaro and Pecchia, 2019) as well as studies that focus on HRV in real-world ambulatory environments (Tsunetsugu *et al.*, 2007). There is less agreement on the analysis of EDA physiological measures (Levenson, 2014). While there are lab-specific experimental and analytical procedures and publication standards for EDA data, no well-established methodological protocols for ambulatory EDA monitoring exist (Dawson, Schell and Filion, 2001; Boucsein *et al.*, 2012). This section looks at analysis precedents in lab research – peaks per minute and amplitude analysis. It discusses standardisation, the complications arising from ambulatory research, and the differences in analyses concerned with individual or group-level comparisons.

EDA data of multiple individuals cannot be compared or aggregated in its 'raw' form. Individuals exhibit a unique EDA range; 5 micro siemens may be high for one person but an average for another. EDA data may require transformation before they can be analysed. EDA can be non-normally distributed and can display signs of skew and kurtosis. The first step in analysis is to establish skew and kurtosis measures if these dimensions are satisfactory or parametric analysis is not required, then no normalisation corrections need be applied. Normalisation, where data is corrected for skew or kurtosis, is not indicated with between-participant comparisons but is useful should one wish to carry out parametric statistical analysis at an individual-level (Dawson, Schell and Filion, 2001; Boucsein *et al.*, 2012).

In any aggregated or group analysis, EDA data must be standardised to be compared between individuals. Some studies opt for a variance-based analysis, this process is known as a range correction (Dawson, Schell and Filion, 2001). This form of analysis is derived from working out a range between an imposed rest period and the maximum EDA level during observation. As we might expect given the previous discussion in this thesis, this is problematic due to the need for a rest period baseline. Another form of standardisation is achieved through the amplitude analysis described above, but as has been stated, this is most suited to lab conditions. Elsewhere standardisation of EDA data captured from ambulatory participants has been achieved by transforming EDA data into Z Scores (Shoval, Schvimer and Tamir, 2018; de Looff, Didden, *et al.*, 2019)**.** As a form of standardisation, a z-score is the number of standard deviations from the mean any given data point is. Standardising this way creates a measure that can be used to compare and aggregate individuals' data. Importantly, this method has been proven in ambulatory studies (Shoval, Schvimer and Tamir, 2018). The research precedents section below will discuss this and other ambulatory studies in more detail.

Lab-based EDA research favours either a peak per minute detection (PPM) or an amplitude analysis when considering individual data (Benedek and Kaernbach 2010; Boucsein et al. 2012; Taylor et al. 2015). Of these parameters, PPM may be used to determine periods of arousal. One issue with PPM is that peaks may occur in rapid succession, which often cuts the rise time and obscures magnitude. One way to avoid this issue is to calculate the area under the peak, determine and subtract the tonic baseline, and then use the area calculation to understand the EDA response – this is known as an amplitude analysis (Benedek and Kaernbach 2010). However, both PPM & amplitude analysis were developed as forms of

analysis in studies conducted under lab conditions with rest period baselines and controls on participant behaviour. For example, participants may be asleep or subjected to stimuli in a controlled environment and given time to return to a resting baseline before another stimulus is introduced (Boucsein et al. 2012; Taylor et al. 2015; Sano, Picard, and Stickgold 2014). Amplitude analysis relies on periods of imposed 'rest' between stimuli where the participants' EDA is given time to drop. As has been noted already, while enforced rest creates a more pronounced rise and falls in EDA, as a form of baselining it can skew data (Levenson, 2014). PPM also has issues – standard PPM analysis draws on publications standards for determining an EDA peak where a rise of 0.5 micro siemens within 3 seconds is seen to represent a peak (Boucsein *et al.*, 2012). Historically this threshold represents the smallest shift visible on paper chart recorders. Advances in technology have led to some studies deploying lower thresholds or individual peak parameters[6], but these do not currently meet the recommendations (Boucsein *et al.*, 2012).

Finally, a further complication arises from the fact that the research precedents for psychophysiological research are overwhelming lab based. As Dawson, Schell, and Filion have written, agreed standards do not exist for analysing skin conductance in ambulatory assessment research (Dawson, Schell and Filion, 2001). Wac and Tsiourti's meta-analysis of studies where ambulatory physiological monitoring was used to evaluate participant emotions found that measures of skin conductance, heart rate, and blood volume pulse were all found to be valid, in so much as changes in these metrics could be linked to self-reported changes in emotion states but not specific emotions (Wac and Tsiourti, 2014). Wilhelm and Grossman review of ambulatory methods concluded that linking experience to physiology requires contextual information, such as the participants' self-reported emotion states (Wilhelm and Grossman, 2010). Wilhelm and Grossman point to ambulatory studies' further challenges: that participants can move freely, thus increasing noise in the sensor signal. The authors also point out that in studies that wish to take a situated, environmental approach to participants' emotions, difficulties are to be had, not just in the absence of research controls but also in the variety of individual responses and biological functions. They suggest a semi-structured ambulatory format to help elicit some form of control over this challenge and suggest lengthy recordings of participants physiology (c. 24 hrs) to establish an ambulatory baseline.

---

[6] Setting individual peak parameters, for within single participants analyses, would involve collecting multiple sets of data for a participant over several days. The counting and

Critical data and wearable technologies

This chapter has covered a wide range of research and detailed challenges inherent in physiological research. Up till now, it has approached this from the perspective of the physiological literature. The intention was to interrogate the evidence and understand what relationships have been suggested and evidenced by physiological research. This investigation opened a methodological can of worms from which the issues in this chapter sprung. This section takes a different tact. It turns a sociological eye on physiology monitoring technology and the data it produces. This section works to create a deeper understanding of such devices and the data they produce. It does this through an engagement with both conceptual debate, empirical evidence, and frameworks developed in critical data studies.

Sociologist Deborah Lupton has argued that technological tools are often surrounded by a sense of heightened authority, which contributes to framing the data they produce as containing informational truths about society and sociality (2014, p. 101). In the inaugural issue of *Ada*, the Journal for Gender, New Media, and Technology, Kember wrote of technology:

> we are still learning to think outside of the terms of all or nothing and to regard it, in short, less as an independent agent – that will either supersede us (in intelligence, in the evolutionary stakes) or act as a panacea on our behalf – and more as a co-constituent of what we call human — a form of agency that we work and are simultaneously worked with (Kember, 2012, p. n.p.).

Such a view speaks to the imagination of what such technology can do rather than reality. In their introduction to *Quantified: Biosensing Technologies in Everyday Life*, Nafus touches on the issues Kember identifies. In particular, they express concern that such enumeration of human experience may become 'social control masquerading as science' and fuel a 'soulless abstraction of bodies into bits' (Nafus, 2016, p. xii). Much like Kember, Nafus believes that it would be a grave error to think of sensing technologies as finished products and claims that technologies are 'never a done deal' (Nafus, 2016, p. xii).

Despite these tensions, Nafus does not dismiss biosensing; rather they appeal for open, generative approaches that work within the space created by critical appraisal and concern with the ethics of seeking to understand the body through sensing technology (Nafus, 2016).

This position understands the interaction between body and sensor as a site of negotiation, contestation, and which may require, where necessary, defence of the body in instances where data obscures or loses sight entirely of persons, aspects of personhood, and aspects of human experience. This thesis aligns this approach to physiological data. Demographic issues and aspects of potential algorithmic inequality are key ethical issues for this study. Such issues are well documented in relation to race, poverty, gender, and age (O'Neil, 2017; Noble, 2018; Eubanks, 2019). This study proceeds with a keen eye on such technologies' potential to fail to serve certain demographics.

In addition to critical issues of social justice, there are calls for a more considered approach to novel forms of data. Technological tools are often presented as part of a technologically glossed future where our quotidian events can be run and measured like clockwork; efficiency is achieved to the *n*th degree and control is algorithmic. Within this condition sits both a theoretical and methodological consideration for this thesis. First, it is methodologically essential not to view these relatively new technologies as providing authority truths – as this chapter has shown, there is no evidence base for such an assumption. Fundamentally, ambulatory physiological monitoring still represents a novel mode of generating data about humans. Second, the position of technology and its assumed authority reveals the power and political issues at stake in this thesis.

While it has been argued that the limits of Foucauldian discourse are reached when having pointed to the way power is enacted in a system (whether that system is an institution, research project, cultural institution, or broader society), there appear to be no further routes for progression and critique become paralysed (Bennett, 2004). Latour writes that this form of enquiry has caused critique to 'run out of steam' (Latour 2004), arguing that sociology and cultural studies have inflicted a fate on objects, where 'explanations resorting automatically to power, society, discourse had outlived their usefulness' (Latour 2004 p.229). However, this thesis argues that conceptualising technology in this manner is not a reactive or regressive act, nor does it exhaust critique. This thesis takes the view that data, all data, are cultural and social artefacts. There exists a wealth of empirical evidence to support the theoretical concerns put forth in this section. Before turning to these examples, this section ends by setting out a critical approach to data that informs how these studies were reviewed.

This thesis draws on the concept of critical data studies to hold a conceptual debate in conversation with methods (Boyd and Crawford, 2012; Dalton and Thatcher, 2014; Kitchin and Lauriault, 2014; Dalton, Taylor and Thatcher (alphabetical), 2016; Lupton, 2016; Beer, 2017). In particular, the practical form of critical data enquiry put forth by Dalton and Thatcher suggests methodically useful ways to approach novel data. Dalton and Thatcher set out seven key provocations for critiques of the 'new regimes of data'. They suggest a model of critical data studies which understands technology and data as bound up in historical and contextual relationships where data are never neutral. Instead, data and technology are in a recursive, non-deterministic relationship with society and are never 'raw', always cleaned, modelled, cleared, interpreted, and subject to data collection goals. Furthermore, data can be co-opted and transformed to support counter positions. Finally, the critical data studies model stresses the importance of academic engagement with novel data and its opportunities (Dalton and Thatcher, 2014). Part two of this thesis engages with the principles directly; it discusses research precedents from a critical data perspective.

Conclusion

This chapter builds on chapter 1 by continuing to foreground evidence. It explains the specific measures and methodological issues associated. It establishes debates on the role of the ANS in emotion, from the views of James and Ekman, who argued for ANS specificity, to the views of Barrett whose contemporary work has continually made a case against it (James, 1884; Ekman, 1992; Barrett, 2009). Increasingly, theories that posit discrete emotions as having distinct autonomic signatures have not fared well in empirical testing (Mauss, Wilhelm and Gross, 2004; Mauss and Robinson, 2009; Gendron *et al.*, 2014). It discusses Kreibig's review which found modal links between the ANS and emotions (Kreibig, 2010). This is suppoted by a number of studies that suggest physiology measures are best understood in terms of dimension (e.g., more or less arousal) rather than discrete emotional states (e.g., sadness, fear, anger) (Mauss *et al.*, 2005; Mauss and Robinson, 2009; Kreibig, 2010; Lindquist *et al.*, 2012; Levenson, 2014). As we have seen in this chapter, HR and HRV are under the influence of numerous biological systems and there is a lack of evidence to tie EDA, HR, or HRV to specific emotions (Mauss et al. 2005; Mauss and Robinson 2009; Friedman and Kreibig 2010; Kreibig 2010; Levenson 2014). As we have seen there is a large degree of variance across studies but relatively sound support for general dimensional relationship between the ANS and emotional arousal (Barrett, 2006; Mauss and Robinson, 2009; Kreibig, 2010).

The methodological challenges and conflict present in the debates presented in this chapter should not be underestimated. In this sense this chapter draws on existing research and debates to inform its approach to a novel and necessary investigation. As the chapter argued, it is crucial to acknowledge the inherent dangers of the fetishisation of technology and data. Novel forms of data are not neutral and often the cultural imagination of technologies implies they can create forms of knowledge that does not match up with the reality. Lupton highlights issues in how data is socialised and interpreted in relation to the individual, calling attention to the way such data is 'conceptualised, used, and interpreted as part of subjectivity, embodiment and social relations' (Lupton, 2016, p. 6). Given the complexity of the issues discussed above, it is useful to have a means for *thinking through* novel forms of data before *thinking with* it. This is the remit of part two.

Part One: Conclusion

Part one aimed to reach a sound theoretical and operational understanding of emotion, affect, and physiological response. The intention was to analyse an interdisciplinary body of evidence in order to inform and build a coherent and robust research design.

Chapter 1 lays the groundwork for a pragmatic approach to affect. Through a sustained engagement with debates in affect studies and the psychological evidence, the thesis settles on Wetherell's idea of affective practices. This thesis draws on evidence to reject approaches to affect that explicitly or implicitly rely on the theory of basic emotions. Affective practices revive human acts of meaning-making within a broader affective assemblage – not at the exclusion of historical patterns, broader cultural contexts, nor in service to a 'dubious chronology' (Smith, Wetherell and Campbell, 2018, p. 1) Affective practice is a means of making sense of a combination of embodied, cognitive, social, cultural, and locative affects.

Chapter 2 provides an overview of physiological monitoring, the methodological issues, and the evidence for and against relationships between physiology and emotion. The challenges inherent in physiological monitoring are made even more difficult by the lack of an agreed standard for dealing with physiological data. Chapter 2 also makes a claim for a critical data studies approach to physiological data. It outlines the tenant of critical data studies put forth by Dalton and Thatcher. This chapter's discussion aims to establish a critical perspective on physiological data. Such an endeavour seeks to offer a pragmatic understanding of

physiological data before any claims for its value as socio-psychological data can be established. Those sceptical of such an approach may ask why draw on critical data studies in this way?

To ignore critical data studies would create a key omission in the thesis. Given the methodological obstacles involved in physiological data, one might reasonably ask why such data is still evocative and appealing? Through a critical data approach, this question is addressed in part two. Furthermore, between affective practices and critical data studies lie essential similarities. Proponents of critical data studies make claims that are not out of place within the claims that Wetherell makes for affective practice. Kitchin and Lauriault argue that one way to enact critical data studies would be to view data as part of a 'data assemblage', where such an assemblage is a 'complex socio-technical system' which transforms as

> new ideas and knowledges emerge, technologies are invented, organisations change, business models are created, the political economy alters, regulations and laws introduced and repealed, skill sets develop, debates take place, and markets grow or shrink. (Kitchin and Lauriault, 2014)

Elsewhere Smith, Wetherell, and Campbell write of affective assemblages that they are 'socially consequential and bound up with ongoing social relations' (Smith, Wetherell and Campbell, 2018, p. 5). This is not just a matter of a shared voculary, the idea of ongoing, dynamic, and socially recursive relationships between affect, emotion and the value of physiological data is central to this thesis. Both data and affective assemblages are always in a state of becoming. The point here is not to obtusely conflate two similar conceptions of different social phenomena. The point is to draw attention to the overlap in these approaches that make them compatible and interesting ways to think through the data under consideration in this thesis.

This thesis is, as chapters 1 and 2 demonstrate, acutely aware of the interdisciplinary relationships involved in this research. What part one brings forth is that there are ways to think about an affective experience that can be commensurate with the challenges of emotion, are open to exploratory approaches to tools and methods, and draw on a coherent range of sociocultural theory. Overall, this offers clear and pragmatic contributions to this thesis in terms of its theoretical basis and methodological challenges. Part two continues in

this vein: it focuses on key studies with ambulatory physiological monitoring components and summarises research on relevant studies of visitor emotion and experience.

Part Two: Research Precedents

Introduction

Chapter 3 discusses a range of disciplinarity approaches to ambulatory physiological monitoring. It does this by looking at studies that deploy wearable physiological monitoring devices in a range of ambulatory settings. The chapter discusses examples from studies concerned with the urban environment, affective computing, empirical aesthetics, and museum visitor experience. These examples chime with the psychological and physiological evidence detailed in part one and explore what values are at stake in approaching affect and emotion through affective practices and physiological data. It is not intended as, nor could ever be, a comprehensive survey of the ways ambulatory physiological monitoring has been used. Instead, this thesis prioritises the evidence-based position established in part one.

Chapter 3, through its sustained consideration of the validity and reliability of the technology used in this study, works to further the critical approach to the technology and data proposed in part one. Chapter 4 considers the museum as a space of multiple affective relationships. It views the museum as part of the context of the physiological data collected in this study. As a result, it discusses museum policy today and the relationship of physiological metrics to said policy. It also draws on precedents in museum and heritage studies to understand the connections between this thesis and extant research in that field. Finally, it discusses a method for understanding how visitors talk about their experiences.

Chapter 3. Ambulatory physiological research

Introduction

The growth in smaller and cheaper wearable biosensors has prompted an increase in interdisciplinary studies investigating physiological response outside of a laboratory setting. Amongst these studies, one can find authors who identify as geographers, psychologists, scholars of tourism and heritage, affective computing researchers and computer scientists (Nold, 2009; Tröndle *et al.*, 2012; Kappeler-Setz *et al.*, 2013; Kim and Fesenmaier, 2015; Resch *et al.*, 2015; Picard, Fedor and Ayzenberg, 2016; Pijeira-Díaz *et al.*, 2016; Sara Ann Taylor, 2016; Shoval, Schvimer and Tamir, 2018). This chapter looks at several precedents and discusses them as part of the context within which this thesis sits. The studies confirm a sensor's ability to indicate some forms of arousal that can relate to participant-reported changes in feeling in some but not all cases. Of course, this is not without issues, and this chapter attends to these issues and unpacks studies from a critical data perspective.

Urban environments

Resch et al. led a research programme intended to integrate human emotional response into urban planning. Their results are described as an 'anthropocentric approach for understanding complex spatiotemporal dynamics and interactions' (Resch et al. 2015 p.221). Resch et al. argue that 'emotions measured by technical sensors cannot be unambiguously correlated with a person's actual emotion (the type of emotion) and the cause'(Resch et al. 2015 p.203). In response to this issue, Resch et al. develop an app that allowed the participant to enter and record emotions in real-time as they walk through the urban environment.

On the face of it, this is perhaps useful. The participant is given a list of emotions to choose from (pleased, angry, afraid, sad, surprised, and shocked) and asked to associate these to a context (traffic, safety, advertisement, tourism, or other). As this is a study concerned with urban planning, this thesis will not take issue with the remit of these emotion terms. It is, however, worth noting that the study did not report on the demographics of participants. Data were aggregated, and any sense of difference pertaining to race, gender, sexuality was omitted. The different experiences of diverse groups in the city space did not feature in the published analysis. This may be a wholly unfair criticism – one expects such work would likely

follow the testing. However, this thesis argues that the focus on a technological solution (an app) to address the issues in interpreting physiological data creates a slippage that elides the complex nature of ANS response and psychological evidence discussed in part one. The rush to deploy sensors results in technological solutionism that does not reflect the complicated nature of the EDA data and emotion reporting. What is needed is research that engages with these issues, placing the social and cultural construction of technologies and the physiological evidence in the foreground. This reflection draws on critical data studies provocations – thinking through technology in this way reveals assumptions that should be addressed in a pragmatic research design.

In another study, Shoval et al. combined the spatial and standardised EDA data of 68 tourist participants who walked through Jerusalem's central areas. After EDA data was standardised and transformed into Z-scores, comparisons between participants and specific locations of higher EDA were identified. When interpreted in the context of the participants' location-tagged self-report data (also collected via an app), these areas were associated with areas of perceived danger or religious significance (Shoval, Schvimer and Tamir, 2018). In coupling this data, the team wrote they could identify 'emotionally evocative' places in the city. Areas with lower EDA fall into 'two general categories: sites characterized by visual or aesthetic pleasure and leisure areas/rest stops along the way' (Shoval, Schvimer and Tamir, 2018, p. 12). Shoval et al. give a breakdown of their sample's demographic but do not explicitly mention whether participants were first-time visitors to Jerusalem. This is significant as EDA is higher in novel experiences (Boucsein, 2012). Furthermore, the sample is predominantly Christian (42.65%), comment is made on the sites of religious significance being those related to the Christian faith, but this is not broken down in detail to explore differences between faiths.

In each of these two studies, EDA data was collected continually on a second-by-second basis. EDA data were then combined with real-time survey techniques and time and location data to aid interpretation. Usefully, both studies indicate the importance of tracking to interpret ambulatory physiological data. It is impossible to get a sense of how invasive the real-time survey might have been for participants. Nonetheless, these studies usefully illustrate how physiological monitoring has been deployed in urban environments. They reveal the extent to which a critical data approach can usefully hold such research to account. This is vitally important if one wishes to use physiological data as a means to quantify human experiences.

The following section approaches this same issue from the perspective of affective computing.

Affective computing

This chapter now turns to affective computing. Within this field lie crucial epistemological conflicts. In addressing these conflicts, Boehner et al. argue that affective computing research largely treats 'affect-as-information' and operates under the assumption that this information can be algorithmically interpreted and sorted into discrete emotion categories (Boehner et al. 2007). Such an approach views physiological data as a neutral representation of affect where affect is correlated with specific emotions. As founder and director of the Affective Computing Research Group at the Massachusetts Institute of Technology (MIT) Media Lab[7], Picard's develops technological tools that generate objective measures of affect, where physiological arousal is described as affect.

Picard cites the development of wearable sensor technology as key to determining states of affect and their involvement in the process of learning (Picard et al. 2004 p.264). Picard laments the variety of approaches to affect and emotion bemoaning the 'generalised references to constructivist theorists' and cites Ekman's theory of basic emotions to support their position (Picard *et al.*, 2004). In an attempt to create a more objective understanding of the relationship between affect and emotion, they set out to build 'tools and technologies that elicit, sense, communicate, measure, and respond appropriately to affective factors' (Picard et al. 2004 p.254). Picard believes new technologies 'play a particularly important role in these efforts, helping us to measure, model, study, and support the affective dimension of learning in ways that were not previously possible' (Picard et al. 2004 p.254). Picard suggests this is possible because their work goes beyond:

> classical armchair observations and thought experiments with the development and use of new technologies that help elicit, sense, measure, communicate, understand, reflect upon, and respond to emotion in learning situations. (Picard et al. 2004 p.255)

[7] Picard is also Chief Scientist at Empatica, who manufacture the devices used in this study, Empatica is an MIT spin-off.

As in the previous section, here lie problematic assumptions about the data's validity and neutrality: the elephant in the room is the issues inherent in physiological research. One charge against this affective computing view is that it elides the issues and evidence in emotion research and physiological research (see chapters 1 and 2) by focusing on neat, quantifiable metrics.

Picard discusses a device developed in their lab: the Galvactivator, an EDA monitoring device that lit up with increases in EDA:

> We observed classrooms of students wearing these, where the light glowed brightly when they were engaged in discussing ideas or writing in their journals and went dim (for many of them) when they were lectured to (Picard *et al.*, 2004, p. 257).

From this, Picard concludes that EDA changes with respect to attention and engagement (Picard *et al.*, 2004). This is a neat conclusion but avoids much of the complexity that dogs EDA research and findings. These types of invariant conclusions are not supported by the evidence put forth in chapter 1. Along with several other researchers, this thesis takes issue with this presentation of EDA (Barrett, 2006; Mauss and Robinson, 2009; Kreibig, 2010; Wetherell, 2012). EDA is an indicator of ANS arousal without relation to specific emotions or cognitive processes. Part one established, while some modal relationships have been suggested and EDA indicates the sympathetic nervous system's activation, this is independent of the cause (Dawson, Schell and Filion, 2001; Barrett, 2006; Kreibig, 2010; Boucsein, 2012).

Computer scientists within the affective computing field are not uniformly aligned with Picard's view. More recently, biosensor data has been described as 'precise yet ambiguous' by BioSENSE, the socio-physiological computing research centre located within the School of Information at UC Berkeley; the authors continue:

> Biosensors are increasingly able to produce readings with many significant figures, yet the high-level inferences drawn from these raw signals will be context-dependent and highly ambiguous. For instance, a single emotion may have different associations or spectrums for one individual compared to others. (Howell *et al.*, 2018)

Howell et al. argue that as biosensing technology is increasingly used in emotion research, such tools are increasingly seen to 'promise authoritative insight by presenting users emotions as discrete categories' (Howell et al. 2018). Howell et al. extend this argument by exploring how biosensing devices propagate forms of biopower and normalise biometric surveillance via their assertions to truth and offer of 'actionable insights', the consequences of which are that the 'shape our cultural imagination about what data is and what it can do' (Howell et al. 2018, p.1).

As part of research within the BioSENSE Lab, Howell et al. took great pains to design a project that enabled participants to interpret their biological data and feel comfortable critiquing the displays (i.e., they attempted to design against the Valins effect). To achieve this, they designed a discrete form of biofeedback named 'Ripple'. It is worth considering this experiment in more detail because it speaks very clearly to the social construction of technology. Ripple was a shirt with integrated EDA sensors that provided feedback changes in real-time via subtle colour changes in the conductive thread woven into one sleeve. The team drew on Boehner et al.'s critique of affective computing to design their analysis process. Boehner et al. propose an alternative theoretical perspective that treats affect-as-interaction and emphasises how emotion is situated in and rises from sociocultural context (Boehner et al. 2007). Such an approach is in line with Verbeek's theory of technological mediation, which argues that rather than view technologies as material objects opposed to human subjects, we might instead understand such tools as mediators and producers of human-world relations (Verbeek 2006). Howell et al. agree and extend this argument to claim that this approach enforces basic emotion theory and ignores the 'socially constructed and performative nature of emotion' (Howell et al. 2018).

Howell et al. designed their study, collecting data by observation, qualitative semi-structured interviews, participant diaries, mathematically coding participants' subjective responses and analysing EDA at an individual-level in the contest of the subjective data. Seventeen participants wore Ripple for 8-10 hours over two consecutive days. Despite the team taking care to explain that EDA is a response to only some kinds of arousal and that the degree of responsiveness varies across people, some participants linked lower frequency of response to being a 'less' emotional person. The researchers also observed that 'by calling attention to moments of excitement, Ripple also called attention away from calmer moments' (Howell et al. 2018, p.5). Feelings of calm, which would not be associated with a change in EDA did not

feature in the participants self-assessments (Howell et al. 2018, p.5). This leads Howell et al. to conclude that 'despite our attempts to invite critical questioning, some participants seemed to invest a potentially harmful degree of authority in the data display' (Howell et al. 2018, p.8).

Overall, Howell et al.'s study is an essential departure for affective computing – one that has resonance with the theoretical and epistemological position of this thesis. This study demonstrates how culturally ingrained views on technologically captured data can position it as competent to speak an absolute truth. It also speaks to the power relationships inherent in the quantification and regulation of our personal data. Meanwhile, the contrast of Picard's approach is striking. This contrast illustrates the difference in epistemological allegiances and approaches to the role of technology in studies of emotion and affect. This section brings the debates in chapter 1 into a clear methodological context.

Empirical aesthetics

As this chapter has shown, the allure of physiological measurement is transdisciplinary. We now consider a study that recorded ambulatory physiological data of museum visitors. Tröndle and Kirchberg undertook a five-year study called: eMotion, which aimed to examine the physiological, social, psychological and aesthetic components involved in museum visitation. Tröndle and Kirchberg were motivated by their claim that only since the 1990s have 'systematic visitors studies … been broadly accepted as a valid and reliable method in the field of museum studies' (Tröndle *et al.*, 2012, p. 103) and that such work is not well regarded as it takes time, money, and professional expertise.[8] Usefully, they note the difficulties associated with defining and measuring the 'effectiveness' of an exhibit. They also claim changing priorities have hindered methodological progress - specifically noting a recent shift within visitor studies from the individual interaction to the 'impact of museums visits on well-being.' (Kirchberg and Tröndle, 2012, p. 437). They also take aim at qualitative visitors studies, arguing that such work is built upon 'certain disciplinary biases' and that the resultant studies 'have one unique purpose, following their disciplinary or methodological origins.' (Kirchberg and Tröndle, 2012, p. 448). Tröndle and Kirchberg state that research drawing only on questionnaires misses immediate reactions. They set out to establish whether an interdisciplinary group of researchers could formulate a methodology that would combat the

[8] The authors note that these comments reflect German speaking countries, where they are based.

problem of disciplinary bias as they saw it. In response, they suggest that physiological monitoring metrics are neutral and objective means to overcoming such biases.

Tröndle and Kirchberg owe and acknowledges a debt to the field of empirical aesthetics. The authors note the lineage of their work and argue that previously empirical aesthetics has been confined to laboratory studies, whereas their field research dealt with 'manifold influences on the data from an uncontrolled environment' (Kirchberg and Tröndle, 2015, p. 182). They continue:

> Our research team—technical experts, programmers, psychologists, art theorists, sociologists, museum staff—worked two years to surmount this problem, developing our measurement device (the electronic glove) and complex algorithms to handle the data. Both approaches were only possible by utilising the latest technology and high-speed computers. (Kirchberg and Tröndle, 2015, p. 182).

This development period, the breadth of expertise and capacity of a large research team, gave rise to several papers associated with the project, which consider the technical and methodological challenges and present the project's findings. (Tröndle *et al.*, 2011, 2012; Tschacher, Greenwood and Kirchberg, 2012; Tröndle, Kirchberg and Tschacher, 2014; Kirchberg and Troendle, 2015). This section draws on these to summarise the project methodology and its findings.

eMotion compared and layered different data sets. This included: tracking data, heart rate, electrodermal activity, self-reported experience collected via surveys. The technical infrastructure demands of this are described as 'complex' (Tröndle *et al.*, 2012, p. 111). The team designed a 'data glove', which consisted of a tag for tacking and two physiological sensors (heart rate and electrodermal response). Physiological variables captured included heart rate (HR) and electrodermal activity (EDA), and from these variables, their levels of variability were also calculated (HRV & EDV). Tracking was performed via the Ubisense tracking system, which through a combination of sensors in the exhibition, the tag within the wearable glove, a dedicated server and network were able to track the visitors in real-time with an accuracy of 15cm (Tröndle *et al.*, 2012). Participants' location data was collated with their physiological data; significant heart rate changes or skin conductance were plotted on the map.

The accompanying survey consisted of a Likert scale, closed questioning, administered at entrance and exit. Survey responses were thematically coded, and a single, dominant codified form of experience established for each participant. This coded experience type was used to establish statistical relationships with the physiological measures. The three established experience types were reduced to three categories: contemplative, enthusing, social. The study found that pre-visit expectations did not match up with those appearing in the post-visit survey. Visitors anticipated experiencing surprise, sensationalism, and reflection but later claimed to have experienced: fame, familiarity, and silence. Statements such as 'this artwork made me think' and 'this artwork moved me' were positively related to the contemplation of experience. Social visitors were more likely to experience laughter, and enthusing visitors were much more likely to indicate that artworks made them feel happy (Kirchberg and Troendle, 2015, p. 181). Tröndle and Kirchberg note that enthusing visitors have higher HRV and EDV than the contemplative types, and HRV and EDV are lowest in the social-experience visitor (Kirchberg and Troendle, 2015, p. 186). Neither age, place of residence, nor education were found to influence the type of museum experience, but the authors report that female visitors were more likely to have a visit than which was coded under the social category.

In the exit survey, participants were presented with six exhibition artworks (three being those that the participant had spent the longest time with and another three randomly selected). Visitors graded statements on whether they found the artwork's properties pleasing, funny, surprising, through-provoking, emotional, scary, or provoked sadness, anger or happiness. In total, 19 different properties were surveyed (each with 5-point scales). The survey covered a wide range of emotion categories and dimensions. This survey data was subject to a principal component analysis, which reduces variables in high-dimensional data (such as that produced by Likert scales) while accounting for variance between them. This resulted in the 19 categories being reduced to five factors of 'aesthetic-emotional properties of an artwork'. These were as follows:

> Aesthetic Quality (the work is rated as pleasing; beautiful; well done with respect to technique, composition, and content); Surprise/Humour (the work is considered as surprising; makes one laugh), Negative Emotion (the work conveys sadness, fear, anger), Dominance (the work is experienced as dominant, stimulating) and Curative

> Quality (the work is well-staged and hung, suitable in the context of other artworks). (Tschacher, Greenwood and Kirchberg, 2012, p. 99)

The averages of these five properties were calculated for each participant's data. Also calculated were the participant averages of the four physiological variables. In this analysis, three of the four physiological measures were associated with the aesthetic experience of specific artworks. Modal relationships were found between HR and Dominance ($p = .017$) as well as HR and Curative Quality of artworks ($p = .075$), in addition to relationships between HR and Gender ($p < .0001$) and Age of participants ($p = .014$). HRV was linked factors Aesthetic Quality ($p = .00$ l) and Surprise/Humour ($p = .011$). Changes in EDV were indicated in Dominance ($p = .025$) and Age ($p < .0001$). Changes in EDA were only shown to be in relationship with Gender ($p = .257$) and Age ($p < .0001$). With only EDA associated with the aesthetic-emotional factors, the author notes that over 96% 96% of its variance remained unexplained within their models, and they cite this as a result of 'properties of the participants, likely unrelated to the museum environment' (Tschacher, Greenwood and Kirchberg, 2012, p. 102).

A total of 576 participants were involved in the study. Data loss is mentioned in one paper associated with the project where the number of participants is reduced due to network malfunction: Valid data were sampled for 373 visitors of the subset of 517 participants that were of concern in *Physiological Correlates of Aesthetic Perception of Artworks in a Museum* (Tschacher, Greenwood and Kirchberg, 2012). Participants moved freely through one exhibition, held in a contained exhibition space, containing 11 artworks at Kunstmuseum St. Gallen, Switzerland. Groups of over 6 or tour groups were discounted, and the sample included a non-gloved control group to establish the potential intervening effect of the glove (this is reported to have had a small to minimal effect and is not considered in detail) (Tröndle *et al.*, 2012).

eMotion represents a significant research undertaking and demonstrates significant investment in the potential of physiological investigation of museum visitor experience. Through its complex statistical analysis, it gets further and further away from the individual emotion experiences and what the visitors felt is compartmentalised into variables to build models. First, self-report data is flattened out to a single primary experience type – enthusing contemplative and social. In the pursuit of neutrality and the avoidance of qualitative biases, it

becomes impossible for museum experience to be an equally enthusing and social experience (or any other affective combination). Relationships between physiology and self-report are based on averages of the physiological measure where no mention is made of whether the data was standardised. This is less of an issue in the study where the focus is on variability (EDV and HRV) or in comparisons between individual EDA and corresponding self-report data.

A critical difference between eMotion and this thesis is that eMotion treats the museum space as a backdrop rather than an active component of the experience. The reliance on individual moments of aesthetic perception as the unit of analysis separates experiences in, what this thesis would argue is, a somewhat artificial manner. The previous section touched on how physiological monitoring in the production of knowledge also shapes and defines that which it seek to study. Here this point resonates as aspects of multiplicity, difference, nuance, and the description of the experience is lost. This is at odds with the affective practice approach put forward in chapter 1. eMotion aims to translate the type of aesthetic studies conducted under lab conditions to the museum environment. In doing so, it reduces the role of individual and environmental contexts, aspects which this thesis understands as in relation to and activated by the contextual processes and forms of entanglement that Smith, Wetherell and Campbell describe (Smith, Wetherell and Campbell, 2018). This is a point the next chapter takes further.

The use of closed questions where the emotion categories chosen follow Tomkins and Ekman's work on the universality of emotions and their expression (based on discrete emotion theory) is, as this thesis has repeatedly stated, a position that has been increasingly challenged (Tomkins, 1962; Ekman and Friesen, 1971; Barrett, 2016). This touches on the discussion of discrete and dimensional approaches to emotion which are a core thread running through this thesis and are central to the construction of this thesis research design which shall be discussed further in the forthcoming methodology chapter.

Saliently, the eMotion team note the limitations of their methodology was the reliability of physiological measurements (Tröndle *et al.*, 2012). As this chapter has discussed, while heart activity and skin conductance are linked to cognitive and emotional arousal in lab conditions, there is no broad agreement on assessing these variables in ambulatory studies. The analysis described were contingent on tracking visitor movement. The eMotion team

suggests that their results indicate 'a partial yes' in favour of such investigations (Tröndle *et al.*, 2012, p. 130). They make this claim based on the variability of these variables in specific regions of the exhibition linked to self-reported assessments of the artworks in these locations. eMotion supports the view that physiological data has value as an indicator that something is happening in the physical body but clearly shows that understanding this arousal and any relationship it may have to potential stimuli depends on self-report data.

Other studies in museums

Since eMotion, there has been little published research where ambulatory physiological monitoring has been deployed in the museum. While neither were conducted on the same scale as eMotion, this section looks at two papers that feature the physiological monitoring of museum visitors. The first was led by marketing academics who sought to understand the museum visitor EDA at group-level. The Museum of Science, Boston, published the second paper. It discusses their in-house exploration of various methods used to understand visitor emotions.

In the first paper, the concern is for understanding visitor' satiation', which in their context is represented by 'a gradual decrease in visitor attention, emotion, and enjoyment to a point when the visitor is no longer interested in the museum content or the visit' (Antón, Camarero and Garrido, 2018). The focus on satiation means that the focus of this study is not aligned with this thesis. For this reason, the discussion of this paper is brief. It is included as it illustrates useful methodological issues in relation to EDA data. Seventy-five undergraduate students participated and were randomly assigned to one of the four conditions. Satiation is explored through two manipulated variables: time spent and the involvement of anticipation. The experience was a guided tour of a new exhibition, which participants had not visited before, at the University of Valladolid's Museum.

This study measures included a self-report questionnaire given at the end of the visit and EDA responses gathered during the visit. Time spent was manipulated by varying the time of the tour. This results in comparisons between c. 15min visits and c.25min visits. Anticipation was also manipulated through variations to the tour. Visitors in the high anticipatory condition were given five minutes before the tour to 'walk freely around the two rooms so that they could gain a general understanding of the content'; during the guided tour, the participants were given 'a quick visual tour, but not to the full explanation of the content' (Antón, Camarero

and Garrido, 2018, p. 56). Participants in the non-anticipated visit were given five minutes at the end of the guided tour for a free visit.

EDA data were collected using a device developed by the University of Valladolid and now marketed through a company called Sociograph. The Sociograph device records the global EDA of a group of individuals processes the signal to output a single response referred to as group electrodermal activity (EDAg). Usefully, it can parse EDAg into tonic and phasic signals. However, while researching Sociograph, it has not been possible to establish how EDAg is compiled.[9] Without understanding the analysis protocols in this study and the standardisation that may or may not be occurring within the data, it is difficult to engage with the study in detail. Finally, EDA has been shown to decline with age (Gavazzeni, Wiens and Fischer, 2008). Therefore, any results in the study apply within the constraints of the sample.

In the second paper, the team at the Museum of Science, Boston, discusses in-house research, which explores methods for investigating the role of emotion in visitor experience (May, Todd and Paneto, 2018). This included exploring measures of self-report, observation, eye tracking, and EDA. The museums' Research and Evaluation department undertook this work with the intention of both understating and learning about how to influence visitors' engagement and emotional journeys. In the described experiment, visitors wore eye-tracking glasses and EDA sensors, they were videotaped, and researchers conducted behavioural observations as the visitors played with one exhibit. Immediately after, visitors completed a survey that asked them to rate given emotions on quantitative scales. This was followed by an interview asking visitors to elaborate on survey answers.

Of EDA, May et al. write that it is a useful indicator of physiological arousal but difficult to interpret without paired self-report and often influenced by motion and physical exertion. The paper discusses the methods under investigation within the museum but does not report an EDA analysis at either a group or individual level. Instead, May et al. reflect on their work and state that it has led the team to realise the importance of understanding diversity in emotional engagement and while setting emotion engagement goals for exhibits is of interest:

---

[9] Sociograph hold the patent for this system, and it is likely this information is proprietary. The company website states this is not an averaged measure and the reasonable assumption would be that it is an z-scored measure. However, this cannot be confirmed.

> Prescribing singular emotion states as visitor experience goals does not align with current thinking related to access and inclusion of diverse learners. Dimensional models of emotion have therefore taken root, seeking instead to describe emotional experiences along ranges of activation and valence while still honouring the varied labels visitors might use to describe their own emotional experiences. (May, Todd and Paneto, 2018, p. 7)

May et al. suggest that the museum's route will still take account of technological advances, but that survey and interview methods best reveal the diversity of emotion response. As a result of their investigations, the team moved towards a more dimensional understanding of emotion.

Conclusion

Chapter 3 builds on the foundations laid in part one of this thesis by looking at several studies concerned with ambulatory physiological monitoring. Examples from research in urban environments illustrate the value of locative data in combination with EDA and the types of demographic omissions that can occur. Debates in affective computing are shown to be in relation to specific theories of emotion and affect. The affect as interaction approach aligns with other key concepts in this thesis. Interaction suggests that affect is part of a larger system of influences – what we might term an assemblage. Wetherell describes the work of an affective practices approach as understanding affect as multiple and distributed parts of an assemblage of personal, social, cultural contexts. Although these understandings come from different disciplinary contexts, they emphasises some similar points: that affects are part of a larger body of interactions. This chapter works to highlight how values associated with technology and data shape affects. In this sense, the chapter also works to reveals the role epistemological differences play in the application of biosensing technology. To make a rather obvious but essential point, these relationships determine research methodologies and outcomes.

The latter part of the chapter looks at ambulatory physiological monitoring in the museum. eMotion takes a view of museum experience as an objective aesthetic interaction between visitor and artwork. They argue that it is "mandatory today to invigorate an empirical, 'bottom-up'" approach to the study of art perception (Tschacher, Greenwood and Kirchberg, 2012).

Drawing on empirical aesthetic approaches, eMotion views physiological monitoring as an objective route for visitor studies. This study is very different from the approach undertaking in this thesis. Unsurprisingly, given the position it takes against extant forms of qualitative visitor studies, eMotion does not view museum experience as contextually produced. It focuses on typifying visitors' experiences to fit them into a statistical model. However, it remains the most extensive study of museum visitor experience incorporating physiological data. For that reason alone, it is worthy of detailed consideration in this thesis. It offers a view onto a type a museum investigation that centres physiological data in a particular way - one that is more in line with Picard than Howell - where Picard draws on basic emotion theory and Howell is concerned with the range and subtleties of affective experience.

Of the two other museum precedents presented, Antón et al. undertake an investigation of EDA at group-level. While the study's aims were different to this thesis, it demonstrates limitations – namely, transparency of analysis and influence of age factors. May et al. reflect on the various methods they have explored in their efforts to understand visitor emotion. They conclude the EDA is an indicator of physiological arousal that must be interpreted with self-report data. Crucially, this has influenced their ongoing approach to emotion, which has come to align more with dimensional rather than discrete models of emotion due to the exploration of methods. May et al.'s concern with moving away from single emotion terms toward more detailed depictions of visitors emotion begins to hint at the relational, meaning-making affective processes discussed in chapter 1. Furthermore, May et al. are the only authors to consider negative emotions as part of a valid experience. As the next chapter will detail, this area is receiving increasing attention within more traditional forms of museum and heritage studies.

The role of critical data studies in this chapter is the continue thread of challenging assumptions and contextualising the data within the evidence provided in part one.
This chapter highlights and develops an essential thread running through this thesis. This is the tension between different conceptions of emotion and affect. *And* how these tensions present as critical and methodological issues across various disciplines. This works to demonstrate a range of issues within the collection and interpretation of ambulatory physiological data in different contexts. While attention is paid to the museum in this chapter, its most pressing aim is to demonstrate that methodological issues are present across a gamut of ambulatory physiological research.

The next chapter focuses on museums as spaces of affective relationships. Chapter 4 unpacks the museum as a unique context in which to record physiological data. It draws out issues in line with Verbeek's theory of technological mediation (Verbeek 2006), as it considers how physiological monitoring tools and the data, they produce function as mediators and producers of social relations in the museum. Whereas chapter 3 foregrounds the technology, chapter 4 asks what the museum brings to an investigation concerned with physiological data and affect.

Chapter 4. The Affective Museum: Context, Politics, Precedents

This chapter starts by making a link between the types of museum based physiological studies described in the previous chapter and the context of the museum today. It does this through a discussion of wellbeing and health as they relate to cultural policy. This discussion is necessarily concise and is quickly framed within contemporary discussions in museum and heritage studies, cultural policy studies, and empirical research on visitor emotion in museums. This chapter provides a necessary bridge between the theoretical and methodological concerns of this study and the location with which the thesis is concerned.

Cultural policy, wellbeing, and physiological measurement

There is a well-trodden path within museum studies literature that describes how the museum was borne out of the collecting practices, first of individuals, then of the Western European nations in the eighteenth and nineteenth centuries, and later evolved in the context of a significant expansion in public display and exhibition in the nineteenth-century (Hooper-Greenhill, 1999; Hein, 2002; Duncan, 2005; Simmons, 2016). Today, the educational role of the museum has no lesser prominence at both institutional and UK policy level; in recent years, museums have come under increasing pressure to provide government funding bodies with evidence of their value and worth (Hooper-Greenhill, 1999; Hein, 2002; Bennett, 2011; Everett and Barrett, 2011; Foreman-Peck and Travers, 2013). However, the educational role of the museum has changed in recent years. Whereas previously, museum education focused primarily on schoolchildren or formal tours for groups of visiting adults, today, education is understood more widely. Foreman-Peck and Travers write:

> Political and economic changes in the last two decades have significantly influenced funding opportunities and shaped the learning agendas of museums, instigating a drive for museums to improve visitor figures, increase access to collections and engage with marginalised communities and individuals. Greater emphasis has been placed on museums to deliver high-quality relevant services, raising questions about the purpose and benefit of museums in society. (Foreman-Peck and Travers, 2013, p. 28)

The changes that Foreman-Peck and Travers described almost ten years ago have continued despite being accompanied by continued budget cuts.[10] In this environment of austerity, museums must evidence their educational efforts, demonstrate value, meet the institution's goals and the requirements of funders.

Weil discusses the shift from prioritising internal and collection centred measures of success (i.e., quality of display and programming) to audience-centred measures (i.e., learning and social outcomes). Weil takes a view of the modern museum as a public service, which can:

> use its very special competencies in dealing with objects to contribute positively to the quality of individual human lives and to enhance the well-being of human communities (Weil, 1999, p. 231)

Ostensibly, one can understand Weil's comments as the idea that contact with the museum should improve the visitor somehow. In this exchange lies the museum's public service and a source of value. It is interesting to note that the assumption is that the museum improves and is a positive experience. This rests upon questionable assumptions about who this visitor is and their relationship to the museum environment and its collections.[11] Although I agree with Weil up to a point, I posit that this is entirely in keeping with the public museum's Western European enlightenment principles. If nineteenth-century expansion in public museums provided the new industrial working classes opportunities to extend their knowledge, thereby encouraging 'responsible citizenry' (Fleming 2008) - a common argument across museum studies (Duncan 1995; Bennett 2005; Bennett 2011; Thomas 2016).[12] Then, rightly or

---

[10] In the case of National Museums Wales, this project's partner, the organisation has been through several rounds of voluntary redundancies, budget cuts, with its operating budget reduced by a further £1m (4.7%) in 2015.

[11] The impact of collection repatriation and historical trauma and the ongoing debates about the decolonisation of museums should not be ignored – particularly in the context of the wellbeing of visitors.

[12] Three Reform Acts reshaped the British electorate between 1832 and 1884; increasing the electorate so that after 1884 the electorate has been tripled. In this context, Museums have been referred to as 'civic engines' enlisted in the task of educating a newly enfranchised electorate (Lewis 1989).

wrongly, today, museums serve another notion of personal improvement that feels entirely resonant with our contemporary context: health and well-being.

Significant attention has been paid to the role of museums as a social intervention or prescription to improve a variety of health issues (Silverman, 2009; Ander *et al.*, 2013; Chatterjee and Noble, 2016; Thomson *et al.*, 2018). Notoriously difficult to define, although many definitions have been ventured, there are many 'blurred and overly broad definitions of wellbeing' (Seligman *et al.*, 2011, p. 81). In an unavoidably broad sense, wellbeing can be understood as a multidimensional construct comprised of physical, psychological, cognitive, and social elements - within which emotion and its regulation play a key part (Ryff and Keyes, 1995; Diener, 2009; Michaelson *et al.*, 2009; Seligman *et al.*, 2011; Dodge, Daly and Huyton, 2012). The question of how wellbeing should be defined and measured is not the remit of this thesis. Attention is brought to this issue to indicate how research into visitors' affective and emotional experiences sit within this broader context.

The research undertaken in this thesis seeks to understand what visitors felt and how this contributed to their experience, whether this was accompanied by physiological patterns in the body, and the methodological constraints inherent in such an investigation. Within a context of austerity, where issues of wellbeing and health are increasing at the fore of museum practice, it is important to understand what rhetoric physiological measurements may be in service to. For this precise reason, the preceding chapters of this thesis have established an evidence-based approach to emotion, affect, and physiological measurement. The aims of this study were not concerned with demonstrating how visits improved visitors. This thesis does not seek to create measurable before and after comparisons of the visitor's state of mind. As the previous chapters argue, there are practical reasons for this: the methodological issues inherent in physiological monitoring. A significant amount of research is needed before claims related to wellbeing can be pursued or demonstrated. Therefore, as the next chapter will discuss in more detail, this study's aims and its research questions are necessarily more modest.

One might ask, when faced with budget cuts and ongoing austerity, why bother with studies of emotion in museums? Yet studies of visitor emotion possess a timely potential, given the well-being terms in which the museum's value and public service have been increasingly framed. In the last ten years, the role of emotion in visitors' museum experience has received

increasing attention. There have been studies that deal with specific aspects of emotional experience – emotion and transformational experience as in the case of Soren, its role in reflection as identified by Packer and Bond, or fascination and interest as per Dahl et al. Pekarik, Doering, and Karns, as well as De Rojas And Camarero, have considered the emotions involved in visitor satisfaction, and there has been significant engagement with the idea of 'historical empathy' (Pekarik, Doering and Karns, 1999; Cunningham, 2004; De Rojas and del Carmen Camarero, 2006; Kohlmeier, 2006; Soren, 2009; Packer and Bond, 2010; Brooks, 2011; Dahl *et al.*, 2013; Endacott and Sturtz, 2015; De Leur, Van Boxtel and Wilschut, 2017; Savenije and de Bruijn, 2017). The common thread across this literature is the relationship between the emotional experience and the creation of meaning or value for the visitor - both personal and social meaning.

Writing in 1995, Silverman described the paradigm shift within a broad range of academic fields known as postmodernism. In the context of museums and their visitors, Silverman wrote that one might understand this shift more colloquially as 'meaning-making' and that the 'concept of meaning-making provides a useful new approach to understanding visitor experiences in museums' (Silverman, 1995, p. 161). Silverman describes how this is useful because it foregrounds the visitors' active role in the museum experience, claiming that through a 'constant process of remembering and connecting' visitors create meaning as new information meets with existing knowledge and emotions (Silverman, 1995, p. 162). Meaning-making has become an established concept in museums - one adopted by museum studies to acknowledge the person, social, physical contexts that relationally contribute to visitor experience (Falk and Dierking, 2000).

Affective Practices and Museums

Despite long-term interest in meaning-making processes that visitors undertake in museums, in 2006, Smith and Campbell wrote there was 'an elephant in the room of heritage and museum studies – that pachyderm is the recognition, or rather lack of recognition, of affect and emotion as essential constitutive elements' in visitor experience (Smith and Campbell, 2015a, p. 443). Responding to this, Smith cited a need for heritage scholars to collaborate with social scientists; this led Smith and Campbell to collaborate with Wetherell. The result was *Emotion, Affective Practices and the Past in the Present* (Smith, Wetherell and Campbell, 2018). Across the case studies collected for the volume, there is a diversity of contexts, concerns and methodologies. Juliff explores the affective practices within

participation and performance in the context of Jeremey Deller's re-enactment of The Battle of Orgreave (Juliff, 2018). Mason, et al. discuss visitors' affective and emotional responses to histories of migration (Mason *et al.*, 2018). Mulcahy and Witcomb detail the affective practices of year 10 pupils in a museum (Witcomb and Mulcahy, 2018). Despite the diversity across the volume, two common threads appear, first is acceptance of experience of affective relationships as plural and complex, and the second is the desire to ask research questions and make interventions that go beyond the notion of visitation based on authoritative knowledge transfer from object or narrative to the visitor. Alone neither of these two perspectives are new or original, but together they enable a new approach to emotion in visitor experience.

Wetherell, Smith and Campbell claim affect as 'flowing, dynamic, recursive and profoundly contextual, challenging static and neat formulations' (Smith, Wetherell and Campbell, 2018). This represents a shared cross-disciplinary understanding of studying emotion and affect that is capacious enough to accommodate human experiences in a way that has real, pragmatic relevance for museum scholars and professionals. The emphasis affective practice puts on meaning-making and discourse can be squared with the existing research precedents that engage with visitor experiences. To understand this approach's development, it is beneficial to examine Smith's work from a period before their work in collaboration with Wetherell.

Smith wrote, of a project which examined visitor responses to different eight exhibitions held across the UK to mark the bicentenary of the British abolition of the slave trade, that acknowledging the trauma of slavery and racial inequality within Britain required 'not only significant intellectual but also an emotional remaking of British self-identity' (Smith, 2011, p. 263). For Smith, visitor meaning-making was interwoven not just with knowledge acquisition but with an emotion-driven creation and validation of identity. At each of the eight institutions, Smith's team conducted post-visit semi-structured interviews to record visitor responses to the exhibitions and the bicentenary. Demographic questions were asked, followed by 18 open-ended questions. Transcripts were read to define thematic responses to each of the open-ended questions, and codes were devised for each theme.

The findings revealed that educational attainment and socioeconomic status produced no statistically significant patterning in the responses. Ethnicity and gender were significant, with the majority of white British visitors either passively or actively disengaged with the

exhibitions. Smith identified strategies of emotional disengagement and avoidance (Smith, 2010, p. 197). African-Caribbean British visitors were more likely to engage with the exhibits. Women, and particularly African-Caribbean women, were more likely to engage actively and to express empathy. In terms of emotional response: 49% of respondents were categorised as 'emotionally neutral', 7% actively disengaged, and 10.8% expressed 'deep empathy' (Smith, 2010, p. 197). Such figures illustrate how personal experiences drive meaning-making in museums. Smith noted that there was often a tactical avoidance of discussions in White visitors that might have led to unpleasant feelings about themselves or their place in society. In these cases, there was an impulse to historicise and move on from the past rather than acknowledge its wounds. One can see how such responses are further illuminated when understood from the perspective of affective practice. Additionally, affective practice invites emotions that might be dismissed as disinterest to be viewed as forms of negotiation, manoeuvring, and meeting with the identity of self and others.

Schorch, who draws on Smith's work, has argued that engagement with museums begins on a 'sensory, emotive and embodied' level (Schorch, 2014, p. 22). Schorch's narrative study of global visitors to the Museum of New Zealand Te Papa Tongarewa (Te Papa) considered Visitors' narrations of their visit to the museum. It revealed that visitor emotions were interwoven in the intellectual and interpretative processes involved in museum visitation. Schorch combines this view with an understanding of 'feelings as interpretations', where *visitor experience is 'a* Gestalt experience' (Schorch, 2014, p. 33). Drawing on an analysis of semi-structured and in-depth narrative interviews with 12 visitors to make a case for the senses, feelings and embodiment as conditions of meaning-making, Schorch makes a case for the role of 'interactivity' between exhibit and experience leading to 'self-inscription' or meaning-making, on the part of the visitors (ibid.). Schorch repeatedly identified these processes at work and reached this conclusion:

> Senses, feelings and embodiment interact with narrative in the quest for meaning. These dimensions and traces are inextricably entangled within the human experience: without one another, they wither and die. In order to maintain such a holistic awareness, I think it requires a shift from an oscillating to a circular dialectic that tracks the hermeneutic relations between the whole and its parts, and vice versa. (Schorch, 2014, p. 33)

They argue that embodied hermeneutics, knowledge and reflection as key processes within visitation. This transgresses the traditionalist view of information transmission and object reception associated with the museum visit to focus on the affective practices that occur during visits.

The focus on this transmission relationships has also been criticised by Smith and Campbell, who understand the emphasis on such connections as obscuring the role of emotion and affect in heritage and cultural experiences (Smith and Campbell, 2015b). Smith and Schorch demonstrate that visitors' affective experiences are multifaceted interpretative processes. This process extends far beyond broad notions of improved wellbeing - it can drive avoidance, as Smith identifies, or the highly individual forms of interactivity that Schorch describes. Smith used the findings to push back against the notion of the museum as a progressive site of social action. They argue that, despite government policy that has increasingly asked museums to tend to issues of citizenship and social cohesion (Bennett, 2005; Message, 2009; Silverman, 2009), the disengagement of the White British audience illustrates how responsibilities concerned with White acknowledgement of racial inclusivity and equality, have not been met in these bicentenary exhibitions.

This section has demonstrated through supporting studies that Wetherell's approach is a compatible, generative, and practical way of thinking about emotions and affect in the museum. This section has aimed to provide an overview of the context of the thesis and continue to make a claim for the affective practice approach. Notwithstanding the points made above, there remains a question about the pragmatic application of an affective practice approach. This thesis must construct a methodology that attends to its conception of affect and emotion. Having discussed physiological monitoring in detail, the following section discusses self-reported visitor experience.

Constructing affective experience

A key aspect of Wetherell's theory of affective practice is that it attends to and rehabilitates talk with affect studies. This attention to discourse is a critical point for this thesis: all the evidence discussed above have repeatedly emphasised the importance of self-report in interpreting physiological data. Clearly, self-report data needs to be a part of a methodology. How one understands a visitors' experience, based on the way they describe it, is not a direct transcription of the experience – but a mediated description parsed into language. In turn, this

process becomes part of the affective assemblage. Therefore, as a final consideration in this chapter, we turn to look at two studies that employed a ‘cognitive tools’ framework for understanding the way visitors talk about their experience in the museum. This section explores whether such a tool would have value for understanding the affective practices of museums visitors.

Leinhardt et al. (2002) studied post-visit diaries written by adult museum visitors - an approach focused not only on the way meaning, experiences, and interpretation layer and develop during visits but also on how visitors recall and communicate their experience. The study undertaken by Leinhardt et al. offers a perspective on emotional visitor experience that focuses on how these experiences are described. By reading and coding the post-visit diaries, Leinhardt et al. identified the tools used to express the meanings made during their visit; they called these tools: 'cognitive tools'. These cognitive tools are classified into four categories: description, narrative, analysis and weaving. Leinhardt et al. found that description and narrative were typically common, whereas analysis and weaving were secondary tools. This draws on Leinhardt and Crowley's previous work on how to capture, categorise and analyse talk within a group in a museum (Leinhardt and Crowley, 1998), and views talk as a key mechanism by which visitors communicate the meaning and experiential nature of the museum, drawing on the work of Rogoff and Wertsch to recognise the complexity of human mental function as culturally, historically, and institutionally situated, where learning and meaning-making are derived from the entanglement of the social and cultural processes (Rogoff, 1990; Wertsch, 1997, 2009).

One could argue that the design of Leinhardt's 2002 study leaves it open to criticism - the sample consisted of ten women and eight men, all of whom were acquaintances or friends of at least one of the authors, each visited museums regularly, and already had some form of reflective writing practice. In light of this, it is helpful to consider a study where another researcher has used the cognitive tools model. Leach took the cognitive tools model and sought to replicate it in a study of Year 4 pupils' recollections of their visit during a school field trip to a Historic House as part of a school field trip. Leach sought to identify the kinds of experiences children recall from their visit and the cognitive tools to communicate and evaluate the experiences. Following a school trip to a historic house, 22 students (between 8 and 9 years of age) wrote reflective essays describing their experience. Coding the journals

revealed that the participants used cognitive tools (description, analysis, and narratives), to communicate their experiences.

Leach's study shows that over half (59.0%) of the children recalled an affective response to the historic site. Enjoyment was recalled by a significant number of students (54.5%). In some recollections, emotion was the hook around which the journal entry was framed. For example, one student structured her entry according to all the objects she had loved in the house. Leach demonstrated the nature of children's experiences at this historic site and identified the cognitive tools they used to interpret and communicate their experiences. Crucially, Leach's research also points to the role of emotive connection in visitor experience: ‘affective aspects of the visit influenced how they chose to describe experiences' (Leach, 2011). The affective, emotional aspect of the experience is involved in description, narration, analysis and weaving; this corresponds to the interwoven and layered nature (thought, felt, and lived) of visitor experience as viewed through the concept of affective practices.

The important joining concept here is that Wetherell is, unsurprisingly for an academic with a background in discourse analysis, concerned with how affect is communicated – an aspect to which Leach and Leinhardt speak. Leach and Leinhardt's work with cognitive tools reveals how visitors communicate experience and how affective practice might be codified in the context of the current thesis. The cognitive tools approach is underpinned by sociocultural approaches to understanding the relationship between narrative, individual experience, and the social context. In this, I argue, there exists much that is shared with the tenant of affective practices and discourse analysis. Affective practice and cognitive tools provide strategies for understanding how individual visitors talk and describe what they feel and think in the museum. The subsequent methodology chapter details how the thesis will proceed informed by an affective practice approach to emotion and use the cognitive tools to understand how such practices are communicated.

Conclusion

Chapter 4 does some important housekeeping for this thesis. Throughout the preceding chapters the focus is the complicated issues arising in affect, emotion, and physiology. The chapter makes connections between the theoretical basis of the thesis and its context. It discusses cultural policy, the wellbeing imperative, and the relationship this has to physiological data. The chapter discusses the work of heritage scholars interested in affective

practice perspectives on museum experience and where such an interest has come from. Finally, it addresses the pragmatic issue of visitor's self-report data, which the thesis has shown to be essential in terms of both understanding affective practices and interpreting physiological data. Therefore, it discusses a method for understanding how visitors talk about their experiences.

Part Two: Conclusion

Part two covers a vast disciplinary terrain before it settles into the very specific context of this thesis. This is intentional. Chapter 3 covers a wide range of understandings of how physiological data might have methodological value and be interpreted or rendered into social forms of physiological data. The chapter discusses ambulatory studies in the museum, and, for necessary perspective, those conducted in other settings. It is useful to be reminded of the 'partial yes'- the conclusion of the eMotion study (Tröndle *et al.*, 2012), such partiality speaks of a need to understand these methods not as enabling total and fixed forms of knowledge about museums and the forms of contextual affective and emotional experiences that occur within them.

Chapter 4 is concerned with making a link between the types of museum based physiological studies described in the previous chapter and the context of the museum today. It draws on discussions within museum and heritage studies, cultural policy studies, and empirical research on visitor emotion in museums. This chapter provides a bridge between the theoretical and methodological concerns of this study and the location with which the thesis I concerned. Chapter 4 draws on cultural policy to demonstrate how physiological data collected from museums visitors may be seen to have particularly loaded forms of value. It discusses the growth in studies concerned with visitor emotion and looks at studies which support the affective practice approach. Finally, it looks at a method for understanding visor talk that is commensurate with affective practices.

This thesis explores what technologies offer the museum and researcher, in constructing an understanding of visitor experience and the affecting nature of heritage and culture. This perspective on technology questions whether technological tools, in this case, a physiological monitoring device, can expand our knowledge of visitor experience in museums and if so, how such tools might construct and define this knowledge. Digital humanities scholars, such as Poole and Kidd (Kidd, 2015; Poole, 2018), have foregrounded an approach to technology

that is critical, reflective, and aware of both human and technological agency in the creation of visitor experience. This thesis is informed by such critical perspectives. Elsewhere, Kenderline has considered how emergent technologies such as 'mobile computing, wearable technology, and augmented reality', may reconfigure the value of the humanities and the institutions associated with humanities research (Kenderdine, 2015, p. 40). This point is illustrated by the discussion of wellbeing in chapter 4, but it also represents a wider consideration.

This thesis resonates with the idea that technologies challenge perceived 'rules' relating to both the creation of knowledge and methodologies, its first two parts do very specific work – they seek to understand the cross disciplinary evidence and constraints of physiological monitoring both in theoretical and pragmatic terms. It is in this foundation that the methodology presented in the next chapter is rooted.

Part Three: Methodology

Introduction

The first two parts of this thesis work to establish the evidence for an affective practice understanding of museum visitor experience. The precedents in physiological monitoring were presented, and the methodological issues in such work unpacked. The implications of conducting such research in museums were also proposed. The first two parts of the thesis represent the foundation of the empirical work in this thesis, and it is to the construction of that work that the thesis now turns. Part three sets out a methodology for exploring the embodied and social organisation of emotion and affect. It draws on the debates and methodological considerations presented in the preceding chapters to propose an actionable research programme.

Chapter Five begins by considering the research paradigm that was adopted by the study. Subsequently, it introduces issues in mixed methods research and outlines the exploratory, comparative case study design and gives a brief overview of a pilot study that informed the methodology. This chapter introduces the project's partner, Amgueddfa Cymru – National Museum Wales, and discusses how the partnership shaped the methodology. It also describes the two exhibits chosen for data collection, states the research questions and outlines a mixed methods research design. It covers the procedure, sampling strategies, issues of validity and reliability, researcher bias and ethics. Finally, the analytical processes are clearly explained. The chapter notes the pilot study's findings in the relevant sections, specifically in developing research questions, visitor tracking, survey testing, data management, and reliability.

The presented methodology explores the role of affect and emotion in museum visitation; within this investigation lies a specific focus on determining what role physiological data might have in this inquiry, how visitors report and recall their experience, and whether these two forms of data can be held in conversation with one another to support an understanding of affective experience.

Chapter 5: Mixed Methods Methodology

This chapter draws on the foundation set in parts one and two to develop the methodological approach. It notes paradigmatic approaches within mixed methods social research. The challenge of mixed methods research is establishing coherence between evidence, epistemological views, theoretical standpoints, and the practicalities of method. Pragmatically, this? chapter focuses the field of inquiry to that which can be soundly and empirically studied within the remit of the collaborative doctoral award. A case study model is proposed, and this choice is discussed in relation to the research environment - the Amgueddfa Cymru National Museums Wales site in Cardiff. The two exhibits chosen as case studies are described. Subsequently, the chapter proceeds with a complete presentation of research questions and methodology.

Mixed Methods Research

Mixed methods research is a type of research in which, within a single study, both qualitative and quantitative methods are used with the purpose of using both methods, and these methods' respective paradigm perspectives, to form a 'better' understanding? of a social phenomenon than would be enabled by a single method (Creswell, 2002; Byrne and Humble, 2007; Creswell and Plano Clark, 2011).

The use of qualitative and quantitative methods in this study is guided by Greene's 'mixed methods way of thinking' (Greene, 2007, p. 20) which is a mixed methods paradigmatic approach that invites multiple ways of knowing into a single study. Such an approach is rooted in the understanding that there are ways of knowing that are represented by qualitative and quantitative research and their associated paradigm characteristics (e.g., constructivism and post-positivism). A wealth of researchers have made the case that the divisions between positivism and constructivism are not absolute; bridge-building approaches are possible (Tashakkori and Teddlie, 2002; Greene and Caracelli, 2003; Greene, 2007; Della Porta and Keating, 2008; May, 2011). This point is neatly summarised by Della Porta and Keating, who argue:

> Between those two extremes, there are positions that admit the differences in the paths of knowledge and deny the existence of a 'better one', but still aim at rendering differences compatible. (Della Porta and Keating, 2008, p. 33)

Della Porta and Keating's comment belies a shift away from seeing positivist and constructivism approaches as incompatible and towards a pragmatic mixed methods approach where researchers use both from a respectful, conciliatory position. Greene extends this view and stresses that this approach emphasizes a 'respectful conversation among different ways of seeing and knowing' via an understanding that each offers only a partial understanding of the social world (Greene, 2007, p. 79).

There currently exists a variety of paradigmatic approaches in mixed methods research. These have been categorized into six different positions: purist, complementary strengths, a-paradigmatic, substantive theory, dialectic, and alternative paradigm (Greene and Caracelli, 1997, 2003; Tashakkori and Teddlie, 2002). Each of these represent unique perspectives about the role of paradigms in mixed methods research, the following section focuses on the dialectic position championed by Jennifer C. Green and Valerie J. Carcelli (Greene and Caracelli, 1997, 2003). Crucially, this position understands a paradigm as offering only a partial understanding of the social world and supports the use of multiple paradigms in order to reach a greater understanding of the subject being researched (Greene and Caracelli, 2003). The dialectic position does not view the differences between paradigms as incompatible. Instead, Greene and Caracelli claim that the juxtaposition of the differences between paradigms "offer[s] the possibility of coordination, integration, and synthesis" through a dialogical interplay of differences (Greene and Caracelli, 1997, p. 12) The significant takeaway from the dialectic position is that in any particular research study, the choice to use particular methods are not necessarily dictated by abstract paradigmatic assumptions but is a negotiation between the practical research issues of the study and the researcher, or team of researchers. According to Greene (2007) conflicting perspectives can be mixed if these conflicts are "engaged through respectful dialogue" (p. 67). Such dialogue can be reflected in a studies design and analysis as is the intent in this thesis. The next section unpacks how the research design was shaped by the dialectic mixed methods approach.

A Case Study Approach

As an investigation bound by defined cases (in this study visitors to specific museum experiences), a case study provides a snapshot, acting as an empirical enquiry into current phenomena in specific contexts.

The mixed methods Triangulation Design is a one-phase case study design consisting of quantitative and qualitative methods implemented during a single phase of data collection and examined with equal weight (Creswell, Plano Clark, et al., 2003). The purpose of this design is to collect different but complementary data on a topic in order to best understand the research problem. Concurrent triangulation designs involve the concurrent collection and separate analysis of different data sets so that a researcher can bring together the separate results via interpretation (Creswell, 2002; Creswell and Plano Clark, 2011). The eMotion project, discussed in chapter 3, is an example of a Triangulation Design, where data collected and analysed were both quantitative and qualitative, analysed separately, and these results were then sued to formulate an overall interpretation. Triangulation Designs have been described as intuitive and efficient approaches to mixed methods research, as both types of data can be analysed using the techniques traditionally associated with each data type (Creswell, 2002; Creswell and Plano Clark, 2011). Therefore, this design is compatible with the dialectic mixed methods paradigm.

An investigation of visitor emotion and the inclusion of physiological data collected via a commercial wearable device within the context of the museum has not been undertaken before the start of this research and is, therefore, in a preliminary stage, concerned with issues of validity and reliability. Babbie cites the usefulness of exploratory research, in that it can reveal the limits of a particular line of inquiry (Babbie 2007). The research design in this chapter was devised to consider similarities, differences and patterns across two cases (two different forms of museum display). This comparison was intended to create a broader data set from which to draw conclusions about validity and reliability. The quasi-experimental design considers participants in two cases and does not involve random allocation of participants to different groups. Participants belong to either case 1, or to case 2. In each case, visitors experienced a different museum display, where simultaneously EDA data was collected, followed by a post-visit survey. The results of the two cases are then compared.

This is a generative model for the current study and its research questions. In the current study this means that EDA and survey data can be examined separately and using appropriate methods and then be subjected to interpretation that seeks to find their individual and commensurate value in tacking the research questions. However, researchers working in this model face challenges including the effort and expertise required in managing diverse data sets and the consequences of having different samples and different sample sizes when converging the two data sets. Criticisms of case studies tend to make arguments that generalisable knowledge is more valuable than context-specific knowledge, and as such, case studies are limited forms of knowledge production. Additionally, critics posit that they are only useful in the preliminary stages of an intellectual investigation, specifically to aid in the production of hypotheses, rather than in the testing of them (Yin 2009). The current study intends to provide an in-depth but exploratory understanding of emotional phenomena in a specific research context – thus, a case study is an appropriate method.

The forthcoming methodology and design merge different data types (skin conductance, demographic variables, and the participants' own self-reported emotional states) with the intention of exploring the subtleties and nuances of interaction with the museum and the objects and people visitors encounter. A mixed methods triangulation design working within a dialectic paradigm enables an exploratory investigation of two forms of data (self-report and physiological) where each form of data might be historically associated with opposing philosophical lineages. This approach is intended to support a greater understanding of both the qualitative and quantitative data drawn from a combination of subjective and objective measures. The design presented is fundamentally informed by the literature and evidence discussed in the previous chapters. This allows the acknowledgment of the affective work visitors undertake in museum, in the form of Wetherell's affective practices (Wetherell 2012), previous research on the cognitive processes involved in museum visitation (Leinhardt and Crowley, 1998; Leach, 2011), as well as an investigation of the physiological measures. It seeks to understand visitor experience as it is embodied in physiology and as it described by visitors. This approach enables a study focused on exploring the value of certain methods and tools to the research questions within a context of a mixed-methods research design.

Pilot Study

In preparation for this research, an opportunity and funding were sought to conduct a pilot study. This work is covered in detail by another publication (Hoare 2020). However, as the aim of that study was to develop and test aspects of this study's methodology, issues of relevance are summarised here.

Tredegar House in Newport, South Wales is a National Trust property comprising of a 17th-century country house mansion, formal gardens, parkland, and outbuildings. The visitor experience team are actively engaged in designing interpretation that connects visitors with the stories of the house with the intention of delivering experiences that 'move, teach and inspire' (National Trust 2015). To mark the centenary of the 1918 Representation of the People's Act, the team decided to shift the focus of their interpretation from the men of the family to those of the women, whose stories the team felt had been consciously absent. The resulting programming *In Her Shoes* offered visitors two routes through the property - one casting the visitor as a lady of the house and a second positioning them as a household maid. This change prompted the team to look for new forms of evaluation - specifically forms that might help them understand how the routes made visitors feel. In response, an evaluative pilot study was proposed with the intention of exploring and comparing visitor experience between the two routes. The pilot study sought to test research protocols and data collection instruments, and sample recruitment strategies. Specifically, as a pilot study for the research conducted with National Museums Wales, the pilot aimed to surface any technical issues related to the Empatica E4 and its data and to test and develop the survey.

Data collected included:

- Physiological data capture via an Empatica E4 wristband
- Self-report via a post-visit survey

Participants were recruited from general visitors over the age of 18. Visitors were met in reception and introduced to the two routes by the reception staff, they were then offered the opportunity to take part in the research. Following an ethics procedure, those that agreed to take part were fitted with a wristband. At this point, the baseline procedure began. As has been discussed in previous chapters, a number of procedures have been adopted by researchers in psychophysiology, most common is the 'rest' period, where investigators adopt baseline procedures in which the subject is asked to do 'nothing' (Levenson 1992). Levenson questions

whether a subject can actually comply with this instruction and asks whether for some it might provoke anxiety, they argue that the most useful baseline for 'any biological system is one that is representative of the modal level of activation for that system, taking into account its normal range of functioning' (Levenson 1992, 24). Therefore, after being fitted with wristbands, all visitors walked the same level route from reception through the first formal garden to a decision point where the routes diverged. They were asked at that point to press the button on the band to indicate that they had made their choice before embarking on their chosen route. When visitors had completed their visit to the house they made their way to the cafe; the wristband was removed, and they were asked to complete a survey.

Demographics

Visitors were overwhelmingly over 55 (73%) with 53% reporting that they were retired. Gender was weighted towards female visitors; those who identified as male were always accompanied by females. Close to 92% of visitors were National Trust Members and for 78% this was their first visit to Tredegar House. Notably, the sample is entirely white and given historical experiences specific to race, this is an important caveat in the consideration of the results.

Physiological data

The Empatica E4 recorded electrodermal activity (EDA), blood volume pulse (BVP), acceleration, heart rate (HR), and temperature. The wristband can be linked to a mobile phone to track participants outside but in early testing this proved an unreliable means of tracking participants inside. Further time and budgetary constraints restricted our ability to explore the indoor tracking options available. In this situation, our priority was to rule out possible data interference - a primary concern being the possibility of skewed data due to heart rate increases when climbing stairs. Testing showed that this could be identified easily through paired fluctuation in the accelerometer and heart rate data.

Following this, two signals were identified for analysis:

- EDA
- Heart activity (both HR & HRV)

A total of 37 participants were enrolled in the study. The following three exclusion criteria were applied:

- Those whose visits fell outside 90 mins in duration ± 30 mins
- Those who had not pressed the device button when making their route choice
- Data capture failures in the device

These criteria limited the sample but were vital in enabling interpersonal comparisons. As one might expect, participant compliance resulted in a considerable drop off (n=14). A less expected factor was the impact of device failures on numbers (n=12). Whilst participants were reminded about pressing the marker in their data, they were not asked to keep their visit to a specific time. They were asked to come straight to the cafe when they finished in the house, but it was difficult to police this. Further controls could have been added but this might have caused anxiety and skewed the data. After exclusion, a total of 11 participants (30%) remained for analysis. Further complications came when the device failed to capture heart rate consistently. In 75% of the remaining sample, HR dropped out part way through the visit. For this reason, HRV had to be dropped and electrodermal activity became the sole physiological unit of analysis. While such exclusions were limiting, the intention of the research was exploratory and this outcome points both to issues with the device and the need for iteration in future research designs. The psychophysiological analysis of electrodermal activity was progressed in order to understand the relationship between the 11 participants' physiology and survey responses. Survey responses were analysed both as a whole (n=37) and as a subset (n=11).

EDA Analysis

For this non-clinical study, an analysis of EDA features over time was chosen to demonstrate the overall autonomic nervous system activation during the time period of the visit. Mean corrections allow data to be read as a point of distance from an individual's mean and range give a sense of activation over the range of arousal (Boucsein et al. 2012; Dawson, Schell, and Filion 2007; Greco, Valenza, and Scilingo 2016). Therefore, a range-corrected standardisation procedure was undertaken to correct for inter-individual variance; this was calculated using the minimum EDA level during baseline and maximum EDA during an arousal period. The participant EDA at any other time period in the study could then be expressed as a proportion of their individual maximum range of psychophysiological

response via the formula:

(EDA - EDAmin) / (EDAmax – EDAmin) (Dawson, Schell, and Filion 2007).

In this analysis, EDA arousal was seen to occur in 4 out of 5 visitors who entered via the maid's route. However, this was only the case in 4 of 5 datasets on this route; participant five represented an anomaly. In the remaining participant, the magnitude of response was very low indicating that his person has a very low level of EDA overall. Given the age of this participant, the participant identified as age 70+, such low levels of response may be attributable to age. Burriss, Powell, and White have shown that EDA responsiveness declines as we age; their study reports a tendency to 'report increased felt emotion but decreased physiological response to emotional stimuli as over the life span' (2007, 182). This participants data is further complicated by existence of 'non-responders' - participants who showed very low to no levels of response (Farrow et al. 2012). This case demonstrates that while EDA is a reliable indicator of physiological arousal within some subjects, EDA arousal is by no means consistent.

The EDA of those following the Lady's route did not appear to rise upon entry. Instead EDA data in this group presents as slow drifts of EDA and? would not be considered 'peaks' or indicative of arousal, but more readily attributed to a form of 'tonic phenomena' (Boucsein 2012; Dawson, Schell, and Filion 2007). There is evidence of what has been referred to as 'tonic drift' (Boucsein 2012), whereby EDA level climbs mildly over tens of minutes without achieving prominent peaks with a pronounced 'rise and decline'. As for caveats that complicate the analysis of visitors on this route, familiarity can lower arousal and that might be one explanation for the levels in these visitors (Boucsein 2012). Indeed, one participant wrote in the survey:

A lot of the general information about houses in this area was familiar to me - I have visited a lot of historic houses in the past. - Visitor 6.

As National Trust members, all these visitors will be accustomed to visiting stately homes and to visiting these in a manner similar to the lady's route, i.e. entering through the front door and starting with the formal rooms. The difference between the two groups at entry could be attributed to novelty.

Survey

The survey was structured in four parts: demographic information, questions asking visitors to recall and describe what they found a) memorable and b) interesting about their visit, this was followed by free-choice and closed-choice emotion questions. Survey responses were coded to identify particular processes participants used to interpret and make sense of the property and this analysis drew on the cognitive tools framework to demonstrate how the meanings of historical sites are transmitted and recalled through description, narrative, analysis and the weaving of the former three techniques together (Leach 2011; Leinhardt, Tittle, and Knutson 2002).

Maid's route *(n=15)*

A total of 67% recalled interpretation specific to the story of the maid. A further 20% described their interaction with the volunteer room stewards and 13% referred to upstairs rooms as the most memorable part of their visit. When asked how their visit made them feel, a total of 68% used affective language and 46% described emotions resulting from the story of the maid - with responses spanning descriptions of empathy, sorrow, admiration or happiness that they did not 'live in those times'. Visitors on this route routinely recalled detailed aspects of the curatorial narrative and interpretation materials suggesting more recall of information specific to the maid's narrative.

Lady's route *(n=22)*

In this group, 50% described the impressive or lavish nature of the rooms or gardens as most memorable and interaction with the guides was twice as likely to have been recalled. One visitor said they found the 'Different aspects of kitchen life' memorable but none spoke directly of the maid. Two visitors (9%) did describe the 'stratification of society' and 'abdication of social responsibility'; 40% identified the stories of the Morgan family but did not refer specifically to the lady. 55% of visitors on this route used affective description when asked how they visit made them feel; unlike those on the maid's route, visitors on the lady's route recalled pleasure or enjoyment as a result of the beauty of the gardens and/or house - describing the experience as 'calm', 'peaceful', and 'relaxed'. Visitors on the Lady's route discuss the upkeep and beauty of the house and grounds. There is a degree of paternalism within the responses that describe caring for and restoring the house and gardens, and we might, therefore, view visitors on the Lady route as having developed a greater sense of

responsibility towards the site. Another view might argue that this data suggests that visitors on the lady's route experience difficulties in 'recognising otherness' described by De Leur et al. (2017). Here the relational element of affect - relating to an upper-class woman in the early 20th Century versus the distinctly different experience of working-class labour – becomes clear. Even though the types of labour and conditions are different across time, perhaps the familiarity of employment and labour enables visitors a greater sense of connection with the maid narrative.

Closed-choice emotion selection

Following the free-response questions, participants were presented with a list of emotion words adapted from affect categories identified by Scherer (2005). While this question did not capture dimensional or scale, the results demonstrated an overall difference in valence between the two groups, with visitors on the maid's route more likely to select negatively valanced emotions. Usefully, it also demonstrated that individuals experience multiple, differently valanced emotions across each route - a factor not readily identified within the free-choice questions where responses tend towards reporting one specific emotion.

Summary

The pilot study demonstrated differences between EDA in groups of visitors who undertook different routes. These visitors also reported feeling different emotions during the visit. The cognitive tools framework and affective practices also appeared to be a generative way to think about typifying affective visitor experiences. This supported further investigation of visitor affect and EDA in cultural settings. Important methodological caveats were also exposed, namely issues around tracking. exclusion criteria, data quality (i.e. heart rate capture failure), participant age, familiarity with the environment may all effect a study's result.

Following a review of the pilot study, research questions were designed for the collaboration with Amgueddfa Cymru – National Museums Wales. These aimed to further test the usefulness of the device, the methodology, and to address questions related to the emotional experiences of visitors. These following sections outline the collaboration with Amgueddfa Cymru – National Museum Wales and the methodology used in the main study.

National Museum, Cardiff

This section turns its focus to the research context. It applies the approach outline above to the study environment: National Museum, Cardiff. The National Museum is the second most-visited of Amgueddfa Cymru – National Museum Wales' seven museums. This PhD project was devised and funded as a collaborative doctoral award – a partnership between Cardiff University and Amgueddfa Cymru – National Museum Wales. Like any collaborative project, this research is mediated by complementary and conflicting priorities.

Access to the museum was negotiated over several months between 2018 and 2019. Due to staff sickness and absence, this took much longer than anticipated. Furthermore, the project's primary point of contact changed several times during the period. In these circumstances, maintaining the museums' investment for the project was vital. Between 2017 and 2019, the researcher and supervisory team repeatedly met with Amgueddfa Cymru – National Museums Wales staff to discuss the project and establish a route forward for the project. During this time, a pilot study was run, and a research design was further developed. The final report from the pilot study, a draft of the survey and the methods proposed were supplied to National Museums Wales' Director of Gallery Development and Visitor experience as a written proposal. Suggestions were made to improve the survey. Subsequently, several options for fieldwork we discussed with the museum in line with specific programming opportunities.

The museum was keen on studying independent visitors' experiences instead of working with visitors involved with their outreach and community engagement programmes. There was also an interest in conducting work at the National Museum in Cardiff instead of other sites. It was felt that some sites had received significant attention from other academic projects in previous years. Museum staff were keen to redress this balance and focus this project on the central Cardiff site. There was also a long-term goal of redeveloping the permanent galleries at the Cardiff site. As a result, the museum was interested in the affective experiences that were current to the space. In speaking with the museums' curatorial and digital staff, two areas for exploration were selected.

It was agreed that data would be collected from two different displays at National Museum Cardiff. The case studies selected offered the researcher the chance to compare different types of museum display and interpretation. The selected case studies corresponded to

museums priorities and offered the opportunity to understand visitor experience at the National Museum beyond their regular visitor surveys. Eventually, a collaborative agreement was reached to focus on a temporary exhibition and a recently launched augmented reality tour of the permanent collections.

- *Snakes* was a 'bought in' touring exhibition created by Blue Tokay, with additional content from the natural sciences collections of Amgueddfa Cymru – National Museum Wales. It was the summer exhibition during an ever-decreasing window for completing the fieldwork. It was installed in a temporary exhibition space with a clear route around the exhibition and a single entry and exit point. The exhibition featured five live snakes, models and taxidermy specimens, interactive displays, video, and traditional text-based interpretation.

- The museum developed *Museum ExplorAR* to offer fresh perspectives on the permanent collections without the cost and disruption of large-scale gallery redevelopment.[13] *Museum ExplorAR* is a self-led mobile experience that provides enhanced interpretation to augment permanent displays. Using a handheld device hired from the museum shop, visitors to National Museum Cardiff can explore three galleries with AR. These cover a range of the museum's collections and include: Underwater Marine Life, Impressionist Art, and Prehistoric displays.

Snakes opened in Summer 2019 and offered an opportunity for prompt data collection. Museum staff were interested in visitor response to this exhibition as it represented a significant investment in an external curatorial company. The inclusion of live snakes was unfamiliar and a first for the museum – there was a great deal of curiosity on both sides about the physiological response in the presence of live snakes. Finally, the museum had been experimenting with more immersive displays in the special exhibition space. *Snakes* reflected this and included forms of lighting and sound design intended to transport the visitor in some way. Again, there was a shared interest here —specifically in the role of lighting, sound and projection to create affective experiences.

[13] National Museum Cardiff has popular free, permanent exhibitions, but some of the galleries have not been updated for up to a quarter of a century.

Regarding *Museum ExplorAR*, the researcher pushed for a second exhibit to be included in the study – one where some degree of tracking could be included. As the literature presented in part two demonstrated, tracking visitors enables physiological response to be understood in situ. The intention was to have the opportunity to better links aspects of physiological response to self-report. The digital team had recently developed the AR experience to reinvigorate the permanent collections and were interested in evaluating it. Their interest was in the affective visitor experience of the tour and the technology.

Methodology

This section translates the study's worldview and theoretical frameworks into actionable social research. The research design: a case study adopting a mixed methods design is presented. Research questions are outlined; the measures and analytical processes are discussed. The procedure and sampling strategies are clarified, aspects of validity, reliability, and researchers' positionality are considered. Finally, ethical issues are raised. Throughout the chapter pays attention to tensions between theory and method.

Research Questions

As a collaborative doctoral project, the questions were guided by the study's attention to theory, methods, the psychological and physiological evidence, and the values and interests of Amgueddfa Cymru – National Museums Wales.

The study aimed to understand the embodied and social organisation of emotion and affect. Second, to investigate methodological approaches associated with these pervasive concepts, and finally, the value of using wearable physiological monitoring in such a study. These aims were the starting point for question development. The results of the pilot study also influenced the development of research questions. The pilot indicated that differences between EDA could be seen in groups of visitors on different routes who reported different emotions during the visit.[14] In the pilot, heart activity failed to be reliably captured. As a result, the EDA became the sole physiological measure under consideration.

[14] EDA increased when entering the house in 80% of visitors who experienced the house via the maid's route (n=5). These visitors also reported the maid's story as moving and emotionally engaging.

The following five research questions were formulated:

1. How do visitors describe and recall their experience of *Museum ExplorAR* and *Snakes*?

2. Does visitors' response vary between different displays?

3. How do open and closed survey questions contribute to understanding affective experience?

4. In the cases considered, is the analysis of aggregated electrodermal data a valid and useful methodological approach to investigating visitor experience in museums?
    a. When standardised and grouped by exhibit and sub-divided by demographics, how is physiological response distributed and do distribution differences exist between groups?

5. In the cases considered, is the analysis of individual participants electrodermal data a valid and useful methodological approach to investigating museum visitor experience?
    a. Do relationships exist between visitors' self-reported emotion data collected via surveys and the electrodermal data collected from the Empatica E4?

Physiological Measures

Visitors were fitted the Empatica E4, a wearable wristband that recorded electrodermal activity (EDA), blood volume pulse (BVP), acceleration, heart rate (HR), and temperature. The device can be syncef to a mobile phone for GPS tracking. In the pilot study, linking the wristband to a mobile phone to track participants proved unreliable when attempting to track participants inside; therefore, this form of tracking was not enabled.

As stated in part two, several analytical processes exist for dealing with EDA data. These come from clinical research rather than studies concerned with ambulatory monitoring. As

---

Such rises were not present in the visitors on the Lady's route (n=6), 59% of whom described the calm and screen experience of the house and gardens.

there is no universally agreed way to evaluate group-level ambulatory EDA data and one must determine, given prior literature and present context, the most suitable route forward. First noise in the signal was determined then the remaining data was standardised.

Two programs were explored for analysis: Ledalab and EDAExplorer. The latter identifies noise in individual datasets and identifies EDA peaks based on parameters set by the researcher. Ledalab is MATLAB-based software for analysing skin conductance data; its primary function is as a GUI for EDA data. This function can map the distinction between phasic and tonic levels, enabling a view of the rapid reactive peaks and slower changes within the 'background' of the subject's physiological function. Ledalab has no noise detection. Therefore, one can use EDAExplorer to identify EDA peaks, but this does not enable one to know how they relate to the participants tonic EDA. Ledalab gives a better sense of EDA that is not associated with tonic levels of EDA, but without noise detection, there is no way to confirm data quality. Noise detection was taken as a priority in this study. Therefore, EDAExplorer was used to identify datasets with over 25% noise – based on de Looff et al. suggestion that this figure represents a conservative exclusion of potentially complex datasets (de Looff, Noordzij, *et al.*, 2019). All data sets with over 25% noise were excluded from the study.

In this study, group-level means the aggregated data of all valid participant data in each respective case. Individual level data means the data of a single participant that was subject to analyses independent from the data of other participants. This study makes this distinction in order to explore the validity of EDA data at both levels. Therefore, research questions were developed for both group and individual-level data. The key reason for doing this is that different forms of analyses can be conducted in each approach. This study is concerned with the validity of these analysis *and* what each approach to the data can add to an investigation of affective experience. This approach enables group-level distribution of z-scored EDA to be graphed. When working on an individual level, EDA peaks can be determined and compare the timing of peaks to self-reported experiences. Therefore, as an exploratory study, this investigation sought to include these two perspectives on the data in order to form a comprehensive response to the research questions above.

- Group level analysis

The researcher learnt to code in Python (a computer programming language) as this was the most appropriate means for managing large sets of data. All EDA data was subjected to a z-scored standardisation. This study avoids the issues in range-corrected analysis and proceeds based on z-scored analysis favoured by Shoval et al. (Shoval, Schvimer and Tamir, 2018).

Group analysis involved producing histogram and box plots of the data for each case. Each case was then further broken down into three specific demographics: age, gender, and visit frequency - these demographics relate to bodies of research that make claims as to the variability of EDA between gender, age, and the novelty of the stimulus to the participants.

- Individual level analysis
  Given this thesis is concerned with ambulatory data collected in an open, continually stimulating public space and working with participants on a one-time basis, amplitude analysis must be ruled out. Therefore, as the best available option, for individual-level analysis, the choice was made to work with PPM, where peaks were calculated based on the agreed peak parameters established for lab-based studies (Boucsein *et al.*, 2012). EDAExplorer was used to detect peaks within the data, i.e., EDA increased by 0.05 micro siemens (the unit in which EDA is measured) within a 3-second window. These criteria are drawn from agreed publication standards for electrodermal data and represent what is agreed to indicate a 'peak' in EDA (Boucsein *et al.*, 2012).

Part two discusses studies that use tracking in order to link EDA to stimuli. To be clear, this study's position is that direct EDA responses linked to particular emotion categories is not a position supported by the evidence put forth in parts one and two. In line with this evidence, the study views modal changes in EDA related to stimuli and self-reports as potentially likely and worthy of exploration. The study might have tracked participants during their visit in the same manner as Tröndle (Tröndle et al. 2012). Discrete tracking provides locative contextualisation for EDA data and is compatible with the study's epistemological and theoretical positions. The Empatica E4 can be connected to a mobile device for GPS tracking, but this does not work inside. Concerns about data privacy and budgetary constraints restricted this study's ability to explore the indoor tracking options available.

Notwithstanding the museum's valid privacy concerns, video footage of participants was considered. However, the more intrusive the mechanics of data collection, the more likely they are to impact participant behaviour. In was felt that an additional layer of surveillance on top of the Empatica E4 risked influencing participants. Tracking did present an almost insurmountable challenge. However, *Museum ExplorAR* followed a set route with three-set periods of AR activity. The researcher made a case to National Museums Wales for including *Museum ExplorAR* based on the fact that as a set tour, it has an inbuilt yet informal form of tracking. In this case, it was possible to observe participants, determine average dwell times and compare these to the overall length of visits. Through this rudimentary form of locating visitors, EDA could be examined to see

- whether EDA peaks were more prominent in an individual's data in the three specific galleries where AR was used.
- if EDA peaks related in any modal way to self-report data.

This enabled an individual-level analysis of the relationship between EDA and self-report with the addition of locative context. Albeit this is based on a broader indication of which gallery the visitors is in rather than an exact location as a technological solution may have provided. However, an indicative location is more helpful here, as the study's understanding of affect as dynamic and recursive is not compatible with a programme of study that pursues causative relationships between specific stimuli in a specific location and EDA at the exclusion of the environment as a whole.

Survey Measures

A post-visit survey was used to collect demographic information and self-report emotion data. Visitors were asked to respond to open and closed-choice emotion questions. As chapter 1 discussed, open responses provide greater levels of specificity and the removal of potentially priming emotion labels. In addition, open-response enables a view of combinations of emotions and a better understanding of their context and role in the meaning-making process. A closed choice tool was used to enable a view on the differences in self-report between the open and closed methods. The intention was not to labour the fact that variability will be greater in open response, but instead enable comparisons as per the research questions. The survey also underwent a period of development, testing and iteration as part of a pilot study. Overall, this found that visitors responded well to open questions, did not

query them or need more information on how to answer and gave detailed reflections on their affective experience (Hoare, 2018, 2020).

In both the pilot and main study, participants were first asked to recall what they found memorable and most interesting during their visit. This draws on research that understands the development of interest as affective - to be interested in something, one must have a cognitive and affective relationship with it (Krapp, 2002; Silvia, 2006). The survey questions asked participants to recall their experience before being asked about their emotions. This was followed by open response questions asking how they felt during the visit. The visitor was asked whether they attributed these feelings to any particular point of their experience. This staging of the open response questions eased participants into the questions and gave then the opportunity to reflect on their experience in detail. Open questions were presented first to avoid biased responses to the closed-choice question that followed. This approach to the open-response survey questions was trialled. As it worked well to provide detailed retellings of visitor experience in the pilot study, it was also used in the main study. It has been argued that it is difficult to analyse open responses in a quantitative, statistical manner as their number is often extremely high, and the response frequency per label extremely low. As a result, researchers generally sort open-response into a processable number of emotion categories, using 'notions of family resemblances and synonyms' (Scherer, 2005, p. 713).[15]

This study needed a way of analysing open-response self-report data that was sensitive to the critical aspects of museum engagement that the survey sought to capture, i.e., looking,

[15] Scherer suggests a pragmatic solution for sorting open-response labels in emotion categories exists: the Geneva Affect Label Coder (GALC), which is based on an Excel macro program that attempts to recognize 36 affective categories (Scherer, 2005, p. 713). This programme picks up commonly distinguished by words in natural languages and parses text databases for them and their synonyms. The 36 categories were chosen on the basis of both empirical grounds (occurring in a quasi-representative population survey of what respondents freely report when asked which emotion they experienced yesterday) and published surveys of emotion terms in different languages (Averill, 1975; Gehm and Scherer, 1988; Russell, 1983). In this method, qualitative interviews can be searched for emotion words and these can be categorised accordingly. However, the pilot study revealed a danger here. Occurrences of emotion words needed to be recorded in context – for instances, participants would refer to an emotion they did not feel, and this would be positively coded by the label coder.

digesting, and reflecting, processing, and assimilating to create meaning. An iterative process of analysis was conducted on this data and was completed with the help of the build-in data coding abilities of Qualtrics. Specifically, thematic analysis was used on all free-response survey data as it enabled a diverse data set to be sorted into broad themes. This provided a way of identifying and connecting patterns in the data. Here, the 'cognitive tools' coding framework developed by Leinhardt et. al. and subsequently employed by Leach (Leach 2011; Leinhardt, Tittle, and Knutson 2002) was found to have a particular value. The 'cognitive tools' approach uses four key coding categories: description, narrative, analysis, and weaving. In this study, it was essential to develop coding categories fitted with data drawn from casual visitors whose level of investment with the study and museum was potentially lower or more casual. However, under inspection, the cognitive tools categories were present in the data - the essential acts of looking, digesting information, and creating meanings via these processes appeared throughout. Therefore, the 'cognitive tools' framework was chosen as a good fit with the initial thematic analysis outcomes.

The pilot study trialled the use of the Discrete Emotions Questionnaire (DEQ), a tool that is rooted in the theory of basic emotions and is sensitive to eight so-called 'core' emotions: anger, disgust, fear, anxiety, sadness, happiness, relaxation, and desire (Harmon-Jones, Bastian and Harmon-Jones, 2016). Numerous tools could have been used here, e.g. the Positive and Negative Affect Schedule (PANAS) (Watson, Clark and Tellegen, 1988). However, a decision was made to trial DEQ over PANAS as the evidence for DEQ has shown it to be a more accurate measure (Harmon-Jones, Bastian and Harmon-Jones, 2016). The choice to work with a tool built around a defined list of emotions and Likert scale was supported by Scherer's critique of the Affect Grid, which asserts that a similarly positioned point on a dimensional grid is less likely to have the similar meaning for participants in comparison with a defined emotion word (Scherer, 2005). Using an established measure avoided the issues associated with bias, and researcher chosen lists of emotion descriptors (Scherer, 2005). However, in practice, the DEQ has 32 emotion categories which require the visitors to respond to a Likert scale for each one. In the pilot, it was found to induce survey fatigue, and visitors found it frustrating.

A more concise closed choice tool was sought. The Epistemically-Related Emotion Scale (EES), which measures surprise, curiosity, enjoyment, confusion, anxiety, frustration, and boredom occurring during epistemic cognitive activities, was selected as the closed-choice

question for the survey. The scale focuses on these affective states as representative epistemic emotions known to relate to cognitive activities' knowledge-generating qualities (Brun, Kuenzle and Doguoglu, 2008; Morton, 2009; Pekrun *et al.*, 2017). The EES represented a concise, proven tool relevant to both the research environment and questions (Pekrun *et al.*, 2017). The choice to try a different tool, particularly one orientated towards acts of epistemic activities, reflected the study's interest in the role of emotion in meaning-making in the museum. Care was taken to make sure the particular scale or question tool was a good fit and neither biased nor complex and demanding for the participants. The interest here was in the differences present in the open response – the degree to which focusing on a particular set of closed choice- emotions could omit other forms of affective experience. Average scores for each point on the ERE Scale were produced and graphed to give a general sense of distribution. This was used for comparisons against the coded open response emotion descriptions. Further analysis could have been undertaken here depending on the physiological data's validity and its ability to withstand statistical analysis. The statistical relationship between ERE and other forms of self-report data was not under consideration in this study, and therefore, this was not investigated as a potential avenue for analysis. For some, this is a potential limitation of this study. However, this analysis attended to the remit of the research questions.

This thesis works hard to retain focus and exploratory research has the potential to open up many avenues of inquiry and stimulate more questions along the way (Babbie, 2007). There are additional forms of demographic segmentation, that given time and scope this thesis might have sought to include. While the physiological data is subject to this form of analysis, the self-report is not. In chapter six, this is due to the extremely small sample size under consideration – a demographic analysis would not have been valid here. In chapter 4, overall sample demographics are given for each case, but the primary focus is a detailed textual reading of the data in relation to the cognitive tools framework. This also speaks to the demands of the analysis presented in this thesis and a need for prioritisation. It has been noted that the 'large volume of data generated by *mixed methods research* can create *challenges* in analysis and dissemination' (Halcomb, 2019, p. 500). Even when equipped with a multi-person research team, Halcomb cites the need to acknowledge the 'resource implications of mixed methods research' (ibid.). Therefore, it acknowledged that other forms of analysis could have been performed here, but in view of the research

questions and the need to present data and findings in a timely and coherent manner priorities were established.

In summary, the following investigations were made:

- Free-response data were coded iteratively, and emergent themes noted in Qualtrics.
- Data for each of the free-response questions were coded and categorised within the cognitive tools framework.
- Mean responses to each of the emotions on the ERE Scale was produced.
- Differences between the self-reported experiences of visitors in each of the two cases were analysed.

Procedure

At recruitment, visitors were told that the researcher was working with the museum to learn more about what visitors thought and felt during their visit. The wristband was described as a research tool which we were exploring as another means of understanding how visitors react in museums and likened to a Fitbit. Visitors were told, should they choose to take part, they would be asked to wear a wristband and to complete a survey at the end of their visit. Ethics information and consent forms were introduced, explained, and visitors were the asked if they consented to taking part in the study before completing the forms. Explicit and repeated attention was paid to making visitors aware that all their data was and remains anonymous and securely stored. They were also made aware that it was possible to withdraw at any time.

For *Snakes*, visitors were recruited over several hours over five days in July 2019. *Museum ExplorAR* visitors were recruited over several hours over three days in July 2019.[16] In both cases, data was downloaded from each device and the device was cleared of data and tested following each day of field work. The pilot had shown that using a device for multiple sessions of data capture across multiple visitors increased data errors and loss. Therefore, Empatica E4 was only used for one visitor per day. This procedure limited the amount of data and visitors that would be recruited.

[16] Two further days were planned and advertised but participants were not forthcoming.

In line with Levenson, this study rejects the notion of the 'rest' period, in which the subject is asked to do ‘nothing’ (Levenson, 1988). However, as Levenson has written, the process of baselining is itself a construct that provides false levels of activity and often a lower level of activity that one might reasonably expect to see in a minimally active subject (Levenson, 2014).Instead, it opts for a baseline activity that produces a moderate level of ANS activation. In practice, this was a short walk between recruitment and the galleries. In each case, there was a short distance to be walked between recruitment and the museum collections or exhibitions. This distance differed in each case but crucially there was not a presumed low EDA ‘rest period’ rather a period between leaving the research and entering the gallery where ANS system was not subject to the specific environmental stimuli under consideration in the study. In *Snakes*, this rest period consisted of a short walk from the researcher to the introductory panel which began the exhibition. For visitors to *Museum ExplorAR*, there was a short walk from the main atrium to the Natural History Gallery.

Surveys were provided to participants on tablets at the end of their visit. Participants were asked to provide an identifying number found on their wristband in order to match survey data to physiological data.

Sampling

With regard to sampling, both adequacy and appropriateness in relation to the study’s research questions must be considered. The sample size was contingent on attendance and recruitment in each case but also dictated by the demands of the methodology and technical setup. The differences in recruitment have an impact on the study’s generalisability and analysis but were a result of the project’s collaboration with Amgueddfa Cymru – National Museum Wales. In each case, Visitors aged 16 or above were eligible for inclusion in the study.

- In the case of *Snakes*, participants were sampled using an open continuous sampling of exhibition attendees across multiple days at the museum.

- For the AR experience, the museum requested that participants be recruited offsite. This was done via various local email newsletters and social media.

While both approaches are indicative of convenience sampling, the differences in recruitment must be addressed. The motivation for *Snakes* visitors was to see the special exhibition regardless of the research project. All *Snakes* visitors paid the exhibitions' admission charge. The *Museum ExplorAR* sample was recruited via email newsletters and social media. For *Museum ExplorAR*, there was an incentive to experience the museum via an AR device that ordinarily would have cost £10. Participants in *Museum ExplorAR* did not have to pay this fee. This introduces a clear difference in visit motivation.

The use of case studies supports 'internal generalizability', where generalisability refers to the particular setting and experience studied, and 'external generalizability' where a wider population might be considered (Maxwell, 1992). In practical terms, this refers to what can be said about the experiences of visitors to different exhibitions National Museum Cardiff versus what can be said about the experiences of visitors to the museum (or museums) more broadly. In both cases, the study sought to understand the experience of visitors who chose to attend the museum rather than recruit visitors who would not regularly attend. Therefore, the sample is able to provide insight into emotional experiences of visitors to two different types of displays at National Museum Cardiff. While the later analysis chapters do offer comparisons between these groups this is done with caution and care is taken to acknowledge the visitors had different motivations for visiting.

Finally, sample sizes are small and there are several reasons for this. First is the challenge, as a single researcher, of running the research procedure smoothly – that is managing the flow of people in and out and making sure that all devices are set up correctly, returned and accounted for, surveys completed, questions addressed, ethics procedures robustly completed, within the bustle of a museum space. The pilot study showed this task to be significantly time-consuming and demanding and this put limits on the number of participants. Prioritising issues of study management ensured a good experience for participants and maintained a good university-museum relationship. Second, the procedure created a large amount of data.

It was important to manage the project schedule and provide time for data cleaning as well as for analysis. To ensure this, the study works with the data of a smaller number of individuals in greater detail and tests two forms of analysis in relationship to the physiological data as

well as an affective practices and cognitive tools analysis. In taking this approach the study is better able to explore the relationship between the concepts and methods it is interested in.

Ideally, the cases would have samples of equal size. This was hindered by recruitment for *Museum ExplorAR* and the limited amount of interest in participating. While the invite and webpage were widely shared there was a small window of time in which data collection could take place around museum events and collection re-hangs. As a dynamic public space, the museum changes its displays and content regularly. Shortly after the *Museum ExplorAR* finished data collection the experience was changed and therefore it was deemed inappropriate and invalid to collect data with additional participants as it would not have been comparable to the *Museum ExplorAR* data already collected.

Validity & Reliability of Physiological Data

A significant amount of published EDA research has been conducted under clinical settings. As one might expect, precedents set by clinical research do not translate perfectly to research in a museum. Conducting research in the real world or as Robson puts it an 'open system' presents some challenges with regards to reliability and validation (Robson 2002, p.29). The lack of control over extraneous variables is a complicating factor in this research.

In terms of reliability, signal noise or disruption in the Empatica e4 signal was an issue. Interference on the wristband distorts the signal and renders the data unreliable. Devices were fitted for participants and removed prior to the survey. Correct fitting reduces data issues. Instances of signal dropout and device malfunction also impact data validity. Data was visually inspected, and the duration and end time of EDA data recording was matched with timestamps on the survey. This enabled data affected by device failure to be ruled out. Such an undertaking also indicates why data cannot be thought of as 'raw' – this process of cleaning subjects it to distortions in order for it to be suitable for analysis. This privileges data of a certain quality. This poses the question as to whether higher quality data is equally distributed across different demographics? This question is returned to in the analysis chapters that follow.

The Valins effect was considered. The implications this has for the current study are clear and easily addressable. To avoid any effect, the visitor was blind to the physiological measures. In this study, the Empatica E4 does not have a screen or data relay and is worn

without a connection to a mobile device that relays data in real-time. The visitor has no access to physiological data unless they requested it.

Validity & Reliability of Self-Report Data

It has been argued that experiences in museums cannot be investigated reliably via questionnaires or surveys alone, as they often fail to depict unconscious or experiential elements (Tröndle *et al.*, 2012; Tschacher, Greenwood and Kirchberg, 2012). In this view, that questionnaires are commonly deployed at a temporal distance from the experiences itself means they attend only to the cognitive and linguistically processed echoes of a previous experience. This thesis agrees with this view up to a point. That is to say that it is not possible to capture some element of experience but that is not a fault of a particular method but is because we cannot accurately assess what people 'think' as people are always involved in some kind of social interaction and meditation when they communicate with others be that in interviews or via a survey. This study did not set out to pursue closed and complete answers on affective experience. This would conflict greatly with the theoretical underpinning of the study. Instead, this study aims to understand how visitors represent and make sense of their emotional response within the museum. It approaches this problem via an affective practice understanding of emotion and affect, and through the use of the cognitive tools framework to categorise the types of talk deployed by visitors when the recall and relay their experience.

With greater resources, it would have been possible to conduct more observation of participants. Again, as mentioned above, the amount of data this methodology produced was already sizable. The section above dismissed video recording as potentially intrusive and it would be remiss not to echo the same concerns here. The issue in both cases is that the Empatica e4 device is a form of surveillance. It is also a tool under exploration and investigation in this study. In order to properly address that investigation, other methods that could have potentially added to the sense of being surveilled were not used in this study.

The use of a priori framework can complicate interpretation and introduce bias towards fit with the framework rather than meaning emerging from the data (Robson, 2002). Data were put through multiple, iterative coding processes which examined, and then re-examined all qualitative data in this study. In practice this meant data was read, re-read, coded, and recoded multiple times. After this process, the links with the cognitive tools framework were apparent and therefore this framework was applied after themes emerged rather than as a

priori. In a larger study, further validation could be provided by working with additional researchers to compare and validate the data's codes.

Ethics

Good research requires ethical rigour and a keen awareness of the power relations between the researcher and the participant. In this study, the ethics of data collection, analysis and presentation are all keenly considered. The study's research design was assessed and approved by two separate ethics committees, one acting on behalf of the School of Social Sciences at Cardiff University and another internal to Amgueddfa Cymru –National Museums Wales. Further to these processes, this section discusses how a high ethical standard was maintained in relation to the research design and discusses the potential for harm, researcher positionality, the use of findings, and informed consent.

- Informed Consent
  Drawing on a definition of informed consent as an essentially truthful and respectful exchange between researcher and the people participating in the study, the consent process provided clear information on what was being studied and how - participants were provided with information about the nature of the project (both verbally and in writing) and their right to withdraw and asked to complete an opt-in consent form for each element of the study. How results might be used (i.e., written up into reports, research publications) was made clear to participants at the point of consent. Any participant questions were answered fully and truthfully.

- Data Management
  Research data was held securely in accordance with the policies of Cardiff University and the ESRC's Research Data Policy (ESRC, 2015). Paper consent forms were used and kept separate to participants' interview data. No names were taken by the survey and no identifying information from survey data will be included in any publication or dissemination activity (e.g., conference presentation) arising from this project. Survey and physiological data were tracked and identified using a participant number.

  The E4 data was stored without identifying information on the Empatica server. The Empatica E4 is a proprietary device, which in addition to data collection, offers data

visualisation through its graphical user interface (GUI) and access to live stream data via an application programming interface (API). The survey was administered via the online survey platform Qualtrics and the resultant data stored on the company's server. All data were stored securely, protected by password encryption. In the case where a third party held data (Empathic and Qualtrics) the data security protocols were checked and found to be satisfactory. Qualtrics uses Transport Layer Security (TLS) encryption for all data. Data is protected with passwords and HTTP referrer checking. Data is hosted by data centres that are independently audited using the industry-standard SSAE-16 method. Data held by Empatica was subject to 128 Bit encryption. Data held by Empatica and Qualtrics could be deleted in full at any time. All downloaded data was stored as password protected excel worksheets on the Cardiff University network only.

- Potential for Harm

  In considering potential harm to participants, emotional measurements might lead to feelings of inadequacy and comparison with peers (Howell *et al.*, 2018). This was avoided by blinding participants to the E4 data.

  Lupton has conceptualised the effect of certain technologies on the self and society where the boundary between public and private is not clear, where the self is rendered into digital data to be measured, interpreted, improved and ultimately subjected to additional values or uses that are not always clear or explicit (Lupton 2016; Lupton 2019). Researching affective experiences – both physiologically embodied and self-mediated self-report - in the public museum space has the potential to collapse boundaries and render visitors into digital data. Greenhalgh makes the argument that an increased focus on metrics and the flow of quantitative digital information, rather than on lived experience may be render a participant 'less human' (Greenhalgh *et al.*, 2013). The issues were addressed through the survey. Participants were able to give voice to their experiences, describe their feelings in detail (should they wish to). In the survey, no questions were mandatory; emphasis was placed on the study's interest in participants' thoughts and feelings rather than right or wrong answers. The researcher was on hand to answer questions and/or any aspects of the survey. This is a valid form of data collection for this project, and as such, it aimed to avoid the reduction of participants to physiological metrics without their lived experience being captured.

The datafication of the person has been described by Beer as part of the 'data gaze' (Beer, 2018). Beer suggests this gaze has been stimulated by "a culture that is shaped and populated with numbers", where quantification is the route to holding attention, interest, and perceived validity (Beer, 2017, p. 149). In line with its critical data studies perspective, this study views the physiological data in this study as 'technological phenomena, which are about using computing power and algorithms to collect and analyse comparatively large datasets of largely unstructured information', but they are also 'a cultural phenomenon' that are associated with a 'higher form of truth' than can be interpretively achieved (Lindgren, 2019, p. 3). The thesis is cautious, throughout, to refer to data as self-reported data or as physiological data. It very deliberately avoids qualitative or quantitative labels except where absolutely necessary. This emphasises the fact that the quantitative EDA data is reliant on the qualitative self-report data. From an ethics standpoint, this works to ground the thesis in a view that these data types can be used to unform one another and where that process concerns linking EDA to human experience that process is led by the qualitative self-report data. Any analysis must be shaped by the self-report to be empirical and ethically valid.

- The Use of Data and Findings

  Recording physiological data speaks to issues surrounding health and data privacy, the researcher's expertise in EDA enables the data to be cleaned, standardised, and interpreted in relation to the study. There is an issue of researcher power and in this study its role with potentially sensitive data relating to an individual's biological function. Only a trained health professional would be able to diagnose any underlying health conditions by examining the data collected for the study. Participants were not asked about medical conditions or drug regimes. While certain conditions or drugs impact EDA, this level of questioning was deemed intrusive and not ethically sound, given the nature of the project. For instance, depression has been seen to cause lower levels of EDA. Such variation can be addressed, without the researcher's knowledge, through the standardisation of the data. Therefore, it was prudent not to ask for private medical information and avoid framing the study as medical and misrepresenting the researcher's expertise.

Strict data management protocols were followed; data were only used for analysis within the context of the research questions proposed. All data and results were anonymised, and no identifying material is included in this or any other publication arising from this study. All dissemination of this study has and will explicitly discuss how authority is commonly ascribed to biosensing devices. For example, the ways physiological data might be seen to amplify/reduce elements of experience irregularly submit human experience to quantification and has the potential to skew the individual and social values associated with emotion. As an exploratory study, these issues are reflected by the research questions – specifically those concerned with the validity of EDA data.

- Researcher Positionality

  An adequate reflection on positionality enables the researcher's relation to the study's social and political context to become clear. Researchers and participants are social actors and are influenced by the power relationships of the groups to which they belong (Robson, 2002). In line with Breen's argument that the 'insider/outsider dichotomy is simplistic', the study understands researcher positionality as a continuum process rather than a binary choice (Breen, 2007). It is important to differentiate between research projects that have links to the environment they intend to study, and those that lead a researcher to become intimately involved with a community during the research process (DeLyser, 2001). In this study, the researcher is not a member of the museum staff nor do they have any interests in the Empatica E4 or similar devices; this promotes a more critical position. Some insider background must be acknowledged but the specific nature of the research's position does not imply an insider/outsider binary in this case.

  Within the context of data collection, the relationship between the study, the researcher and participant may influence the outcome (Laine, 2000). The choice of research methods created a greater sense of space and avoided the researcher influencing participants. Both the physiological and survey data were collected at a distance from the researcher. The survey administered on tablets anonymously with space for participants to spread out in the museums' atrium. EDA data was recorded without live real-time feedback. By comparison, the inclusion of structured or semi-

unstructured interviews and being more demanding and unsuited to the public environment could have led to more research influence over participants.

It would be disingenuous if the researcher was not clear about their professional experience and its impact on the project. Since 2012, the researcher has worked with leading public institutions across the UK, including Tate, Nesta, Watershed, the Pervasive Media Studio, Arts Council England, Arts Council Wales, National Theatre Wales, Shakespeare's Globe, the Guardian, and the British Council. Between 2015 - 2017, they ran the Digital Innovation Fund for Wales on behalf of the Welsh Government and the UK's National Endowment for Arts, Science and Technology (NESTA). They sat on the Digital Innovation Board of the UK's Office for National Statistics. Previously published works cover affect at Tate Britain and human agency in relation to the Internet of Things (Hoare and Reddington, 2014; Hoare, 2015). This combined experience in the creative and cultural industries has shaped the approach to this study; it has developed a critical approach to technology and its role in understanding human experiences.

Conclusion

Any sound methodological choice should align with theoretical convictions and the specifics of a given study. A significant proportion of this thesis worked to establish a sound, well-evidenced foundation; part three proposes a means to put this to work in an exploratory manner. As an exploratory study, attention is paid to setting up reliability, validity, and ethics issues. The first two parts of the thesis introduce many of the issues presented in part three. As we shall see in the coming chapters, these issues present as methodological in nature, but they are also inextricably linked to theoretical and epistemological beliefs about data, technology, and affect. These issues arise in the following analysis chapters and are discussed in detail in the concluding chapter. The issues in this section speak to tensions between theory and method in affect and emotion research. These present in the analysis that follows and are discussed in the concluding part of this thesis.

The approach and methodology set out in this chapter aim to understand the role of affect and emotion in museum visitation and determine the value of EDA data in this inquiry. This thesis has repeated evidenced the fact that EDA data must be held in conversation with visitors self-report data. The methodology reflects this and engages with visitors self-report as

a substantial body of data in its own right. The results of the relevant analyses can be found in chapters 6, 7, and 8. These chapters focus on self-report data, interpersonal analysis of EDA data at a group-level, and a mixed methods intrapersonal analysis of the relationships between individual EDA response and self-reported data, respectively.

Part Four: Data Analysis

Introduction

Part four contains three empirical chapters with each approaching the data collected for this study in a different manner. The different analyses presented in this part respond to specific research questions. As a result, Chapter 6 discusses the survey data only and responds to research questions 1, 2, and 3:

1. How do visitors describe and recall their experience of *Museum ExplorAR* and *Snakes*?

2. Does visitors' response vary between different displays?

3. How do open and closed survey questions contribute to understanding affective experience?

Chapter 7 looks at the group-level distribution of EDA data and responds to 4 and 4.a.:

4. In the cases considered, is the analysis of aggregated electrodermal data a valid and useful methodological approach to investigating visitor experience in museums?
    a. When standardised and grouped by exhibit and sub-divided by demographics, how is physiological response distributed and do distribution differences exist between groups?

Chapter 7 brings together self-report data from the survey with EDA to undertake an integrated mixed method analysis. This is concerned with question 5 and 5.a.

5. In the cases considered, is the analysis of individual participants electrodermal data a valid and useful methodological approach to investigating museum visitor experience?
    a. Do relationships exist between visitors' self-reported emotion data collected via surveys and the electrodermal data collected from the Empatica E4?

This structure reflects the aims of the thesis. Each chapter contributes to understanding the embodied and social organisation of emotion and affect within museum visitors' experiences. Within each chapter, connections are made to the debates and methodological challenges presented in the thesis's preceding parts. This structure enables a comprehensive exploration of the collected data via three different approaches to data analysis. Each chapter concludes with a discussion of the analyses conducted in the context of the relevant research questions. To avoid repetition and maintain momentum, the chapters in this part do not have individual conclusions. Instead, part four ends with a conclusion and summary of findings before the thesis proceeds to its concluding part.

Chapter 6. Survey Analysis

Introduction

This chapter considers the survey data from the *Museum ExplorAR* and *Snakes* exhibitions. The survey was administered via tablets using the Qualtrics survey platform. The chapter presents the thematic analysis of visitor survey responses to open response questions and results of a closed response emotion scale (the previously mentioned EES). The chapter presents an analysis of the survey data and follows this with a discussion in the context of the research questions below:

1. How do visitors describe and recall their experience of *Museum ExplorAR* and *Snakes*?

2. Does visitors' response vary between different displays?

3. How do open and closed survey questions contribute to understanding affective experience?

At the end of this chapter, each of these questions is answered. Further analysis relating to research questions 4 and 5 sits in the following two chapters. A demographic breakdown of the data for each case is provided in Appendices A and B. A demographic analysis is not used in combination with the cognitive tools framework in this chapter. Instead, this chapter pursues a between case analysis due to the restricted sample size and the remit of the research questions.

Analysis of Open Response Data

This section builds on discussions in the preceding chapters. The following investigations were made in order:

- A thematic analysis of survey text data was done directly into Qualtrics.
- All free-text responses were analysed and coded.
- The researcher worked through the data three times to capture themes to their full extent and check for consistency.

Once coded the open response data for both *Snakes* and *Museum ExplorAR* were found to map onto the categories within the cognitive tools framework without any need for significant amendments or alternatives. One unrepresented category – social narrative - was found in the data and this was added to the framework and is discussed later in this chapter. In *Snakes* and *Museum ExplorAR*, two dominant themes were identified: 'Description' and 'Narrative'. The first category, 'Description', identifies where visitors recall and describe the objects and displays they saw during their visit. The second category, 'Narrative', represents visitors sharing information they encountered during the visit, i.e., aspects of the museum's interpretation and storytelling materials. Narratives are broken down into more specific categories – information narratives deliver facts drawn from interpretation. Historical narratives also contain facts, but these are concerned with the collection and provenance. Curatorial narratives reference where visitors discuss the museum environment and the choices made in staging displays. Social narratives focus on interactions with others in the museum during the visit. Learning narratives include instances where visitors refer explicitly to the act of learning and the visit's educational nature. These categories are not mutually exclusive, and visitors responses were coded with multiple categories. As we shall see in the following data, description and narrative categories form the basis of how visitors describe and retell their experience. Two categories that are seen less frequently are 'Analysis' and 'Weaving'. The third category, 'Analysis' relates to comparisons, judgements or opinions often following on from descriptions and narrative associated with the visit. Finally, 'Weaving' takes these processes further and identifies instances of reflection, critical thought, self-identification with a form of narrative that makes connections to the world beyond the museum.

The analysis which follows takes each survey question in turn and presents the percentage of respondents whose answers can be classified within each category. This analytical process was undertaken for each exhibition. The decision to segment the analysis by each question in the order visitors encountered them corresponds to the study's aim of understanding how visitors recall their affective experience. Questions relating to memory and interest were included as prompts in the survey to enable visitors to reconnect and remember their visit. Separate tables are presented for each exhibition; these illustrate the coded responses for each survey question. The visitors' responses within each exhibition and the differences between the two exhibitions are discussed for each survey question presented. The findings presented here are summarised and discussed in response to the research questions in the

next section. The choice to include each of the questions and the data they generated was made based on their contribution to the study's methodological investigation. The pilot study found that asking visitors to recall aspects of their visit in terms of memory or interest did not directly access participants' emotional world but helped visitors recall the experience.
The first open response question that visitors were asked to answer was: ***'What Did You Find Most Memorable About Your Visit Today?'***.

Tables 1 and 2 show visitor responses to this question. When asked what they found memorable, over half (69.23%) of the visitors to *Snakes* described specific displays or objects. The live snakes and snake skeleton feature prominently in visitor accounts. The recall of interactive objects is 7.89%; in this case, respondents name or describe an activity: "*Touching the fake skin in the drawer*" (Participant S32) and "*Find a snake game*" (Participant S18). Almost a fifth of visitors (17.94%) used narratives centred on specific facts, with a smaller number of participants explicitly mentioning learning (5.12%). Participant S7 wrote: "*All the interesting facts, thought I knew a lot about Snakes, but learnt some interesting things!"* (Participant S7). Participants using forms of analysis would identify objects and then offer a comment on them. For example: "*The Snakes skeleton was stunning. The Snakes in jars were memorable but not in a good way."* (Participant S26) and *"The snake skeleton! That was incredible"* (Participant S24).

All visitors to *Museum ExplorAR* used 'Description'. In all but one case, this recall was interwoven with descriptions of the augmented images, for example: "*Probably the swimming shark and whale in the aquatic section of museum (sic)*." (Participant A6). Participant A6 references an entirely computer-generated shark and the museum's whale skeleton, presented with an augmented reality overlay of a computer-generated, flesh covered, moving whale. The distinction between real objects and computer-generated ones can become unclear in some cases; one visitor writes: "*Waterlilies in the impressionists room and the talk by the Davis sisters and Monet*" (Participant A5). The talk described is delivered by AR, but the waterlilies could be a reference to computer-generated waterlilies transposed across the gallery floor or the painting present in the room. As a relatively novel form of interacting with museum collections, it is interesting to note the potential for augmented reality to confuse and collapse 'object' and 'interactive'. This poses questions concerned with the differences and interplay between real-world experiences with digital technologies.

Table 1**:** Memorable aspects of museum experiences as recalled by *Snakes* participants (n = 39)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	27	69.2
Specific object mentioned:		
- Live snakes	14	36.8
- Snake skeleton	4	10.5
- Interactive displays	3	7.9
Narrative	9	23.0
Types of narratives used:		
- Information narrative	7	17.9
- Learning narrative	2	5.1
Analysis	3	7.7

Note: One participant said they didn't know, and a second mentioned a display outside the Snakes Exhibition.

With 92.31% of *Museum ExplorAR* visitors describing augmented reality objects, the technology-enhanced experience seems to have been significantly memorable. In contrast, the interactive displays in the *Snakes* exhibition appear less memorable. Nonetheless, it would be inappropriate to make direct comparisons between the interactive aspects of *Museum ExplorAR* and interactive displays in *Snakes*. Augmented reality is delivered through a solo engagement with a screen, whereas physical interactive displays and games were peppered throughout *Snakes.* There is, of course, a difference between a screen overlay on reality versus games, puzzles, and touch screen quizzes in *Snakes*.[17] As an emergent immersive technology, the experience of *Museum ExplorAR* is interactive in a different

[17] These types of displays were described as 'interactives' by museum staff and included both analogue and digital formats.

manner. As augmented reality continues to receive attention and investment from museum professionals, researchers, and educators, the question of how this technology shapes experience becomes more pertinent but, to be clear, it is a subject worthy of study in its own right. It is, however, beyond the scope of the current study.

Table 2: Memorable aspects of museum experiences as recalled by *Museum ExplorAR* participants (n = 13)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	13	100
Specific object mentioned:		
- AR objects	12	92.3
- Impressionist Gallery	8	61.5
- Dinosaurs	3	23.1
- Marine animals	2	15.6
Narrative	2	15.4
Types of narratives used:		
- Information narrative	2	15.4
Analysis	3	23.1

As Tables 1 and 2 show, in both *Museum ExplorAR* and *Snakes*, description is the primary tool used by visitors when they are asked what they found memorable about their visit. Forms of narrative come second in frequency of use for *Snakes* visitors. This fits with Leach and Leinhardt, Tittle, and Knutson's findings, who also identify these tools as the most frequently used when the cognitive tools framework was applied to visitor data in their own studies (Leinhardt, Tittle and Knutson, 2002; Leach, 2011). This speaks to the practices of looking and voyeurism being central to the experience and recall of the museum for many visitors. Arguably, in the case of this study, this is most explicit in the recall of the live snakes and the snake skeleton, where both offer visitors a chance to gaze intently at the unfamiliar, with the

latter taking them within the body of the creature, stripping away its flesh and exposing its inner structure. Analysis is used to a lesser degree by *Snakes* visitors when compared to 'Description' and 'Narrative'. *Museum ExplorAR* visitors make more use of analysis and use it as a secondary to the primary descriptive tool. No visitor, in either experience, used 'Weaving' to recall what they found memorable about their visit.

In both *Museum ExplorAR* and *Snakes*, no visitor described an affective or emotional response as the most memorable aspect of their visit. In both *Snakes* and *Museum ExplorAR,* the response to what was memorable is often a visual recall of a display or object. Responses align with the cognitive tools framework as the recall of objects, information, and forms of analysis are present in the data. While this question does not directly access emotional and affective descriptions, the answers to this question given by visitors begin to establish how visitors recall and share their experience in the museum. This aligns with a view of affective practice as a dynamic, multi-layered process that is individuated according to personal attachments and experiences.

The second open response question asked visitors: '***What Did You Find Most Interesting About Your Visit Today?'.***

Tables 3 and 4 show that both *Snakes* and *Museum ExplorAR* visitors, when asked what they found interesting, use description in their responses. *Visitors to Snakes* responded to this question with forms of description and narrative. Here information narrative feature most prominently: "*Astonishing facts*" (Participant S13) and "*Antivenom*" (Participant S6). Learning narratives present to a less significant degree., for example, Participant S21 wrote: "*Learning about the longest snake ever*". Description is the most commonly used cognitive framework tool deployed by *Snakes* visitors, followed by narrative and analysis. *Snakes* visitors use narration to build on the description of objects, specifically by detailing their visit's informational and educational aspects. As in the previous question, forms of analysis are used less frequently. Participant S4 analysed the change in themselves following the visit by extending their description of the live snakes, saying that they found them "fascinating" and discovered "a new found appreciation" for snakes.

Table 3: Interesting aspects of museum experiences as recalled by Snakes participants (n = 37)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	21	56.8
Specific objects mentioned:		
- Live snakes		
- Snake skeleton	9	24.3
- Interactive displays	2	5.4
	2	5.4
Narrative	17	46.0
Types of narratives used:		
- Information narrative	14	37.8
- Learning narrative	3	8.1
Analysis	2	5.4

Note: Two participants did not complete this question.

Almost half of all *Museum ExplorAR* visitors (46.15%) reported that the most interesting thing about their visit was the augmented reality objects. These responses centre on the technology's ability to bring the collection to life and include: "*The movement of the animals that were encountered*." (Participant A6) and "*Seeing the digital recreation of animals*" (Participant A12). As one might reasonably expect, there is a sense of awe that arises from the augmented reality experience, where dinosaurs are brought to life and marine animals swim overhead. It is also interesting to note, though it presents to a lesser degree, the concern with the curatorial role of the technology and visitors' reflections on how augmented reality shapes their experience. It is this interest in the curatorial choices and implication of the technology that sees Participant A13 consider their own experience and the role of augmented reality, they write: "*Thinking about how the AR interacts with & influences my/ our*

experiences of the exhibitions". It is interesting to see that for this visitor the analysis of the technology and its role in the experience draws on both the analysis and weaving tools – where they reflect on their experience *and* the experiences of others.

In the case of Museum ExplorAR, historical narratives associated with the collection's provenance resonate with a small number of visitors. Participant A5 wrote: *"The information about the whale and how parts had been destroyed by fire",* and Participant A11 uses another narrative related to the history of the collection: "*Learning that the sea creatures, such as the whale and turtle were washed up in Wales."* Aspects of the visit recalled as 'interesting' by *Museum ExplorAR* visitors predominately relates to specific aspects of the collection provenance, how it came to be in front of them and the things that have happened to it - this shines a light on an essential difference between *Snakes* and *Museum ExplorAR*. For *Museum ExplorAR* visitors, the permanent collection is not just the objects but also the objects' story. The differences in how museum displays are recalled, specifically between a permanent national collection in a capital city versus a touring exhibition is worth noting. *Museum ExplorAR* Visitors recall the provenance and history of the collection and connect to events and contexts outside the museum. *Museum ExplorAR* visitors use narrative to communicate connections to place. The objects in *Snakes* do not meet with the same degree of placemaking and storytelling when they are recalled and described in the survey. *Snakes* visitors use narrative to recall wonder and awe at the natural world.

As before, no visitor to either *Museum ExplorAR* or *Snakes* explicitly reported an emotion or affective state when asked what they found interesting. However, visitors describe connection to place or relationships to nature and these descriptions speak to forms of affective experiences – understanding these recollections as such is a vital point in an affective practices approach. In the aspects of the visit participants find interesting, one can see how visitors create meaning from museum displays. In this sense, the combinations of the affective practice and cognitive tools framework reveals the seeds of affective experience without merely pursuing specific emotive terms from visitors – this a more nuanced approach to understanding the work visitors undertake when making meaning in museums. Furthermore, it is interesting to see how different questions elicit the use of different cognitive tools. There is an increase in narrative use in both cases compared to the first survey question. This is a relatively minor and obvious point but is a useful methodological observation in the tool's subtlety and may inform the formation of survey questions in future

research. As with memory, what visitors find interesting helps one to understand how visitors recall and retell their experience of the museum and its displays. This provides a foreground to the next question, which asks explicitly about their emotional experience.

Table 4: Interesting aspects of museum experiences as recalled by *Museum ExplorAR* participants (n = 13)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	7	53.8
Specific objects mentioned:		
- AR objects	6	46.2
- Impressionist Gallery	1	7.7
- Dinosaurs	1	7.7
- Marine animals	2	15.4
Narrative	3	23.1
Types of narratives used:		
- History narrative	3	23.1
Analysis	2	15.4
Weaving	1	7.7

The third open response question asked visitors to: '***Take A Moment to Think About What You Encountered at The Museum. How Did Your Visit Make You Feel?'***

Table 5 gives the categorised emotions reported by visitors to *Museum ExplorAR* and *Snakes*. The categories presented arose through manual coding of the responses. While the modest sample sizes in this small exploratory study prevent generalised conclusions, the data reveal six types of affective experience common to visitors to both exhibitions: engaged, excited, enjoyment, calm, curious, and connected. Each exhibition appears to contain a blend

of these six accompanied by others that are more context-specific. For example, visitors to *Snakes* report nervousness and, in one case, nausea. As previously discussed in Chapter 1, Feldman-Barret claims that certain experiences have associated affective or emotional combinations. A total of 61.58% of *Museum ExplorAR* and 79.48% of *Snakes* participants responded to the question with multiple forms of affect. This finding is strongly supportive of Feldman-Barret's view, and this study's data suggest that it may be useful to investigate these six common states (engaged, excited, enjoyment, calm, curious, and connected) further and determine whether they play a role in the emotional experiences visitors have in museums more widely.

Table 5: Affective aspects of museum experiences in both groups of participants

	AR: Percentage of total question respondents (n=13)	*Snakes*: Percentage of total question respondents (n=39)
Engaged	46.2	38.5
Enjoyment	15.4	38.5
Excited	30.8	7.7
Connected	15.4	12.8
Calm	15.4	5.1
Nervous	0	12.8
Educated	0	10.3
Curious	7.7	7.7
Impressed	0	5.1
Nausea	0	2.6

In both *Museum ExplorAR* and *Snakes,* visitors report feeling engaged with the exhibition. In many cases, visitors specifically use the word 'engaged'. After forms of engagement, visitors

reported feelings of pleasure: visitors to *Snakes* report enjoyment (38.46%), while *Museum ExplorAR* visitors describe excitement (30.77%). A small number of visitors to both exhibitions reported feelings of connection to the world outside the museum. For example, one *Museum ExplorAR* visitor wrote: "*In the underwater section I felt a connection to the whale which was excitement and sadness especially within the current environmental position.*" (Participant A7). A visitor to *Snakes* responded: "*Educational. Real sense of connection to natural history. Sad because of loss of species but amazed by diversity*" (Participant S2). Participant S28, a visitor to *Snakes*, describes being *"Amazed by God's creativity"* (Participant S28). These comments illustrate a museum's ability to provoke reflections that extend beyond its walls - regardless of whether such thoughts focus on the natural or supernatural world. In the case of the three examples given here, one can see how emotions interweave with meaning - whether that is the sense of amazement connecting with religious belief or the sense of grief at ecological devastation. These participants' comments speak to Wetherell's view of affect as a form of embodied meaning-making, where affective experience shapes meanings and is shaped in turn by personal experience and knowledge.

The final open response questions asked**: *'What About the Museum Made You Feel This Way?'***

This question used a looping feature in Qualtrics to present visitors with the answer they had given in the previous question ('*Take A Moment to Think About What You Encountered at The Museum. How Did Your Visit Make You Feel?')*. It asked them to identify what about the visit made them feel what they had previously written in the survey. Tables 6 and 7 show that, in both *Museum ExplorAR* and *Snakes*, description and narrative were the most prominent tools used by visitors to respond to this final question and identify the aspects of their visit they found emotive. When visitors were asked to identify and communicate what caused their response, description was used to express that 'what' and narrative to explain the 'why' of their emotional response—in this sense, attending to the what and why of their affective experiences was intended to reveal forms of embodied meaning-making in relation to the affective experience. This question asked visitors to reflect on an answer they had previously given and presented this answer back to them as part of the question – it is interesting but perhaps unsurprising that acts of analysis and weaving increase.

Table 6: Source of affective responses as recalled by Snakes participants (n = 37)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	15	40.5
Specific objects mentioned:		
- Live snakes	5	13.5
- Interactive games	3	8.1
- Dead snakes	2	5.4
Narrative	15	40.5
Types of narratives used:		
- Information narrative	6	16.2
- Curatorial narrative	6	16.2
- Social narrative	3	8.1
- Learning narrative	2	5.4
Other	5	13.5
Analysis	4	10.8
Weaving	1	2.7

Note: Two participants did not answer the question. The 'Other' category refers to responses that cannot be coded within the framework. These responses are general or all encompassing, e.g., 'Good' and 'Everything'.

Table 7: Source of affective responses as recalled by *Museum ExplorAR* participants (n = 13)

	Number of participants mentioning at least once	Percentage of total question respondents
Description	10	72.9
Specific objects mentioned:		
- AR objects	6	46.2
- Impressionist Gallery	5	38.5
- Dinosaurs	2	15.4
- Marine animals	3	23.1
Narrative	10	72.9
Types of narratives used:		
- Information narrative	2	15.4
- Curatorial narrative	7	53.8
- Historical narrative	3	23.1
Analysis	5	38.5
Weaving	1	7.7

As Table 6 demonstrates, this question leads to an increase in visitors using analysis as they reflect on their emotive experience. The question also sees the first uses of weaving in the *Snakes* case. For example, Participant S27 discussed their experience of “Real sense of connection to natural history. Sad because of loss of species but amazed by diversity.” within the *Snakes* exhibition in the context of the Extinction Rebellion event they were taking part in outside the National Museum. They related their feelings to: “Reading displays and discussing exhibits in comparison to our event outside - Extinction rebellion.” (S27). Responses also include an increase in the types of narratives visitors use to communicate

their experience; social and curatorial narratives make an appearance for the first time. *Snakes*, held during the summer holidays, was hosted in a gallery often used for temporary exhibitions. The exhibition space was transformed by colour, lighting, and sound. It was intended to be transportive, and one visitor writes they felt "*As though I'd entered a tropical world.*" (S17). Another visitor attributed feeling "*relaxed*" to *"The ambient light, temperature and the background wild noises.*" (S32).

Of the visitors that use description to identify emotive objects, 85.71% of those in the *Museum ExplorAR* group described feeling engaged and excited; the same is true for 62.5% of *Snakes* visitors. One visitor to *Snakes* wrote that the "*Variety of types of exhibits*" made them feel "*Informed and engaged*" (S10). *Museum ExplorAR* Participant 12 wrote that they felt "*Absorbed in a different way. More focused on the information and less distracted.*" and that "*Delving into the experiences was thought-provoking and I felt quite focused and away from the rest of the day.*" (A11). Comments on the act of accessing more information and being more focused appear in other *Museum ExplorAR* accounts. Another visitor writes that: "*The additional experience and information presented*" made them feel "*Engaged"*.

A small number of visitors (8.10%) to *Snakes* reference social interaction as the key force shaping their emotions in the museum. This is not a feature of the cognitive tools framework but was picked up in the coding and was included in this study as an addition to the cognitive tools framework. *Museum ExplorAR* visitors do not describe a social aspect when recalling their visit. Despite representing a small percentage of visitors, the social component of museum experience has long been valued as a core aspect of meaning-making and learning (Falk and Dierking, 2000). That social narratives are not present in the *Museum ExplorAR* group is likely indicative of the more solidarity nature of experiencing the museum through a screen designed for one person to control and view the collection. This touches on a need to revisit and perhaps reformulate previous research in view of how certain interpretative technologies may reshape the museum experience. While a comprehensive discussion of such an issue sits beyond this thesis's remit, it is worth noting that this study finds that Museum ExplorAR, as a form of technological delivered museum interpretation, impacts the social component of affective museum experiences when compared to *Snakes.* However, a simpler explanation can also be offered by the fact that Snakes visitors often attended as part of a group (92.3%). In contrast, Museum *ExplorAR* participants were more likely to attend alone (only 61.6% of Museum *ExplorAR* visitors attended in a group).

In contrast to the reduced use of social narratives, curatorial narratives feature significantly in *Museum ExplorAR* visitors' responses. This indicates that in recalling the *Museum ExplorAR* experience, visitors paid attention to how the collection was presented. *Museum ExplorAR* provided new perspectives on curation and the museum environment itself:

> During past visits, I've loved looking at the exhibitions, particularly the dinosaur exhibition and the content of the art galleries. The details and the textures. What felt different this time is that although I was given another perspective, I felt that I looked less at things and skimmed over the detail. And somehow 'looked' less and more detached.
>
> - Participant A6

Participant A6's comments reflect the intentions of the museum's staff who set out to explore how to provide new perspectives on permanent collections without a 'major physical overhaul involving big budgets, lots of staff, contractors, and complex project management' (James and Davies, 2019). Participant A6 describes how *Museum ExplorAR* did offer them new perspectives on familiar collections but that the experience of the museum through augmented reality felt somewhat removed from the displays. Participant A5 echoes this sentiment:

> I enjoyed being followed by a shark, even if the image itself wasn't the best of the bunch. The AR encouraged me to navigate the spaces in a different way. It meant I didn't engage fully with the static exhibitions though and went more for thrill seeking.
>
> - Participant A5

There is an emergent theme in Museum ExplorAR visitors' experiences relating to the museum experience as shaped by the technology. Revisiting the data across the different open response questions reveal another visitor who writes, in response to the previous question ('*Take A Moment to Think About What You Encountered at The Museum. How Did Your Visit Make You Feel?')*:

> I felt more engaged with the things I could see and interact with via the AR device which meant I paid a bit more attention to the information. However I was also are I wasn't paying as much attention to the things that weren't on the AR device.
>
> - Participant A10

These comments point to the role of augmented reality shaping the visitors attention and focus during this visit. Here further research questions arise relating to augmented reality in the museum and its role in constructing affective experience. In particular, it would be of use for a future study to undertake a more detailed examination of how visitors experience the museum through augmented reality technology. A particular focus of such a study could be whether visitors feel augmented reality creates more distance from the displays vs how it enables focus. Such a study could locate itself in a research space between interaction design and affective practice to understand the construction of attention and affective experience in the museum. However, this is beyond the remit of the current study.

Analysis of Closed Choice Data

After the open response questions, the survey included a closed choice emotion scale to compare visitor response between open and closed choice emotion questions. The Epistemically-Related Emotion Scale (EES) is a systematic multi-item instrument measuring seven emotions shown by Pekrun et al. to occur during epistemic activity. Furthermore, its validated short-form enabled greater ease of integration and avoidance of survey fatigue in participants (Pekrun *et al.*, 2017). Data are presented below for each visitor group—comparisons are made between the two groups (*Museum ExplorAR* and *Snakes)* and comments are made on the differences between responses to the EES and the open response questions.

In response to the EES question, visitors in both groups report comparatively higher feelings of surprise, curiosity, and excitement versus lower levels of confusion, anxiety, frustration, and boredom. In both cases, frustration and boredom are reported the least. The overall similarities between the groups are striking. The first impression this data gives is that the closed scale may not, as argued by Barrett, attend to variability in affective experiences (Barrett, 2009). This may appear to be a relatively benign statement, given that one cannot expect variability in terms of the specific represented emotions in a closed choice instrument.

However, the similarities in the intensity and patterning within reporting is notable, i.e., in both cases, surprise, curiosity and excitement more readily reported in comparison to emotions that may be perceived as negative (boredom, confused, anxious, frustrated).

Figure 2: *Museum ExplorAR* participants' responses to Epistemically Related Emotion Scale.

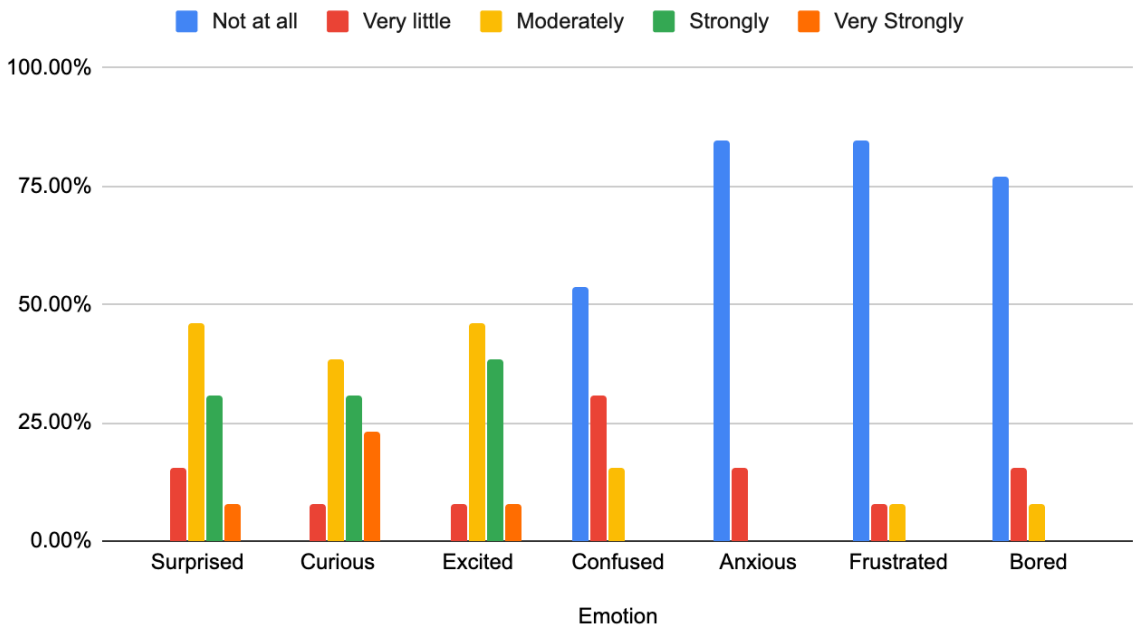
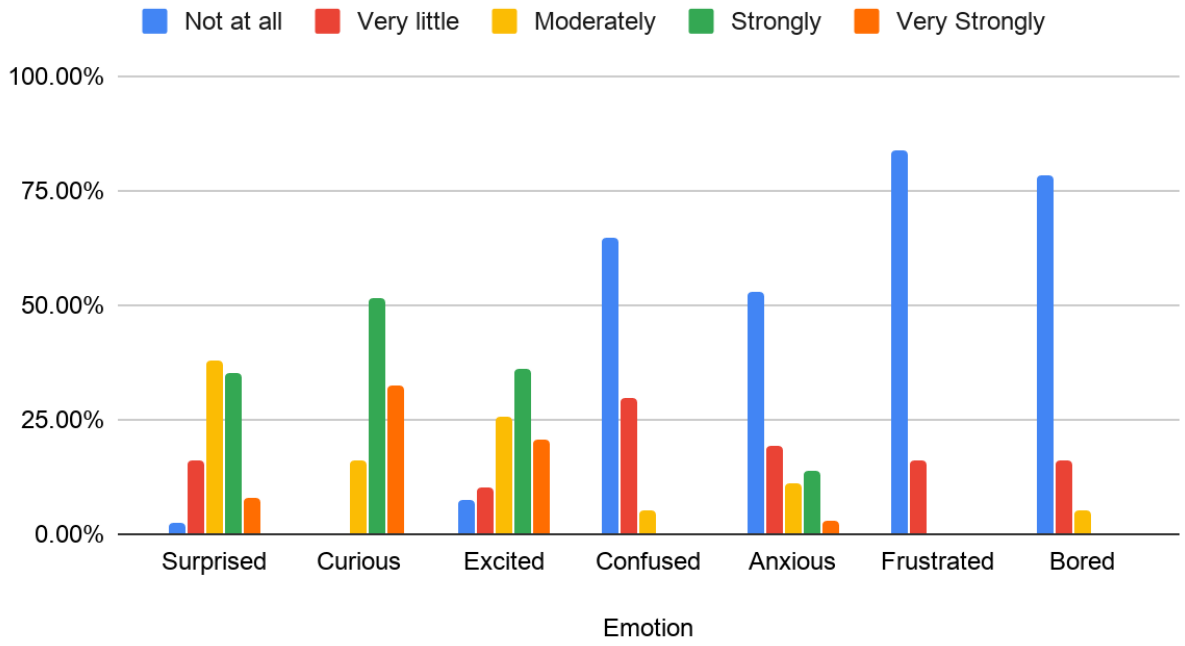


Figure 3: Snakes participants' responses to Epistemically Related Emotion Scale.



Differences do exist between the cases. A larger proportion of visitors to *Snakes* felt anxiety. One might suggest this could perhaps be attributed to the presence of live snakes. One might posit that the *Museum ExplorAR* experience could have provoked anxiety about using an unfamiliar gadget. Still, in this sample, it seems the overwhelming majority (84.62%) of *Museum ExplorAR* visitors did not report this emotion and those that did say they experienced it 'very little'. This thesis is cautious not to make conclusions here - how *Museum ExplorAR* visitors were recruited would have likely predisposed the sample to contain individuals with an interest in technology.

In contrast to the EES responses, it is worth considering the six affective states (engaged, excited, enjoyment, calm, curious, and connected) that emerged in the data created by the open response emotion questions examined earlier in this chapter. Excitement ranks highly in responses to the EES and open response questions. Meanwhile, curiosity makes an appearance at a much higher rate in visitor responses to the EES - where all participants report some degree of curiosity. Similarly, while it features in the EES responses, descriptions of surprise are not present in the data from open response questions. Meanwhile, the EES does not capture the calm and connection feelings revealed by the open response questions.

Overall, the open response questions provide space for divergent forms of affective responses in the museum, including feelings of connection.

Table 8: *Museum ExplorAR* participants' responses to Epistemically Related Emotion Scale (n = 13)

Emotion	Not at all	Very little	Moderately	Strongly	Very Strongly
Surprised	0.0%	15.4%	46.2%	30.8%	7.7%
Curious	0.0%	7.7%	38.5%	30.8%	231%
Excited	0.0%	7.7%	46.2%	38.5%	7.7%
Confused	53.9%	30.8%	15.4%	0.0%	0.0%
Anxious	84.6%	15.4%	0.0%	0.0%	0.0%
Frustrated	84.6%	7.7%	7.7%	0.0%	0.0%
Bored	76.9%	15.4%	7.7%	0.0%	0.0%

Table 9: Snakes participants' responses to Epistemically Related Emotion Scale (n = 39)

Emotion	Not at all	Very little	Moderately	Strongly	Very Strongly
Surprised	2.7%	16.2%	37.8%	35.1%	8.1%
Curious	0.0%	0.0%	16.2%	51.4%	32.4%
Excited	7.7%	10.3%	25.6%	35.9%	20.5%
Confused	64.9%	29.7%	5.4%	0.0%	0.0%
Anxious	52.8%	19.4%	11.1%	13.9%	2.8%
Frustrated	83.8%	16.2%	0.0%	0.0%	0.0%
Bored	78.4%	16.2%	5.4%	0.0%	0.0%

Discussion & Research Questions

This chapter presents an analysis of the visitor survey data from the *Museum ExplorAR* and *Snakes* exhibitions. The analysis responds to three research questions and this section responds to these in detail below.

1. How do visitors describe and recall their experience of *Museum ExplorAR* and Snakes?

This study has used the cognitive tools framework to explore what might be at work within the acts of memory and connection. The study employed the cognitive tools framework to understand how visitors talk about their experiences in the museum, beginning with memory and interest, through to reflection on emotion. The cognitive tools framework enables a clear view of how visitors construct responses to the questions before them. This study demonstrates that engaging with memory primarily required descriptive and visual tools. Recalling instances of interest also required description but also prompted the use of narrative. Reflection on emotion is much more likely to require a multi-tool approach where

visitors need more than description only. This reflects the dynamic, discursive understanding of emotion and affect that this thesis argued for in part one. When asked to give more information about their emotive response, visitors use description and narration equally and call upon analysis and make connections to issues beyond the museum. Here, combined with an approach to affect, which sees it as a form of embodied meaning-making, the cognitive tools model enables a more detailed view of the contribution of affect and emotion to museum experiences. This offers a valuable perspective on the affective potential of museum collections. This study uses this framework to identify moments where acts of memory, description and the recall of information and interpretation interweave with personal, sociocultural, and physical contexts. This is a critical methodological contribution. First, it supports an affective practice approach to affect and emotion, as argued for in part one of the thesis. Second, it contributes to the literature on understanding how museum visitors construct and share their affective experience.

In this study, visitors repeatedly recall aspects of their visit - be it an object, fact, or perspective - often supplementing this memory with their existing knowledge or experiences. Examples of this at work include Participant A7 describing the sadness they felt in the whale skeleton's presence or the wonder felt by Participant S28, who framed the diversity of the reptilian world within their religious belief. Silverman tells us that ‘memory may be viewed as the core mechanism of meaning-making’ - a claim which informed the study’s survey questions asking visitors what they remembered from their visit (Silverman, 1995, p. 162). Silverman described the process of visitors making-meaning in the museums as a ‘constant process of remembering and connecting’ (Silverman, 1995, p. 162). Since Silverman, museum and heritage scholars have drawn on the paradigm of meaning-making widely to illustrate and explore the visitors' active role in their museum experience (Falk and Dierking, 2000; Schorch, 2014; Smith, 2015; Hohenstein and Moussouri, 2017; Blakely and Moles, 2019). In that time, research in museums has sought to demonstrate that learning in the museum is dependent on the assimilation of information into existing bodies of knowledge and frameworks of reference (Hooper-Greenhill, 1999; Falk and Dierking, 2000; Hein, 2002). This study draws on foundational museums scholarship and looks in detail at the tools used by visitors to recall and share their experience. In doing this, it avoid a didactic educational approach in favour of accessing moments of meaning-making and affective experience and attending to the role of discourse in understanding affect.

This study takes a broad view of the act of meaning-making – it takes the perspective that in every realm of human activity, we seek and make opportunities to create, express and affirm whom and what we believe ourselves to be - aspects of self and community - formed and validated in the process of creating meaning out of our experiences and environments. In this sense, all meaning in museums is subjective viewed through the retelling of the visitor's inner emotional world. Crucially, however, the subjective responses collected in this study are not idiosyncratic and unpatterned. The research responds to the question posed by Silverman: 'what patterns exist in these "personal" ways of making meaning?' by focusing on affective practices and employing a framework of cognitive tools to understand the practices that form the affective response (Silverman, 1995, p. 164). In doing this, this thesis extends beyond identifying affective response into the processes associated with it and reveals the central role of analysis and connection to emotive meaning-making within museums.

2. Does visitor affective response vary between different displays?

In terms of the closed choice question, this study finds that responses across the two exhibitions are remarkably similar. Visitors to both *Museum ExplorAR* and *Snakes* report higher levels of surprise, curiosity, and excitement than boredom, frustration, and anxiety. This raises the question of whether the data is influenced by the visitors' bias towards more stereotypically 'positive' emotions. Given that negative comments were included in the museum's visitors' book for *Snakes*, it is clear that some visitors were frustrated. However, in the study's context, visitors did not report this. Either these visitors did not feel the types of emotions conveyed in the visitor book or were biased by either the scale, the study more generally, or both. This raises an issue of reliability in relation to the EES. The visitors surveyed by this study reported feelings of wellbeing and connection when answering open response questions - forms of emotion not included within the EES. Closed choice tools like this EES, while designed to measure emotion in a manner agreeable to aggregation and statistical analysis, would likely become onerous at the point it also became comprehensive.

In agreement with the evidence in part one of this thesis, this study considers that open response questions provide a more detailed, nuanced, and individualised view of a participant's affective experience. In the open response data, six common affective experiences were reported by visitors to both exhibitions. Where differences appear is in context-specific emotions relevant to the individual displays - i.e., visitors to *Snakes* reporting

nervousness and nausea. This thesis supports the view that a core set of emotions can be related to museum visitation and suggests that it is possible to understand these six common states as some of the master 'ingredients' in the forms of personally constructed meanings associated with the museum. Led by the data presented in this chapter, the author strongly agrees with Feldman-Barrett's claim that emotions are constructed and appear in blends rather than discrete packages. This was a similarity across the cases presented in this study. Further granularity could be brought to the differences in affective response by working with the data to understand multi-emotion reporting further and explore affective combinations in more detail. Any future work in this area needs to seek a larger and more diverse sample to adequately engage with a broad range of personal experiences. In particular, researchers should pay attention to the relationship between racial backgrounds and national identities in shaping affective practice in the museum. This point is returned in the thesis' conclusion.

Other similarities were also striking, in response to open choice questions, visitors in both cases report feeling 'engaged' (38.46% of *Snakes* and 46.15% of *Museum ExplorAR* visitors). When considering the similarities between the two groups, it is worth giving this further consideration. While this thesis does not question that this is a valid response, engagement, arguably, does not map onto an inner emotional world in the same way as other reported emotions, for example, excitement or calm. Engagement is an outwardly directed focus, usually associated with a sense of being engaged in or busy with a task. The primary response to the museum then, is the sense of being 'engaged' with the task of visiting it, and from that sense of focus, other emotions may flow, such as enjoyment or sadness. One might interpret this to mean visitors felt busy or occupied and expect this to be an expected feature of a museum visit. Furthermore, one might contend that feelings of engagement are part of an observer effect and participants report this experience as a result of participation in the study (Frey, 2018). In considering the adaptation of participant behaviour to the study and the environment, it would be a mistake to omit the fact that this discussion relates to an all white sample – an area for future research would looks to analysis a more racially diverse sample to get a better sense of these issues.

One might contend that previous research has argued that museums are free-choice learning sites (Falk and Dierking, 2002), where learning is characterised by being unpressured and open-ended in nature. Museum displays are designed with a wide variety of audiences in mind to respond to a range of interests, needs and expectations. In this context, choice-

driven engagement might be expected to flourish. However, the language used by visitors in this study to describe their feelings requires some consideration. The use of 'engagement' echoes years of public policy centred on cultural engagement and participation (Bennett, 2011), where museums are increasingly under pressure to perform social and civic roles under the banner of 'engagement'. It may be the case that this role of the museum has filtered into visitor consciousness and is being repeated back as a means of describing a 'successful' visit. The issue of how visitors connect to perceived or actual expectations and behavioural norms for museum visiting, such as how to behave appropriately, the level of noise to make, and the direction and pace at which to move around the exhibitions, has been commented on by numerous academic and museum professionals (Silverman, 1995; Duncan, 2005; Simon, 2010). The data in this study suggests that the acceptable behaviours and norms identified by previous research have not only been assimilated by visitors to *Museum ExplorAR* and *Snakes* but potentially shaped by contemporary economies of attention and productivity. Odell has written about resisting the attention economy, which they see as a model that acknowledges the cognitive demands that attend living in era of endless amounts of information (Odell, 2019). Such cultural shifts and broader technological influences are worth considering in this context and they enable the formation of more detailed questions about affective practices in museums today. One particular question concerned with how the language of cultural policy and museum professionals has shaped the museum visit, its affective potential, and what relationship this transformation might have to late capitalist forms of productivity and consumption arises. In terms of research and professional practice, one might extend this by asking: what are the political, economic, ethical, and affective implications of 'engagement' as a dominant means of experiencing the museum?[18]

3. How do open and closed survey questions contribute to understanding affective experience?

[18] Future research might include an analysis of the language used over time by visitors in response to museum surveys over a significant period. Extending as least as far back as the introduction of free entry in 1999 would reveal longitudinal changes in how visitors have described their museum experience within the context of key UK cultural policy developments.

While open response provides the advantage of greater specificity and understanding of an individual's experience, some argue participants can find the process of naming their emotions difficult, and responses may be affected by the individual differences in active vocabulary across participants (Bermond *et al.*, 2007). It has also been argued that open response questions enable visitors to describe multiple, connected forms of emotion should they wish – a total of 61.58% of *Museum ExplorAR* and 79.48% of *Snakes* participants did precisely this. The presence of multi-emotion reporting supports Feldman-Barret's view that certain types of experience can be associated with particular affective mixes or recipes, as they term the phenomena (Barrett, 2017). This study demonstrates that open response questions expose the visitors' interpretation of their emotions and the synchronous multiplicity of the affective work associated with a museum visit. The study also presents six common emotive states (Engaged, Excited, Enjoyment, Calm, Curious, and Connected) reported by visitors to each exhibition in different combinations. Further research might be undertaken to establish which combinations or 'recipes' appear frequently and in which context.

The closed-choice EES used in this study used interval scales underpinned by a discrete theory of emotions. The data from this scale show that emotions are more positively weighted towards surprise, curiosity, excitement. Whereas, as has been stated above, boredom, anxiety, frustration, and confusion are experienced to a much lesser degree, if at all. A key criticism of such a question is that it suggests emotions to visitors they might not otherwise have reported. This study demonstrates this effect in the contrast between those who report feeling curious between open response and closed choice. Responses to the ESS show that all visitors to both *Snakes* and *Museum ExplorAR* identified some level of curiosity, whereas this is only present for 7.69% of visitors to each exhibit in open response data. The EES demonstrates that visitors to both exhibitions largely feel excited and curious. The EES data also indicates that people appear to experience frustration, boredom, and anxiety less than excitement and curiosity. This supports the open response data, but the limited number of emotions represented in the ESS means that if this scale had been used in isolation, this study would have missed calm and connection feelings. It is also notable that as a scale for measuring emotions associated with learning, it cannot represent the engagement and attention-related feelings present in the open response data. This is a feature of a discrete model of emotions versus self-reported data; it speaks to methodological issues relating to closed choice categories where these are defined by researchers but do not always correspond with the lived emotional experience of participants. The tension inherent in such

an issue is between the validity of the visitor's lived experience and the scalability and analysis of the data.

In designing a survey concerned with participants' emotions and experiences, methodological choice follows theoretical convictions and the specifics of the given research questions. In this study, open response questions allow spontaneity and specificity to present in visitors' recollections of their affective experience. However, data derived from open response questions is limited because it is difficult to analyse open responses in a quantitative, statistical fashion (Scherer, 2005). That said, sorting open responses into emotion categories, using 'notions of family resemblances and synonyms' (Scherer, 2005, p. 713) has a mediating effect and allows one to subject open response data to more complex quantitative analyses – should this be desirable. This cannot be pursued in this study due to the sample size and remit of the research questions.

This study has shown significant similarities in the way visitors describe memorable, interesting, or emotive elements between the two displays through the use of the cognitive tools framework. In both cases, visitors use description to identify memorable aspects of the visit. The use of narration increases when visitors are asked what they found interesting about their visit, although description remains the dominant tool. When asked to engage with a feeling they associated with the visit and identify what caused them to feel this way, narration and analysis instances increase. A small number of visitors make connections to issues outside the museum (an act understood in this study as weaving). When asked what they found emotive, the types of narrative used to expand to include museum atmosphere and aspects of curation are reported for the first time. This study's open response data indicates that six common states (engaged, excited, enjoyment, calm, curious, and connected) play a role in the emotional experiences visitors have in museums regardless of the type of exhibition they attend. The study demonstrates how the EES misses emotions that open response questions can capture. Furthermore, the emotions reported by visitors in open response have revealed a new question relating to how visitor experience and the language associated with it may have changed over time and been influenced by policy and cultural changes. In line with precedents discussed in chapter 1, this study demonstrates that open response provides greater nuance and reveals further lines of inquiry, which in turn enable the generation of knowledge.

Chapter 7. Group Level EDA Analysis

Introduction

This chapter responds to the thesis' aim of exploring whether the EDA data can contribute to understanding museum visitor affective experience. The chapter is concerned with group-level data; individual-level analysis is the subject of the next chapter. This chapter compares grouped visitors' EDA data from the *Museum ExplorAR* experience and *Snakes* exhibition within the context of the research questions below:

4. Is the analysis of aggregated electrodermal data a valid and useful methodological approach to investigating visitor experience in museums?

    a. When standardised and grouped by exhibit and sub-divided by demographics, how is physiological response distributed and do distribution differences exist between groups?

For the analysis presented in this chapter, the data were standardised and then represented via histograms and box plots to determine and illustrate its distribution. The chapter draws on the discussions of appropriate analysis procedures already presented in this thesis and addresses data collection and quality issues. Subsequently, the chapter presents standardised and EDA data at the whole group exhibit level and then sub-divided by demographic groups. For some demographics, the sample sizes are notably reduced, and this is discussed in the chapter. There is a return to debates and concerns related to EDA measures previously discussed in Chapter 2; these discussions contribute to answering the research questions.

Before engaging with the analysis presented in this chapter, it is useful to remind the reader that this is an exploratory study. The use of the Empatica E4 within the context of the museum is in a preliminary stage. While electrodermal research is not new, collecting ambulatory EDA via a commercial, research-grade device in a museum is a novel endeavour. This chapter deals with a novel form of data and data collection in a field where data is difficult to collect and validate (i.e. objective measures of subjective emotion). These challenges are representative of the hallmark features of exploratory research (Babbie, 2007) and they require exploratory research to be flexible and open to failure. Exploratory research

can address research questions of all types (what, why, how), but often it is most instructive in revealing the limits of a particular line of inquiry. This study is no different. In this sense, this chapter is a practice-based means of working through many of the issues that critical data studies discusses – for example, the chapter works to demonstrates that EDA data is not neutral and that noise measures exclude demographics and shape data sets. In this vein, before the analysis is presented, issues relating to the reliability of the device and its data are discussed.

Data Issues and Reliability

Any study employing emergent technology to capture data must carefully consider the validity of the data it presents. Several factors influence the reliability of the data collected: hardware, software, signal noise, the visitor, and the sheer capacity for the type of data collected to answer the questions put to it. This section tackles the first four of these issues, with the final issue addressed later in the chapter, specifically in relation to the chapter's findings and the research questions outlined above.

Table 10: Breakdown of EDA data loss

	Museum ExplorAR	***Snakes***
Total participants	13	39
Data lost to noise	5	14
Data corrupted (Firmware or visitor error)	1	8
Non-responders	1	1
Withdrawn	0	2
Total loss	7	25
Remaining for analysis	6	14

Any wearable sensing device is powered by a mixture of hardware and software. In the case of the Empatica E4, a combination of sensors, processors, firmware in the device itself meets with a software platform (called 'E4 Manager') to remove data from the device for cleaning, processing and analysis. Problems can arise during this process. Firmware errors produce communicative errors in the device hardware. This means that the collected data cannot be accessed. The information cannot be retrieved from the device. A small number of firmware

errors occurred when an attempt to download the data from the device. Table 10 details the degree to which firmware errors affected the sample.

Signal noise is unwanted interference in the information during capture, storage, transmission, processing, or conversion. The signal and the information it contains is polluted. In the case of electrodermal activity, the unwanted disturbance in an electrical signal is often produced by an interruption in the wristbands contact with the participants' skin. Poor device fit or adjustment by a visitor, excessive movement, or a fault in the internal wiring may contribute to signal noise. To control this, the EDA signal was checked against accelerometer and temperature data using EDA Explorer, a tool developed by the Massachusetts Institute of Technology Media Lab to automatically detect noise in EDA data (Taylor, Jaques, Chen, *et al.*, 2015). EDA Explorer checked the data in 5-second epochs, and where excessive movement or temperature fluctuation is detected, hyper electrodermal activity is attributed to noise. Given pre-existing literature on noise thresholds, the study follows recommendations published by de Loof and excludes all data sets with over 25% noise (de Looff, Didden, *et al.*, 2019). In the case of *Museum ExplorAR* and *Snakes,* respectively, this criterion resulted in 41.66% and 38.88% data exclusion due to noise. EDA data were visually inspected for signs of signal drop out (Boucsein *et al.*, 2012; Taylor, Jaques, Chen, *et al.*, 2015).

The visitor also plays a part in the quality of the data. For instance, data quality can be impacted by the degree to which visitors are compliant with the researchers' requests not to fiddle with the device to avoid disturbing the sensor's contact with the skin. The pilot study asked visitors to press the device to record a marker in the data, but this proved unacceptable because many visitors turned the device off (Hoare, 2020). As stated in Chapter 2, a small percentage of people may have little electrodermal lability. These non-responders were identified by the absence of EDA peaks in their data. The publication recommendations for EDA determine what may be counted as a 'peak' in EDA; activity must rise by at least 0.05µS within 3 seconds (Boucsein *et al.*, 2012).[19] After removals for noise, only two visitors (one in each exhibition) were non-responders. These visitors were excluded.

[19] This level was originally determined based on the fact that it is the smallest shift visible on paper chart recorders. Actual EDA fluctuation is imagined to be much subtle, and advances in technology have led to smaller thresholds (e.g. 0.04µS, 0.03µS and 0.01µS) becoming more common in the literature associated with lab-based, physiology studies (Braithwaite and Watson, 2015).

Table 10 demonstrates a high data loss rate with an average loss across the two studies of 52.78%. The demographic analysis shows that of those excluded, a significant majority were female (68.75%). In *Snakes*, two Asian / Asian British participants were also excluded - meaning all participants remaining for analysis were White British. Such a level of loss is significant enough to call into question the value of electrodermal data collected via the Empatica E4 in the context of museums. Arguably, a loss > 50% represents a significant investment of fieldwork time for a relatively poor return. However, this study contributes to the ongoing evaluation of data collected via wearables where the 'scientific evaluation of the reliability, sensitivity, and validity of such data is limited' (Düking *et al.*, 2018). Data loss is a limitation of this study. It also enables the study to respond to its research questions, specifically those concerned with EDA data's efficacy and validity.

Producing & Interpreting Histograms and Boxplots

The analysis in this chapter involved producing histogram and box plots of the data for each exhibition, which determined the distribution of standardised scores for each exhibition. Each exhibition was then further broken down into three specific demographics: age, gender, and visit frequency - these demographics relate to bodies of research that make claims as to the variability of EDA between gender, age, and the novelty of the stimulus to the participants (Román *et al.*, 1989; Dawson, Schell and Filion, 2001; Gavazzeni, Wiens and Fischer, 2008; Boucsein, 2012).

The inter-participant analysis was completed using EDAExplorer and code written by the researcher in the Python programming language (using its pandas and matplotlib packages). All individual EDA data sets were checked for noise in EDAExplorer. Valid data were transformed into Z-scores using Python before aggregation. A Python script, a text file containing the statements that comprise a Python program, was written by the researcher and executed for each data set. This process takes each visitor's data set and the EDA values within it; then subjects these values to a standardisation process to enable comparisons between visitors. Using the mean EDA value and the standard deviation, the value is standardised and becomes a Z-score, where each EDA value becomes a measure of the distance between the EDA value and the mean, measured in units of standard deviation. These individual standardised, z-scored data sets were then combined using a second Python script which generated descriptive statistics and histograms. Histograms were plotted

for each case to assess distribution; these were also produced for subsets data broken into specific demographics.

Histograms were used to illustrate the distribution of a sample and reveal the shape, centre and spread of data. Box plots are also used to demonstrate the distribution, median and variability between groups. There are two aspects of a histogram relevant for determining distribution:

- Skewness refers to the overall shape of the curve. If skewness is positive, the data are positively skewed or skewed right, meaning that the distribution's right tail is longer than the left. If skewness is negative, the data are negatively skewed or skewed left, meaning that the left tail is longer. If skewness is less than -1 or greater than 1, the distribution is highly skewed. If skewness is between -1 and -0.5 or between 0.5 and 1, the distribution is moderately skewed. If skewness values fall between -0.5 and 0.5, the distribution may be considered approximately symmetrical.

- Kurtosis is the measure of the degree of flatness or steepness of the curve. It is a measure of outliers present in the distribution. It describes distribution as located in the tails of the sample rather than around the mean (the latter being achieved by skewness). High kurtosis means data has heavy tails or outliers. The closer kurtosis is equal to 0, the more it indicates a normal distribution. Parameters for kurtosis vary; figures between -2 and 2 or -3 and 3 are often the standard parameters for normal distribution.

The analyses below report on skew and kurtosis as indicators of negative or positive skew. Descriptive statistics and histograms for each exhibition (AR and *Snakes*) are given and described; this is then segmented into demographic groups with histograms. While skewness and kurtosis enable the distribution of data to be understood, distribution also indicates which tests of statistical significance can be performed on a given data set. However, significance testing is not the main focus of this study. This chapter explores distribution as the first step in data analysis. It aims to understand the relationship between mean and median in each data set. Where the median is higher than the mean, this means most EDA values in the data set are higher than the average EDA value in the set. This indicates a higher overall EDA modality. However, with such high amounts of data loss and exclusion, this study refrains

from further statistical analysis. Indeed, as shall be argued later in the chapter, it finds further support for avoiding such forms of analysis in this study in the course of the demographic breakdowns. N numbers are given for each group. In three cases, the group may only contain one participant. The factors which informed the choice not to exclude these individuals are discussed at the relevant point below.

Whole Case Distribution

Figure 4: Histogram of Z-scored EDA Data in All *Museum ExplorAR* and *Snakes* Participants (n=6, n=14)

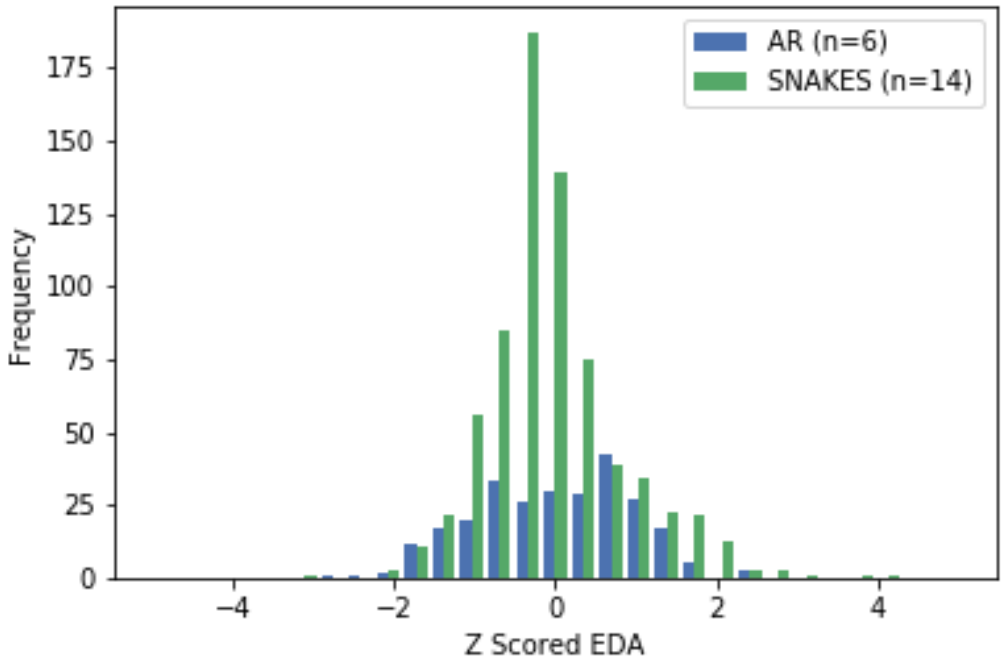
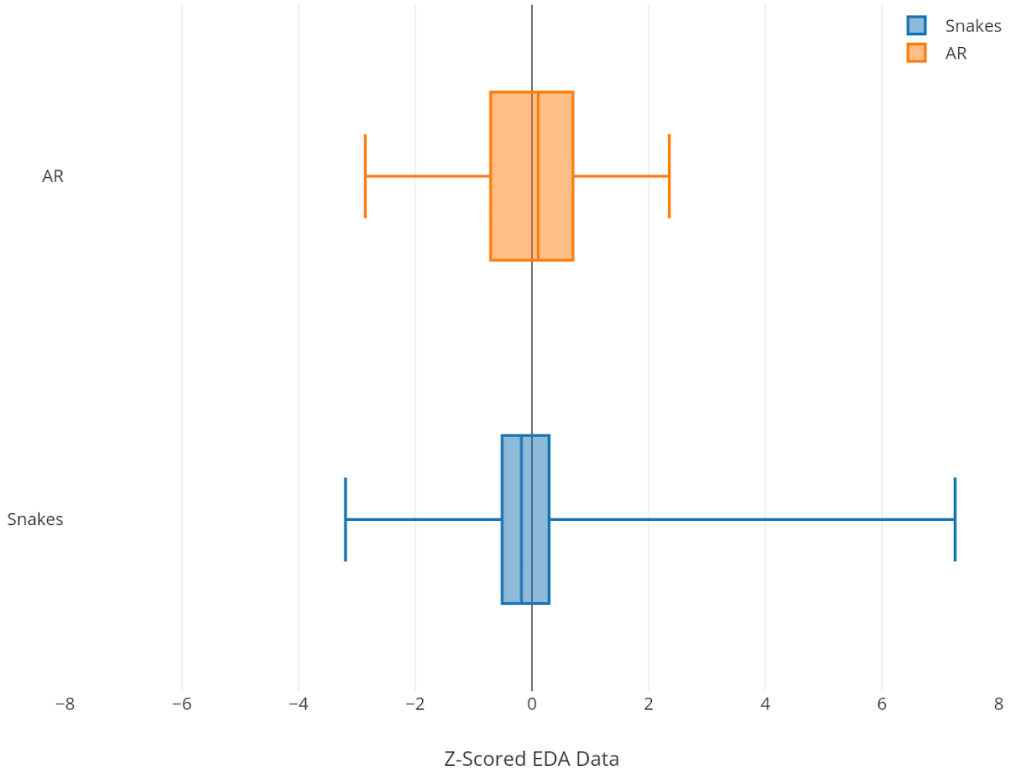


Figure 4 shows the spread of Z-scored EDA data for all *Museum ExplorAR* and *Snakes* visitors. Skewness for *Museum ExplorAR* participants is between -0.5 and +0.5; therefore, the distribution is approximately symmetric. Kurtosis is within parameters for normal distribution. Overall, the scores of visitors to *Museum ExplorAR* are normally distributed. Figure 6 also illustrates the spread of Z-scored EDA data in the *Snakes* case. Skewness is greater than +1; therefore, the distribution is highly skewed. Kurtosis for this data is outside the parameters for normal distribution, and the histogram is leptokurtic in shape (i.e. with

steep tails). Overall, the scores of visitors to *Snakes* are not normally distributed - the shape and spread of the histogram shows that most values fall below zero.

Figure 5 compares the distribution of each group through the use of box plots. Box plots are advantageous when comparing distributions not based on the overall shape but rather where the distributions lie with regard to one another. Plotting each group side by side, in this case, visualises the greater spread of *Snakes* participants' data. This is expected given the kurtosis stated above. However, the comparatively broader spread (the fatter central box means a larger spread of the middle 50% of the data) and median above zero (where zero is the mean) in *Museum ExplorAR* visitor data is worth noting as these features of distribution indicate greater EDA in the *Museum ExplorAR* group. The longer whiskers in the *Snakes* visitors' data set show that the *Snakes* visitors' overall range is greater. However, range differences may be observed due to the differences in sample size. The differences in box dispersion and median position are more informative in terms of the overall distribution of visitors EDA and more clearly illustrates the higher level of EDA in the *Museum ExplorAR* group.

Figure 5: Box plots of Z-scored EDA Data in *Museum ExplorAR* & *Snakes* Participants



Demographic analysis

The distributions of three specific demographic categories were also plotted. The chosen categories were gender, age, and frequency of visitation to the museum site in question. Studies have shown that EDA response declines as we become familiar with a given stimulus and that EDA response declines as we age (Dawson, Schell and Filion, 2001; Gavazzeni, Wiens and Fischer, 2008). Although these vary on the stimulus situation, differences between genders have also been reported (Román *et al.*, 1989; Carrillo *et al.*, 2001). Elsewhere the frequency of exposure to a given stimulus has been shown to decrease arousal (Dawson, Schell and Filion, 2001; Leiner, Fahr and Früh, 2012).

Gender

Figure 6: Gender Histogram of Z-scored EDA Data in *Museum ExplorAR* and *Snakes* Participants

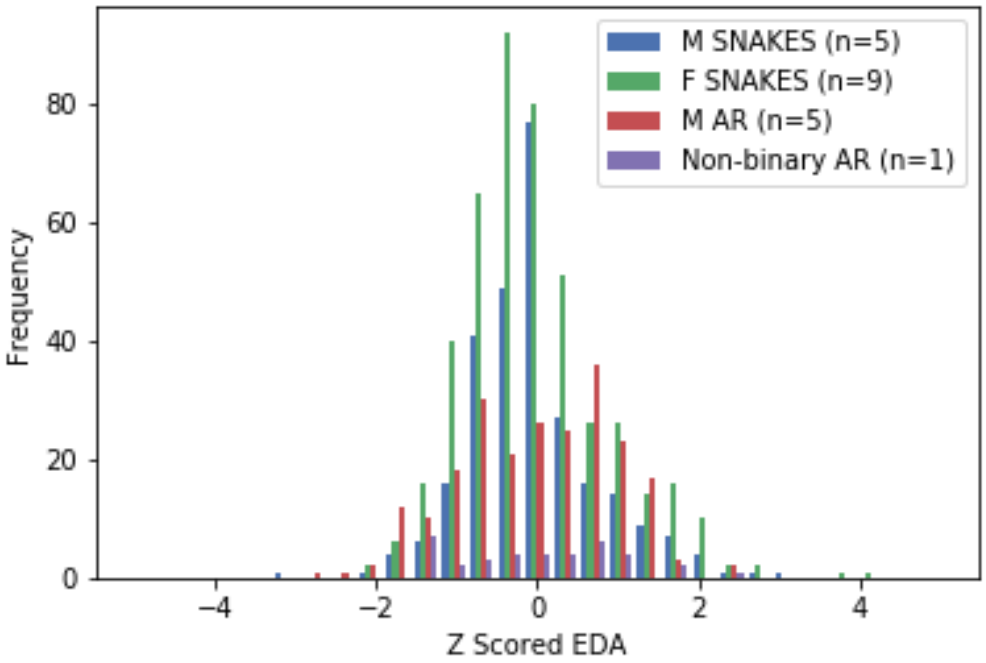


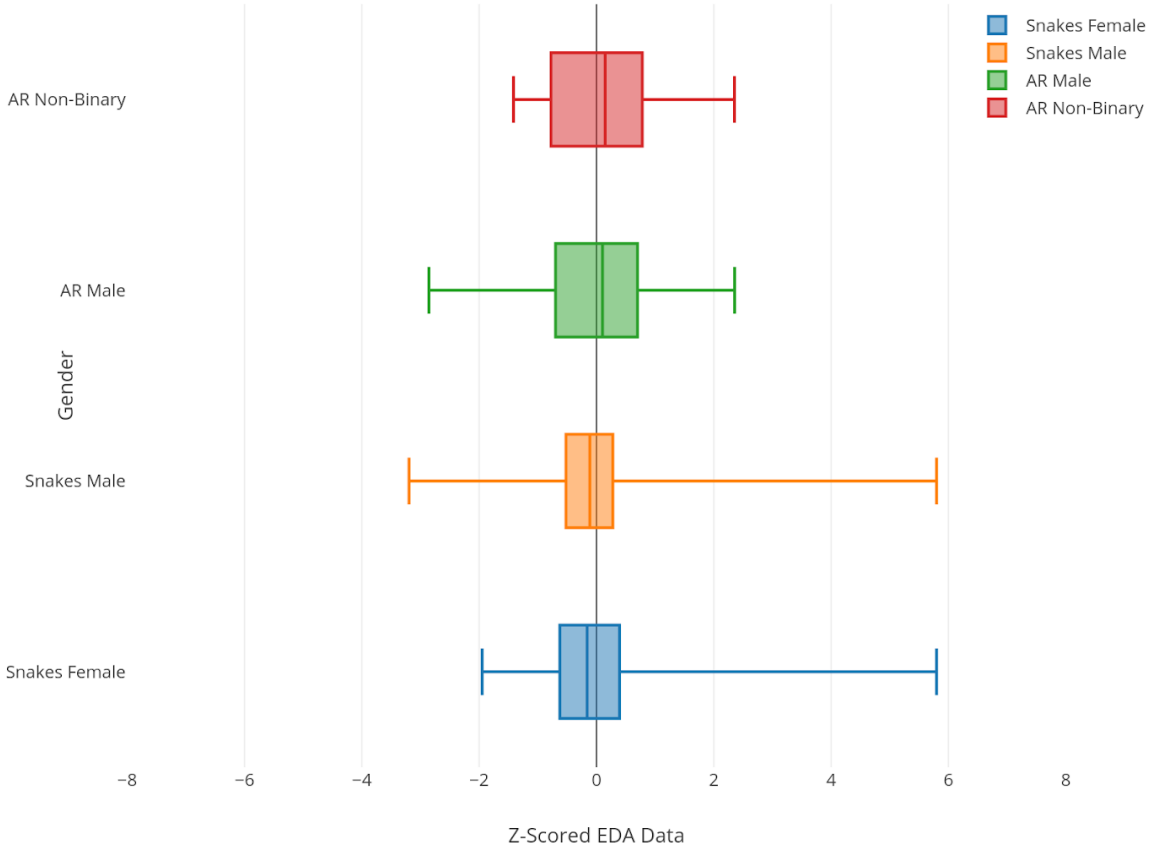
Figure 6 shows the spread of Z-scored EDA data for each gender demographic for *Snakes* and *Museum ExplorAR* participants. For male *Museum ExplorAR* visitors, skewness is -0.25258017; therefore, the distribution is approximately symmetric. Kurtosis is within parameters for normal distribution. Overall, the aggregated scores of male visitors to *Museum ExplorAR* are normally distributed. In the Z-scored EDA data for male *Snakes* participants, skewness is greater than +1, indicating the data set, which is highly skewed. Kurtosis is high, which points to the influence of outliers on the data. This data is not normally distributed with more scores falling to the lower side of the scale.

Female *Snakes* participants show a highly skewed distribution. Kurtosis is outside the parameters for normal distribution. This data is not normally distributed with more EDA Z-scores falling towards the lower side of the scale. For *Museum ExplorAR*, participants identifying as non-binary, skewness, and kurtosis are within normal distribution parameters.

Overall, the data is normally distributed. The small sample size for the non-binary category (n=1) means this is not a multi-participant data set. It is included here to avoid trans-erasure.

Figure 7 compares the distribution of each gender group through the use of box plots. Plotting each group side by side here reinforces the greater range of the data of *Snakes* participants. However, the box plots demonstrate that *Museum ExplorAR* visitors have a greater range between the 1st and 3rd quantiles (as shown by the fatter box); this indicates more activity around the mean with the greater median than mean in both *Museum ExplorAR* gender groups. The relationship between mean and median reveals more EDA above the mean in the *Museum ExplorAR* group. Male and female *Snakes* participants both show longer whiskers; this points to the presence of outliers. The plots show very different ranges between the *Museum ExplorAR* Male and *Snakes* Males, with an equal sample size (n=5) in both groups; this illustrates the different distributions of electrodermal arousal between males visiting the two displays.

Figure 7: Box plots of Z-scored EDA Data in *Museum ExplorAR* & *Snakes* Participants Segmented by Gender



A comparison between the represented genders shows a skew towards the lower range of the scale in the male and female *Snakes* participants - both data sets are not normally distributed. All *Museum ExplorAR* participant data is normally distributed. Due to data failure or noise, all female *Museum ExplorAR* participants were excluded from the *Museum ExplorAR* set. This exclusion has significant implications for this section and means this data can only provide a limited picture of any quantitative gender differences in EDA between the exhibitions. This point is discussed in more detail later in the chapter.

Age

Figure 8: Histogram of Z-scored EDA Data in *Museum ExplorAR* Participants by Age

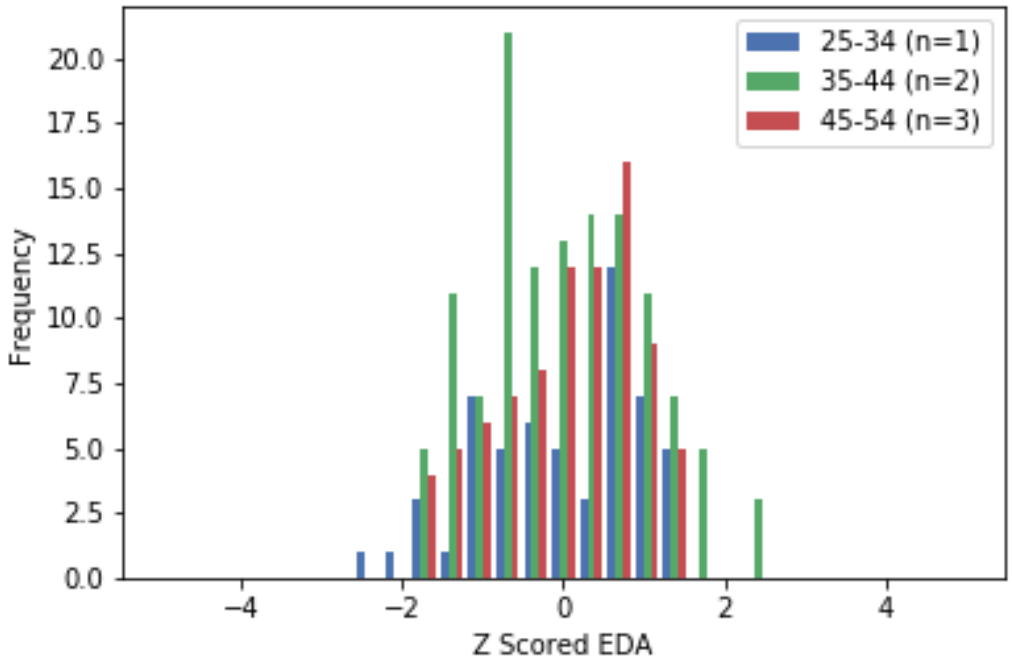


Figure 8 shows the distribution of Z-scored EDA Data in *Museum ExplorAR* participants segmented by age group. For visitors aged 25 - 34, skewness is indicative of a normal distribution. Kurtosis is also with the parameters for normal distribution. In Z-scored EDA data in *Museum ExplorAR* participants aged 35-44, skewness reveals a normal distribution, and kurtosis is also with normal distribution parameters. The Z-scored EDA data in *Museum ExplorAR* participants aged 45-54 also indicates skewness and kurtosis in line with a normal distribution.

Figure 9: Figure 11: Histogram of Z-scored EDA Data in *Snakes* Participants by Age

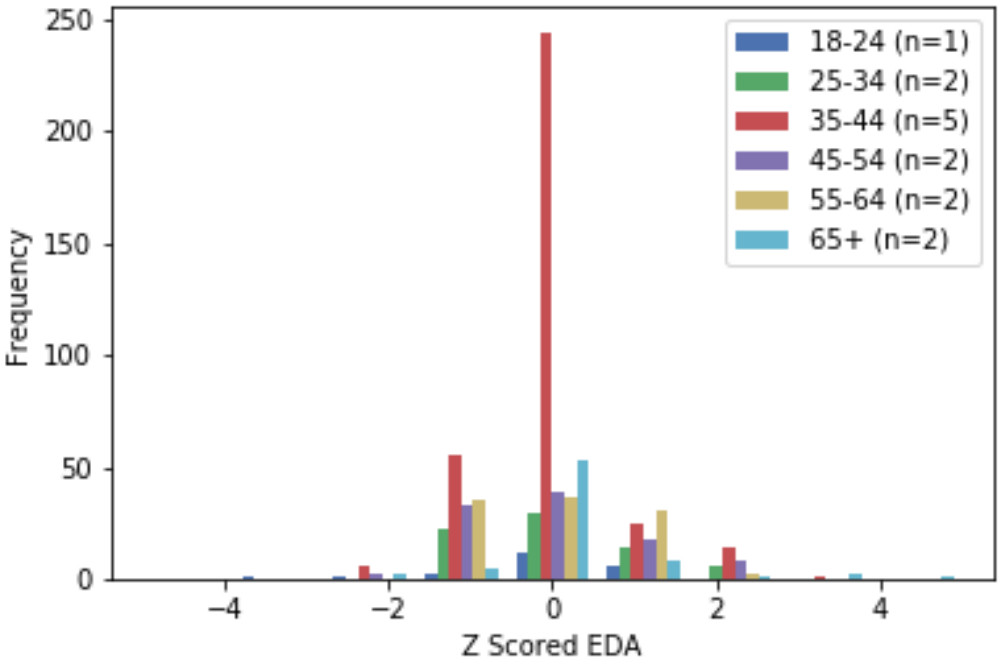


Figure 9 shows the distribution of Z-scored EDA Data in *Snakes* participants segmented by age group. The Z-scored EDA data in *Snakes* participants aged 18-24 shows a skewness which does not indicate a normal distribution. Kurtosis is outside the parameters for normal distribution. EDA response in *Snakes* participants aged 18-24 is not normally distributed, with responses weighted towards the higher end of the scale. In *Snakes* participants aged 25-34, skewness indicates a normal distribution, and kurtosis remains within normal distribution parameters. The Z-scored EDA data in *Snakes* Participants Aged 35-44 is representative of a highly skewed distribution. Kurtosis greatly exceeds the parameters for normal distribution, and outliers can be seen in the histogram. The skew means that the majority of EDA values fall at the lower end of the scale. This group is influenced by a much greater number of observations just below zero, as can be seen at the y-axis. The Z-scored EDA data in *Snakes* Participants Aged 45-54 shows a moderately skewed distribution. In *Snakes* Participants Aged 55-64, skewness indicates a normal distribution, and kurtosis is within normal distribution parameters. *Snakes* Participants Aged 55-64 show a highly skewed distribution.

Kurtosis is outside the parameters for normal distribution. Here the majority of values fall below zero.

Figure 10: Box plots of Z-scored EDA Data in *Museum ExplorAR* Participants Segmented by Age

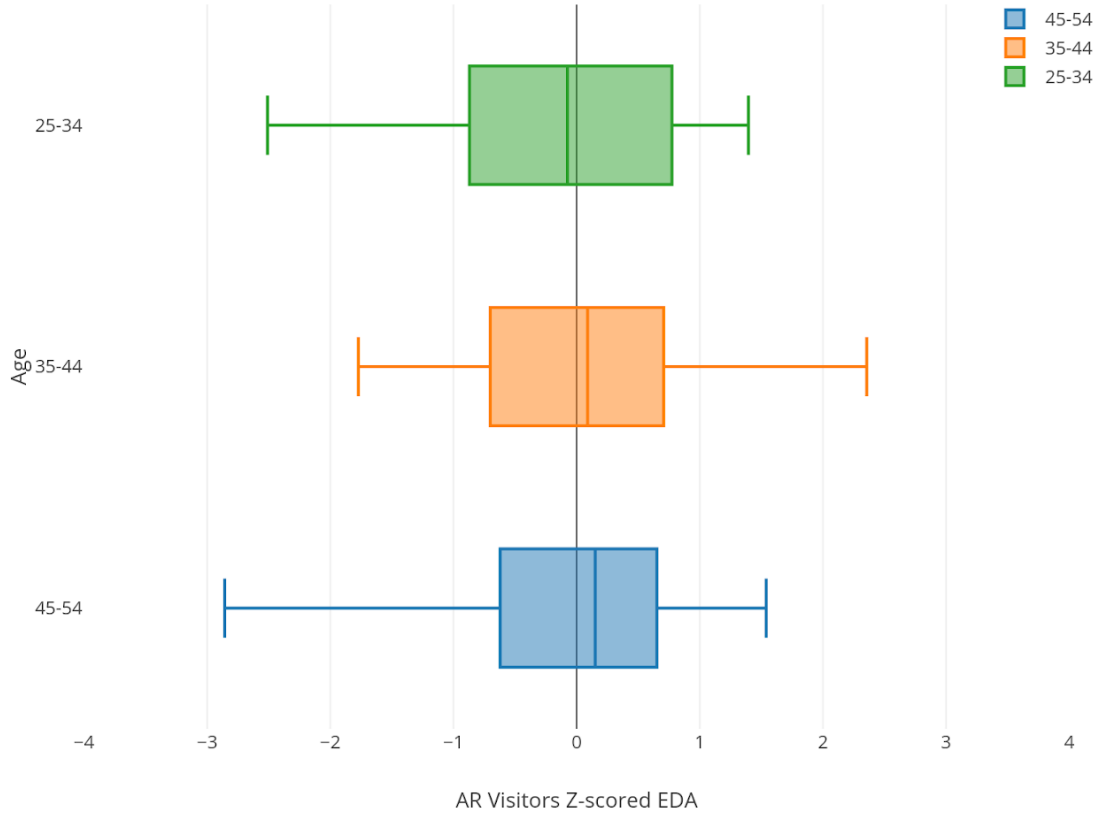
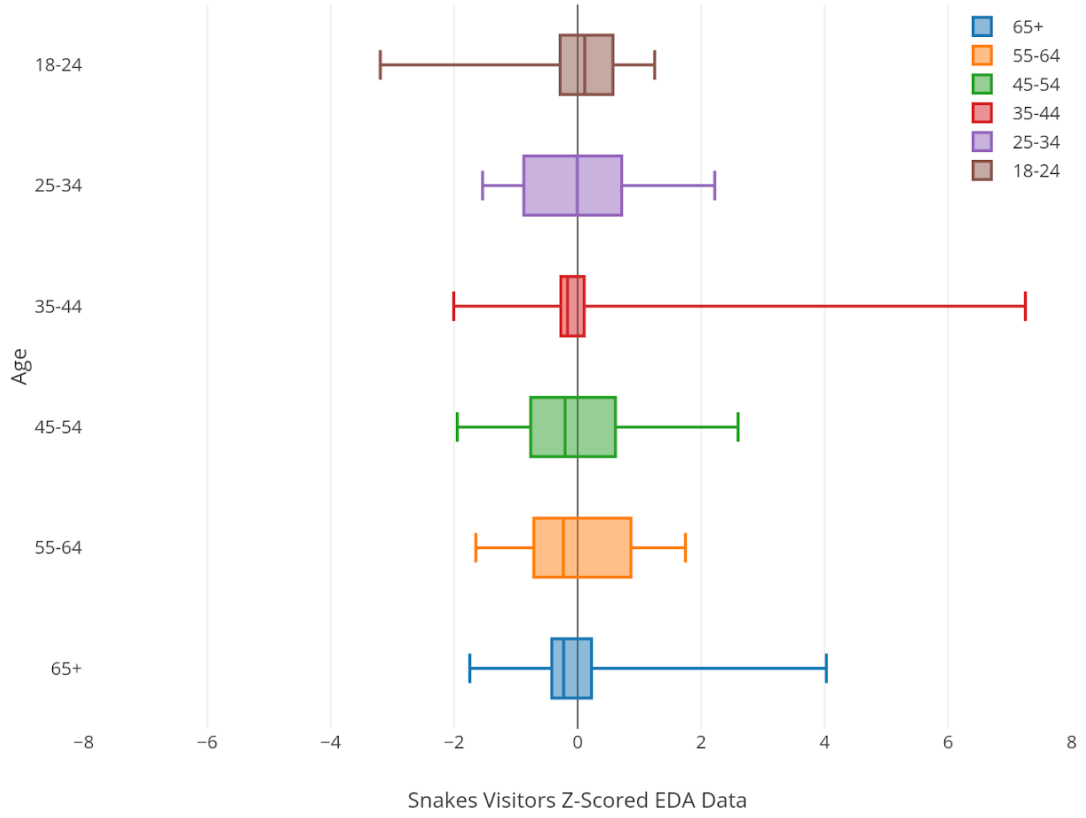


Figure 11: Box plots of Z-scored EDA Data in *Snakes* Participants Segmented by Age



Figures 10 and 11 show the distribution of each age group through the use of box plots. Median increases with age within the *Museum ExplorAR* participants. Within this group, the box size becomes slightly smaller as age increases. Unfortunately, the *Museum ExplorAR* sample constraints limit EDA response to a comparatively narrow range of age groups. In *Snakes* participants, pronounced differences in distribution can be seen between youngest and most senior participants. Median decreases as age increases across the age groups represented, and this data aligns with research that claims overall EDA levels may decline with age (Gavazzeni, Wiens and Fischer, 2008). The *Snakes* plots vary in whisker length, which means outliers significantly influence EDA data when analysed by age. In both *Museum ExplorAR* and *Snakes*, age group 35-44 shows a long right whisker, and this is long compared to its respective nearest age groups in both cases. Sample size may influence this variation (in each case, this age group has one of the largest n numbers of all represented groups). As samples sizes are small, the relations of medians and box shape are better determinants of a relationship than the overall distributions.

Visit Frequency

Figure 12: Histogram of Z-scored EDA Data in AR Participants by Visit Frequency

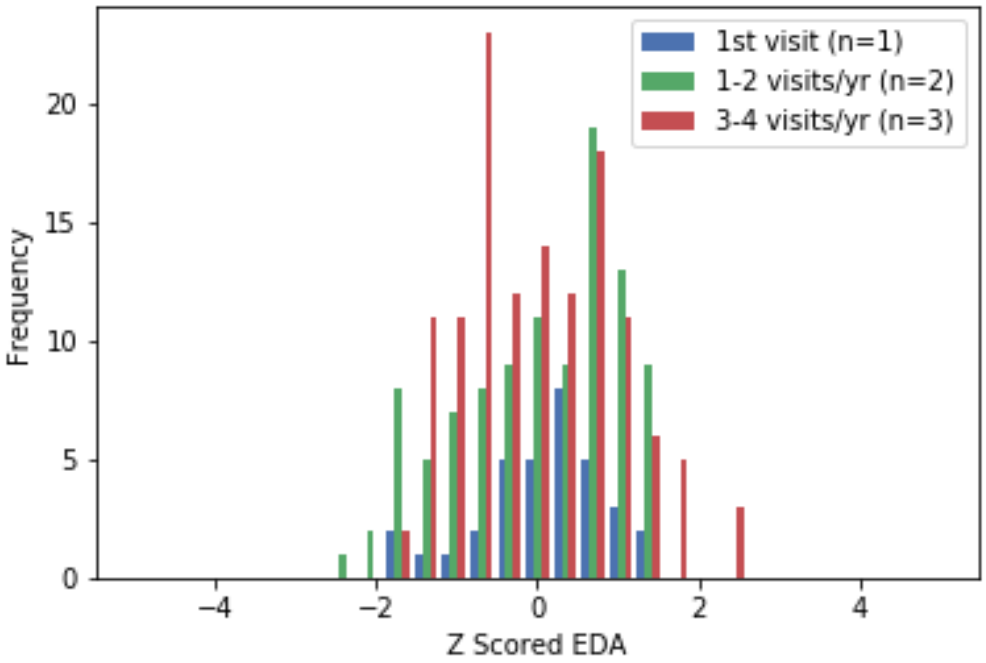


Figure 12 shows the distribution of Z-scored EDA Data in *Museum ExplorAR* participants segmented by visit frequency. The Z-scored EDA data for *Museum ExplorAR* participants visiting the museum for the first time has a skewness of 0.47 - just within the parameters for a normal distribution. Kurtosis is within the parameters for normal distribution. In *Museum ExplorAR* participants who have visited 1-2 times in the last 12 months, skewness indicates a moderately skewed distribution. Kurtosis is also within the parameters for normal distribution. For *Museum ExplorAR* participants who visited 3+ times in the last year, skewness and kurtosis are within the normal distribution parameters.

Figure 13: Histogram of Z-scored EDA Data in *Snakes* Participants by Visit Frequency

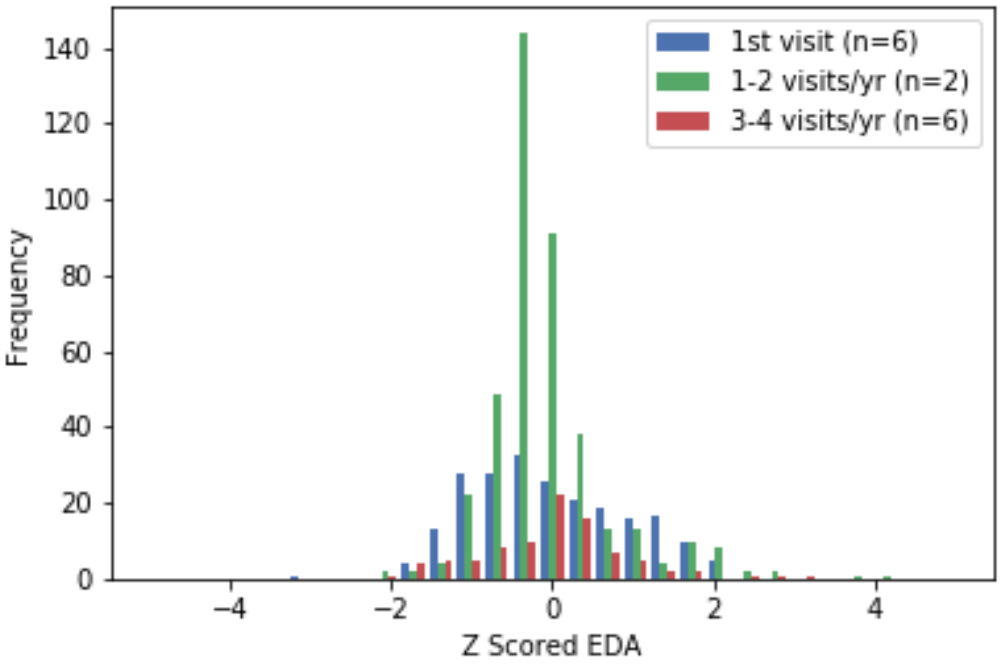


Figure 13 shows the distribution of Z-scored EDA Data in *Snakes* participants segmented by visit frequency. *Snakes* visitors who were attending the museum for the first time show both skew and kurtosis within the range for a normal distribution. The Z-scored EDA data in *Snakes* participants who have visited 1-2 times in the last 12 months is not within the normal distribution parameters and indicates a highly skewed distribution. Kurtosis is far outside the parameters for normal distribution and means this data is not normally distributed. The majority of EDA values fall below zero in this data set. In *Snakes,* participants who visited 3 or more times in the last 12 months, skewness is within the normal distribution parameters. Kurtosis is also within the parameters for normal distribution.

A comparison between visit frequencies shows normally distributed data sets in all but one case. Z-scored EDA data in *Snakes* Participants who visit twice a year has a skewed distribution, and the majority of EDA values fall at the lower end of the scale in this set of values. Box plots for *Museum ExplorAR* visitors show median decreases with increased visit frequency. This aligns with literature that states that familiarity with an environment decreases

EDA response (Boucsein, 2012). This phenomenon is not reproduced in the *Snakes* participants.

Figure 14: Box plots of Z-scored EDA Data in *Museum ExplorAR* Participants Segmented by Visit Frequency.

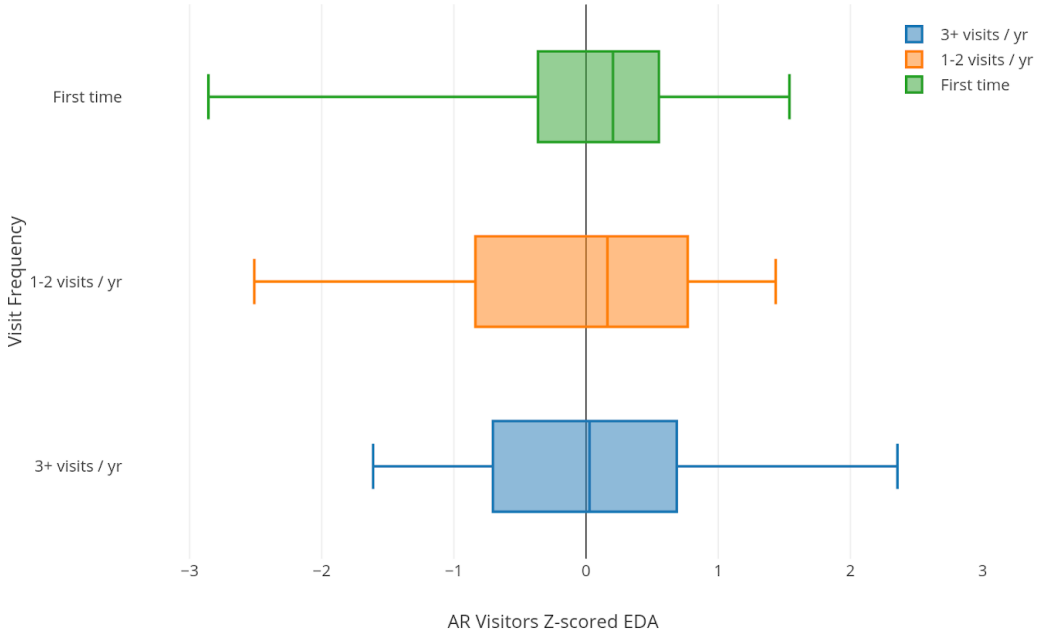
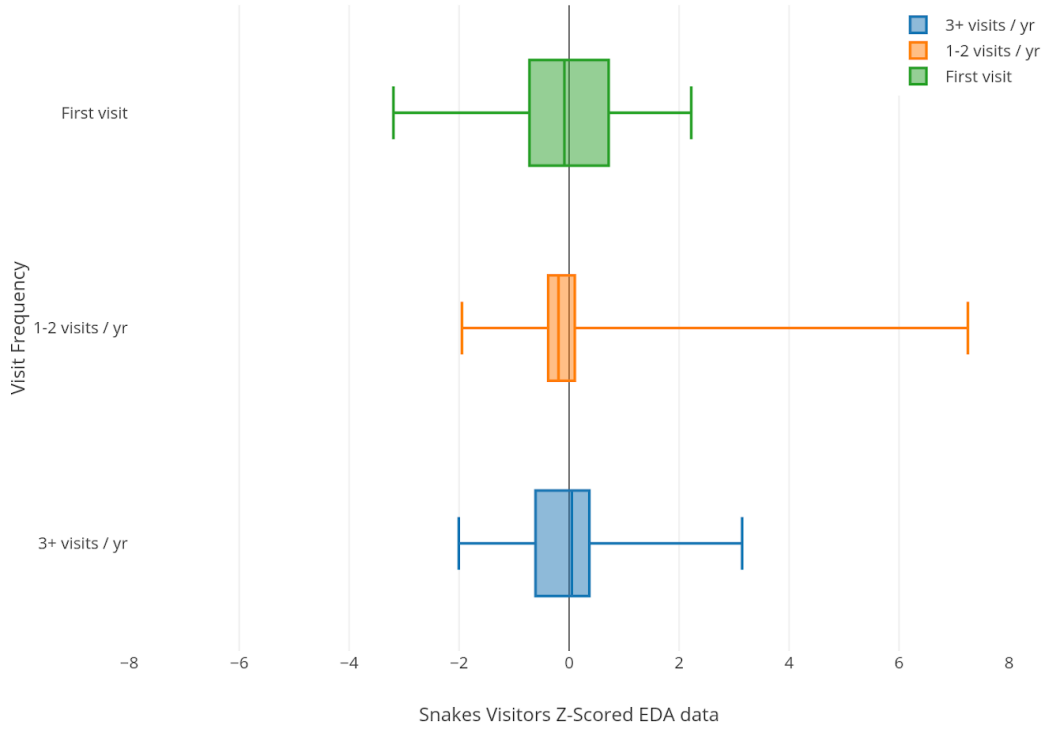


Figure 15: Box plots of Z-scored EDA Data in Snakes Participants Segmented by Visit Frequency.



Discussion & Research Questions

This chapter examines the distribution of standardised, grouped EDA data; it aims to discover whether higher or lower EDA levels at the group-level can be determined in aggregated EDA data. This was assessed by producing histograms and box plots of the aggregated data for each exhibition. These two data sets (*Museum ExplorAR* and *Snakes*) then further broken down into age, gender, and visit frequency demographics. It works to explore the value of aggregating and representing data in this manner. This section summarises this chapter's main findings within the context of the research questions it set out to address. The questions were as follows:

4. Is the analysis of aggregated electrodermal data a valid and useful methodological approach to investigating visitor experience in museums?

a. When standardised and grouped by exhibit and sub-divided by demographics, how is physiological response distributed and do distribution differences exist between groups?

4. This study demonstrates that group-level EDA data has a limited contribution to make to the understanding of museum experiences. Overall, the analysis indicates how little EDA recorded in an ambulatory setting at an interpersonal level within minimally engaged participants can contribute to the overall understanding of museums' affective and emotive experiences. This is because, without self-report, EDA has no context or connection to affective practice. In this respect, the study aligns with the arguments regarding both affect, emotion, and EDA in parts one and two of this thesis. EDA increases and decreases at different rates within individuals and in response to various stimuli. Therefore, when data is aggregated at the group-level, as was done for the analyses in this chapter, there is a limit to what can be concluded from the analysis.

Why bother with this analysis at all? In response, one might be tempted to argue for other forms of aggregation – where EDA data is segmented by the types of response as in the eMotion study (Tröndle *et al.*, 2012). This route is deliberately avoided in this study because of the study's exploratory nature, the limited tracking, and its concern with critical data studies. Considerations of data validity and demographic issues take precedent in this research. Therefore instead of pursuing relationships, this study priorities methodological validity. In terms of the demographic groups represented, the study notes serious issues in that attend samples of female and senior visitors. Furthermore, the analysis is limited by the fact BME visitors are not represented at all.

This chapter reveals three limiting factors in using electrodermal data at an interpersonal level to understand visitor experience in museums. These are data quality, demographic caveats, and the appropriateness of lab-specific and exploratory analysis methods. Data quality is impacted by data loss due to signal noise and firmware errors leading to data corruption during transfer. The reduction of the sample sizes in this study demonstrates that EDA requires more stringent controls. Such controls may be unachievable in an ambulatory study with today's technology, and it may not be possible to minimise noise and data corruption. Data loss is a limitation of this study. Still, it also enables the study to respond to its research

questions - specifically those concerned with the efficacy and validity of EDA data in the context of the museum. This thesis contributes to the literature regarding the validity and reliability of data obtained from these devices. It demonstrates that noise protocols and devices failures limit the validity and usefulness of EDA data.

The demographic analysis revealed that EDA may be distributed differently according to age, gender, and familiarity with the environment. Age group analysis in the *Snakes* visitors reproduced previous findings that demonstrated declining EDA levels with age. Research has shown that despite lower EDA, older populations are more likely to self-report higher levels of emotional response (Gavazzeni, Wiens and Fischer, 2008). This study also speaks to research on EDA in gender where females have higher levels of EDA fluctuation (Román *et al.*, 1989). When following strict noise protocols, females are significantly more likely to be excluded - here, the division between noise and fluctuation can only be assessed through longer-term observation of individuals. This point indicates potential issues with existing noise protocols which may be biased against data collected from females. Finally, as *Museum ExplorAR* visitors' familiarity with the museum increased, median EDA decreased. This reflects the well-established principle that EDA increases with unfamiliar or novel environments (Boucsein, 2012). However, these demographic findings are not uniform between the two exhibitions and some previous results were shown to be unreproducible. For example, the visit frequency pattern in *Museum ExplorAR* was not replicated in *Snakes*. It is not possible to be conclusive other than to say that gender, age, and familiarity cause significant differences in EDA that may influence results. Therefore, caution is strongly advised, and further research is needed to determine the influence of these factors. This study recommends that caution be paid to these caveats before any further statistical analysis is pursued.

The third issue limiting the contribution of EDA data are the types of analysis available to researchers working with group-level data collected in an ambulatory setting. The analysis of electrodermal data is dependent on the design and context of a given study. This study aimed to examine whether, in the context of the museum and working with casual visitors, EDA data could offer a greater understanding of visitor emotional response. This study was concerned with data captured from ambulatory museum visitors who participated on a casual, one-time basis. This short-term engagement limits the types of analysis available - this speaks to a tension between environment, participant recruitment and valid forms of analysis. The lack of

long-term ambulatory monitoring is a severe constraint for any study that wishes to aggregate the ambulatory electrodermal activity of participants with whom the study is not repeatedly and significantly engaged (i.e. studies that do not include multiple museum visits and control activities). Longer-term EDA monitoring enables individual parameters for noise and peaks to be determined. In that case, it may be possible to address some of the limitations in the sample discussed above. As we shall see, the issue of individual parameters arises again in the next chapter.

4.a. This study progressed an exploratory data analysis with grouped Z-Scored data. It revealed EDA data distribution within the two exhibitions groups (*Museum ExplorAR* and *Snakes*) and key demographics. Such an analysis enables a standardised assessment along the lines of more or less electrodermal arousal in relation to the mean, based on distribution, box plot characteristics, and median position. Overall, histograms and boxplots are useful in understanding the general alignment of EDA response. The analysis undertaken in this study demonstrates that EDA does fluctuate and can confirm some demographic patterns described by previous research in some samples. This work is the first to collect and plot visitor EDA data in this way. It furthers this investigation by comparing data from two exhibitions while comparing data distributions with previous literature.

As for the demographic distribution analysis, in some but not all cases, as has been discussed above, distribution broadly aligned with patterns one might expect based on previous EDA research. The study raises concerns about the validity of noise protocols and their predisposition to exclude females at a much higher rate. Levels of EDA in *Snakes* participants decreases with age. Finally, this study cannot speak to race issues and is significantly limited in that regard. These issues stand as a stark caution to anyone seeking to use EDA data as a barometer of emotional arousal. As this study has shown, EDA has the potential to silence multiple demographics.

The analysis in this chapter makes two significant methodological contributions. First, it reveals the limitations of analysing grouped visitor EDA collected in ambulatory settings. The tensions between environment, participant engagement, and analysis are serious constraints for any study that wishes to aggregate participants' ambulatory electrodermal activity. Second, it reveals some alignment with precedents in EDA research, but this is not uniform between *Museum ExplorAR* and *Snakes* visitors. The analysis fails to reproduce consistent

patterns relating to age and visit frequency. This exposes an issue at the heart of EDA research: previous findings are not reproducible. The latter two points have been noted by previous EDA research. A study by de Loof employed such analysis on data collected in an ambulatory setting but reported no significant relationships between individual EDA levels of nurses. The authors note that to be more effective, any analysis would require data from multiple sessions from each individual over successive days to determine an individual baseline better; they also add that the devices are prone to signal noise (de Looff, Didden, *et al.*, 2019). Feldman-Barrett also describes failing to reproduce the electrodermal patterns cited by others (Barrett, 2017).

This analysis in this chapter may tell how visitors physiological responses are distributed, but that doesn't tell us about the feeling and the embodiment of the visit. But what about affective practices? Some readers might rightly be asking this question. Affect is conspicuously absent from this chapter - such forms of aggregation don't attend to individual social practices. It is to affective practices that the next chapter turns.

Chapter 8. Individual EDA and Self-Report Analysis

Introduction

This chapter looks at whether an individual-level analysis of EDA data can contribute to understanding museum visitor experience. It does this by drawing on the self-report data as well as interpreting individual EDA. It brings to a close part four of this thesis, which has sought to understand museum visitor experience and EDA via three distinct forms of analysis.

This final chapter examines the relationship between self-reported emotions and EDA. The analysis seeks to identify whether modal changes in EDA relate to the visitors' self-reported experience. As a result, the chapter responds to the following research questions:

5. In the cases considered, is the analysis of individual participants electrodermal data a valid and useful methodological approach to investigating museum visitor experience?
    a. Do relationships exist between visitors' self-reported emotion data collected via surveys and the electrodermal data collected from the Empatica E4?

The chapter is limited to the analysis of *Museum ExplorAR* visitors only as the form of analysis in this chapter is contingent on knowing the route taken by visitors. This is discussed further below.

Validity and Individual Level Analysis

As Chapter 3 detailed, research on EDA data at an individual-level has often combined EDA with tracking technology to pinpoint the visitor in space (e.g., Tschacher et al. 2012; Shoval et al. 2018). In this study, technological constraints, budgetary constraints, and privacy concerns prohibited using other Wi-Fi or Bluetooth sensing to track participants. The Empatica E4's inbuilt GPS tracking does not work reliably in an indoor environment. Tracking systems like those used in the eMotion are prohibitively expensive for a doctoral project. National Museums Wales had reservations about tracking visitors and considered this potentially invasive.

Furthermore, tracking visitors within a few feet would create a conflict between methods and theory – given the project understands affect and its associated practices as dynamic and enmeshed with many personal, social, and environmental factors. In this sense, the current

study seeks to avoid the trap of understanding the museum as a series of encounters with discrete objects. Instead, it understands the museum as a site where individual experience, contexts, values contribute to affective and emotional processes. While knowing which gallery the visitor is in gives a general sense of the shape of the visit, this study does not track participant in the hope of knowing what object they are in front of at a given time. To do so would be to miss the point of an affective practices approach. Instead, the concern here is not with specific stimuli and coordinates but to gain a sense of the visit's affective shape. Instead, it is about exploring where the visitor reports affective response and whether this response relates to their EDA. The researcher acknowledges that this is a rudimentary line of inquiry but argues that is it necessarily so and entirely in keeping with an exploratory study. From a combined critical data studies and affective practice approach, the intention was to situate both self-report and EDA data within the context of the visitor's experience.

The two displays under examination in this study, *Museum ExplorAR* and *Snakes*, had different structures and layouts. Only *Museum ExplorAR* followed a set route. Visits were timed vis the Empatica E4. The augmented reality experience led visitors on a tour of the permanent collection with visits lasting on average 43 minutes, with 83% of visitor visit times falling within this average time ± 10 minutes. In contrast, *Snakes* was held in a temporary exhibition space where visitors moved independently. Visit times to *Snakes* also varied considerably; the average visit time was 52 minutes, but only 28% of visitor visit times fell within this average time of ± 10 minutes. For these reasons, this chapter deals only with the experience of visitors to *Museum ExplorAR*. Without further tracking measures, it would not be valid to consider visitors to *Snakes* here. Of the two cases, the *Museum ExplorAR* experience had a much tighter structure, with a set route delivered via a device-led guided tour with participants experiencing the museum in a set order. Visitors started with the Prehistoric and Natural History Galleries, then made their way to the Marine Gallery and finished in the Impressionist Art Gallery. At the museum staff's request, the researcher was on hand and waited outside each gallery while the participants were on the tour. Given the set route, the similarity of visit length, and the researcher's observations, it was possible to approximate the visit's shape. This was done from observations - visitors spent c.5 minutes in the beginning before getting to the first augmented reality experience and then followed by c. 10 minutes spent with each of the three augmented reality areas in the Prehistoric, Marine, and Impressionist galleries.

Therefore, this chapter presents EDA data for six individual *Museum ExplorAR* participants. The EDA data has not been standardised as this is an intra-subject analysis. It was subjected to the same noise and data loss protocols. The exclusion rates are the same as in the previous chapter.[20] Data loss and the overall sample demographics mean this sample is restricted by size, lack of female participants, and limited age range. Thus, demographic analysis is not performed, although differences in the visit frequency are considered. The investigation was progressed in line with the exploratory nature of the doctoral project. What follows is the presentation of EDA in parallel with self-reported data.

This approach draws on Dalton and Thatcher's provocations for critical data studies by situating EDA data in time and space. By bringing together self-report, EDA, and some locative information, the chapter attempts to understand physiological response within its originating social processes and context. It does this to determine whether it is possible to form a conciliatory space in affect studies for both EDA and an affective practice understanding of human response and experience. The priority in this chapter is the relationship between the data, and what can be learnt about visitors experience and deployment of EDA monitoring in museums as a result of the data. The chapter aims to situate multiple data types and remain aware of the concept of affective practices - this is one of the central tensions of this chapter and shall be discussed again later on.

Overview of Analysis

The chapter uses two methods commonly used to examine individual electrodermal data: peak counts and a visual inspection of the data represented by Empatica's Graphical User Interface (GUI).[21] Both visual inspection and peak counts are used extensively in affective computing and psychophysiology (Boucsein et al. 2012; Taylor et al. 2015b). The first relies on a machine-learning algorithm to objectively identify peaks in EDA data (Taylor et al. 2015b) and is dependent on user-defined parameters to define peaks. The second is a more subjective visual inspection of the EDA data. The peak analysis was completed using EDAExplorer. All individual EDA data sets were checked for noise in EDAExplorer. A 'peak

[20] See Table 10.

[21] Care is taken not to refer to this data as 'raw' – as it is run through Empatica's system it is subject to a smoothing algorithm.

extraction' was performed on valid data, where noise affected less than 25% of the data set. Using publication standard protocols for peak identification (Boucsein et al. 2012), any rise above 0.05, which subsequently began to fall within a 4-second window, was detected and flagged by the software, which then parsed this peak against temperature and accelerometer data. The software automatically excluded peaks occurring in line with sustained rises in temperature. Areas of possible accelerometer noise were flagged by the program for the researcher to examine. Detected peaks were grouped and plotted in 5 min intervals.

These graphs were mapped against the visit to identify links between EDA and self-identified stimuli. This analysis sought to identify phases of EDA and compare these to stimuli identified in the free-response survey questions. These questions asked the visitor to identify 'memorable', 'interesting', and 'emotive' aspects of their visit. Within each peak graph, the researcher sought to determine whether periods of higher EDA might be visible, if there was more EDA activity during the three augmented reality experiences, and whether periods of higher activity related to the visitors' descriptions of their experience (i.e. do increases in EDA match up with forms of self-reported emotion?).

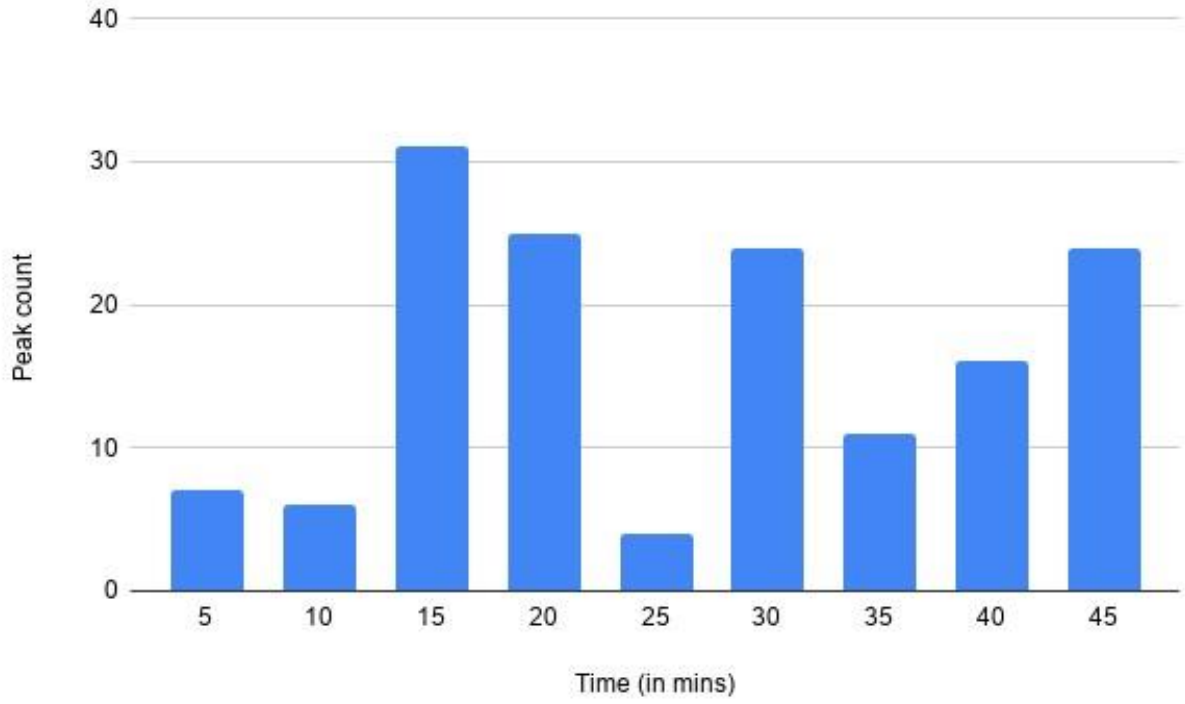
Interpreting Intra-participant EDA & Survey Data

The section contains peak graphs for each of the six valid data sets, the individual's EDA data is also provided, and quotations are provided from the survey responses. EDA peaks are discussed in relation to their position in the visit and each individual's self-reported data.

In Figure 16, EDA peaks centre around three periods of higher EDA activity. These rises in EDA may be mapped onto three augmented reality periods – with the first significant increase in peaks occurring around 15mins, then at 30 mins, and finally at 45mins. EDA rise in the final section of the tour when the visitor is in the Impressionist Gallery. The visitor reports that the Impressionist Gallery was the most memorable part of the visit. It's worth noting that the highest rise occurring in the prehistoric gallery, where the visitors would have first experienced the tour's augmented reality section. Links cannot be made between other specific forms of self-report because the visitor does not name other galleries or stimuli. We might expect the first augmented reality segment to create the most significant number of peaks due to the novelty of the experience (Boucsein 2012). However, we do not see a reduction of EDA with each segment. For context, the visitor attended the museum 1-2 times in the last 12 months. The concentration of peaks across three phases maps onto the

augmented reality experience. For comparison, Figure 17 shows this participant's data as shown by the Empatica GUI, with EDA in blue at the top[22]. In Figure 17, we can see the three phases of higher EDA activity: the first begins at 12:39 pm. It lasts approximately ten minutes before EDA declines for five minutes before starting to climb again. The second rise in EDA lasts five minutes before a decline occurs over ten mins before a final rise. Therefore, both data visualisations support an increase in electrodermal activity during phases of augmented reality. Here EDA is highest when first engaging with augmented reality. However, the visitor's descriptions do not reference this initial experience, and they cite the final augmented reality segment in the Impressionist Gallery as the most memorable. The visitor recalls being interested in the augmented reality objects most of all, and this would seem to align with the three periods of augmented reality delivered by *Museum ExplorAR*.

Figure 16: Participant A3's EDA Peak Extraction



[22] For the reader's ease, images of the raw data are provided here at a reduced scale. Large-format images are supplied in Appendix X

The visitor described feeling connected to the past and linked this feeling to ‘detail and type of information’ encountered on the visit. The visitor uses historical narratives to describe their visit and recalls being interested in the collection provenance; they report that this visit made them ‘More appreciative of our history’. The visitor weaves together description, narrative, analysis and conveys a sense of connection arising from the visit. This demonstrates the use of cognitive tools previously discussed in chapter 6. These tools represent a form of affective practice that speaks to forms of connection and meaning-making. The visitor’s use of the word ‘our’ speaks to their understanding of a collective affect beyond their individual interaction with the collection. In this participant, there is a relationship between self-report of affective experience and increased levels of EDA. The visitors use cognitive tools to relay their affective experience, and these experiences are linked to aspects of the three galleries visited as part of the tour.

Figure 17: Empatica E4 Data in *Museum ExplorAR* Participant A3

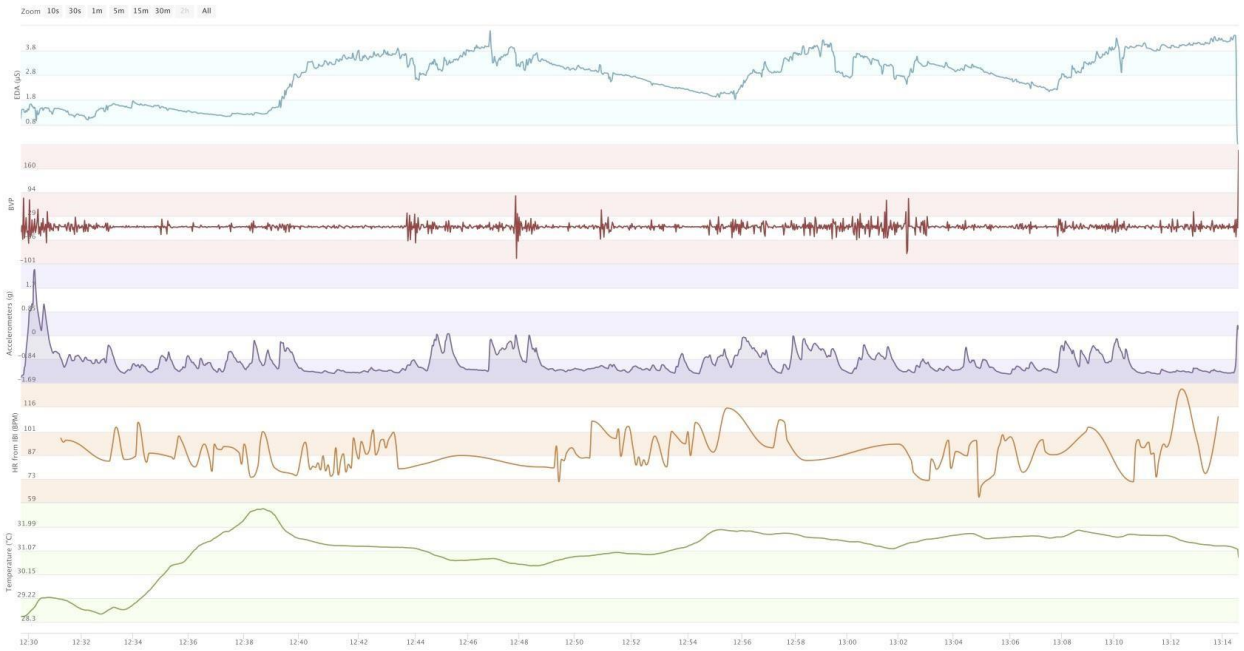


Figure 18: Participant A5's EDA Peak Extraction

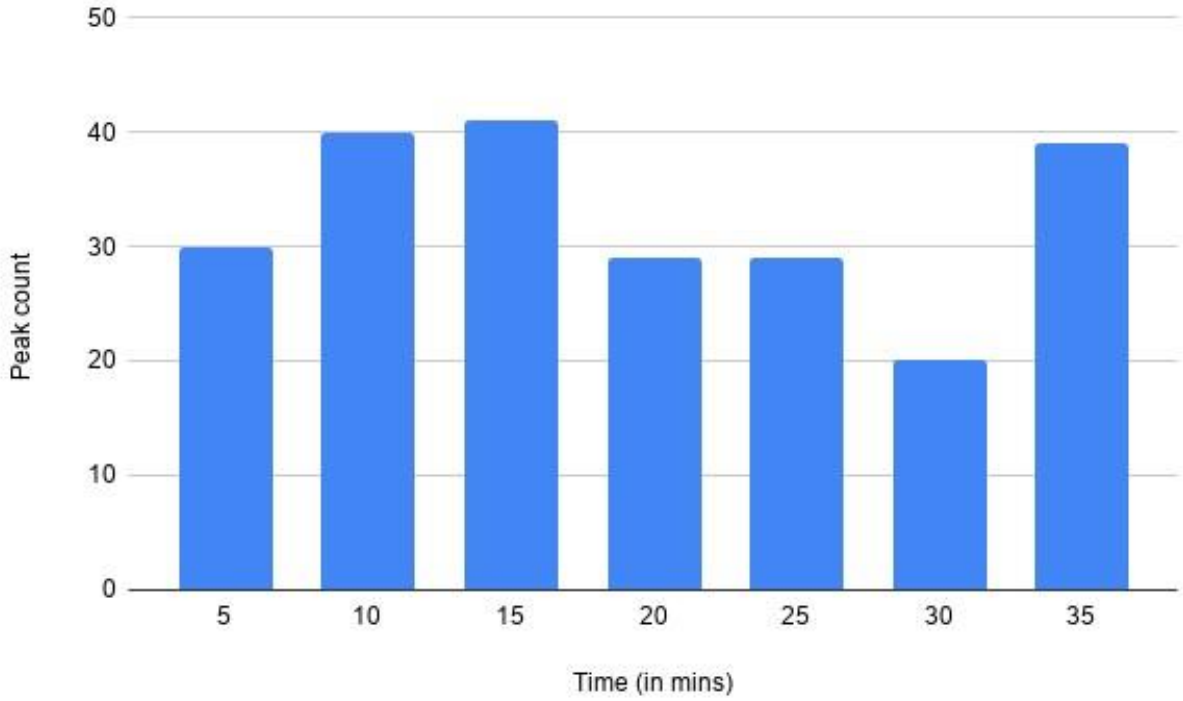


Figure 18 shows the EDA peaks in visitor A5. The peak count climbs from the start and reaches the highest peak count at 15 minutes. The first augmented reality segment creates the largest number of EDA peaks (c. 15 mins) with another large number of peaks at the end (c. 35 mins). The last rise at 35 mins is associated with the Impressionist Gallery. The visitor found the final encounter in the Impressionist Gallery most memorable, was most interested in the Impressionist collection's provenance and found themselves feeling 'comforted' by the museum's atmosphere. The visitor also describes feeling 'calm' throughout their visit and links this to the museum environment. Throughout their self-report survey data, the visitor uses description and narrative to share their experience.

There is a relationship between self-report of affective experience and increased levels of EDA. The visitor makes use of cognitive tools to relay their affective experience, and these affective experiences are linked to periods of the tour with higher levels of EDA. However, the peak graph in Figure 18 shows that Participant A5 demonstrates EDA of over 20 peaks per 5 minute period throughout the visit. This was the visitor's first time at the museum. It is important to note that the unfamiliar and novelty of the experience may have resulted in an increase in EDA overall and not just in areas where self-report affects were noted. Figure 19

shows the participant's GUI data; EDA is in blue at the top, and this graph shows electrodermal peaks throughout. The GUI (Figure 19) or peak graph (Figure 18) data do not demonstrate three clear periods of EDA activity that might relate to the period of the tour – rather, there is activity throughout. Still, there is a link between high EDA and what the visitor identifies as memorable and interesting, i.e., there are EDA rises when we would expect the visitor to be in the Impressionist Gallery. In this participant, the relationship between self-reported affect and EDA is present but somewhat clouded by the level of EDA activity overall.

Figure 19: E4 GUI Data in *Museum ExplorAR* Participant A5

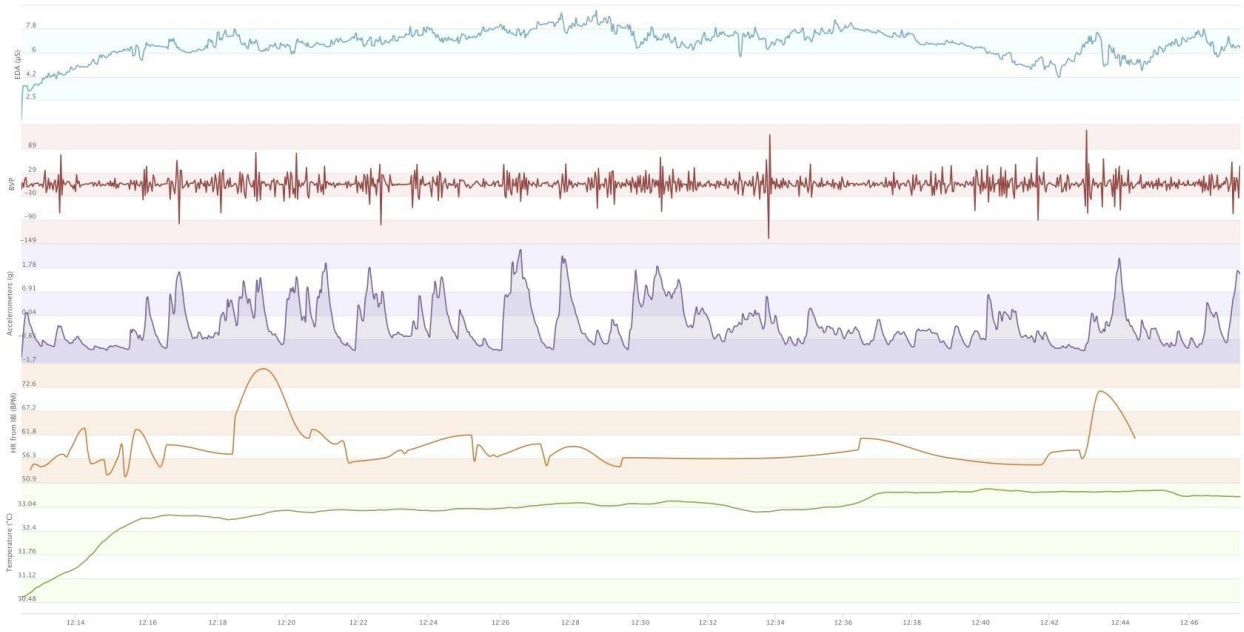


Figure 20: Participant A11 ‘s EDA Peak Extraction

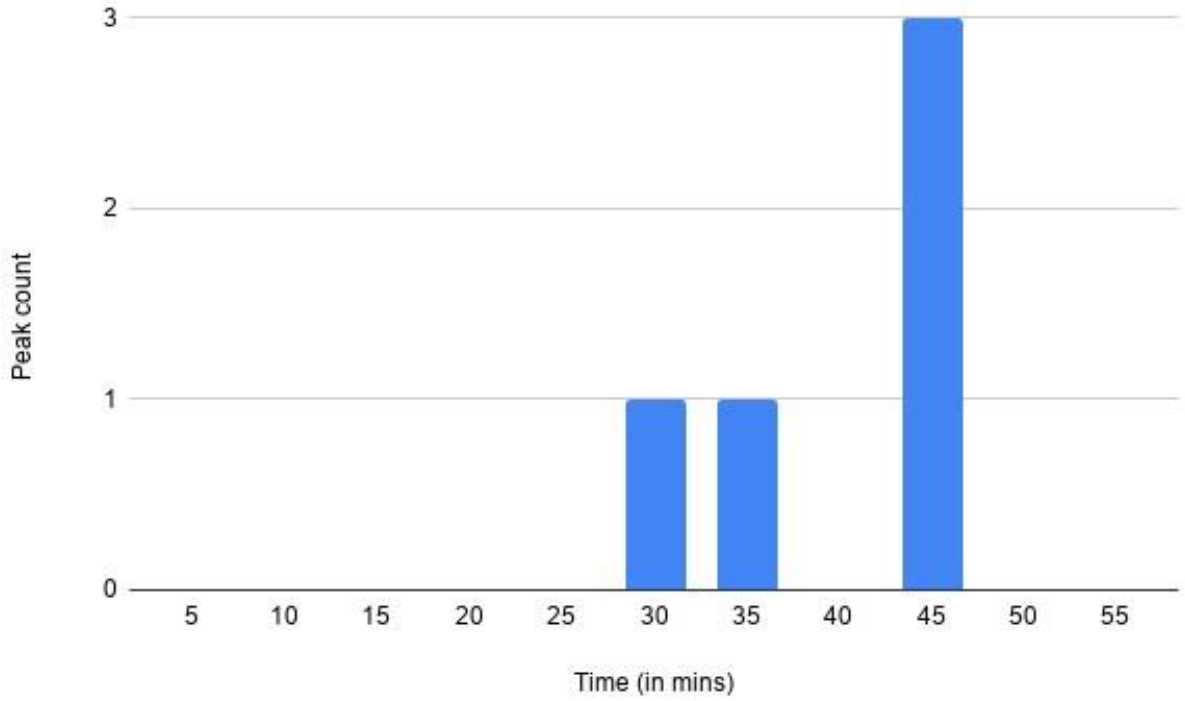


Figure 20 shows few EDA peaks in Participant A11, who attended the museum 1-2 times in the last 12 months. More research with a larger sample is needed to determine how visits frequency influences EDA and what frequency of visits impacts EDA. In contrast to Figure 20, Figure 21 demonstrates EDA activity with clear peaks but at very low levels. In the GUI data, some EDA peaks can be seen in the first ten minutes of the experience. It is possible to determine more pronounced EDA peaks in three areas of the GUI data – but these are at low levels. This is an excellent example of how peak extraction does not account for the magnitude of peaks but is a measure of the density of peaks in electrodermal activity valid in only some participants. This visitor’s data usefully illustrates some of the issues with automatic peak extraction. The current publication standards for peak detection do not adequately encompass the whole range of electrodermal response across the general population. Findings such as these have caused some physiological researchers to argue for a review of these standards (Braithwaite and Watson 2015).

Despite this weakness, it is possible to determine links between higher levels of EDA and what the visitor recalls in the survey. The largest number of detected peaks is in the last ten minutes,

situating the visitor in the Impressionist Gallery. The GUI data shows slightly higher peaks in the Marine experience, whereas more peaks occurred in the Impressionist Gallery as per the peak graph. Their peak graph and GUI data show some peaks in the middle section of the visit – here, we would expect them to be in the Marine Gallery. In the survey, they wrote: “I found the underwater exhibit the most interesting as I had not seen it before.” The is an indication of some relationship between self-reported affect and EDA. Still, this claim is more difficult to sustain and is complicated by issues relating to the peak parameters. This constrains the analysis, and the relationship between self-reported affective experience and EDA data is less clear in this case.

Participant A11 describes a general feeling of engagement attributed to “The way the dinosaurs, animals and people moved and made noises helped to keep my attention.” The visitor described the *Museum ExplorAR* device as the most memorable part of the experience. The visitor primarily uses description and analysis. In particular, they reflect on the way augmented reality shaped their experience:

> I felt more engaged with the things I could see and interact with via the AR device which meant I paid a bit more attention to the information. However I was also are I wasn't paying as much attention to the things that weren't on the AR device.
>
> - Participant A11

The visitor acknowledges and reflects on the role of the AR technology in shaping their experience. From an affective practices perspective, this self-reported experience speaks to the visitor's analysis of augmented reality and its potential to shape and focus affective practices. Rather than understand the augmented reality experience via a dry form of technological determinism where one might view technology as simplistically changing behaviours, one can trace the affects noted by this visitor within the intent of the curators, and the digital team, whose ambition for *Museum ExplorAR*, was that it enabled visitors to look in more detail at specific areas of the collection.

Figure 21: E4 GUI Data in *Museum ExplorAR* Participant A11

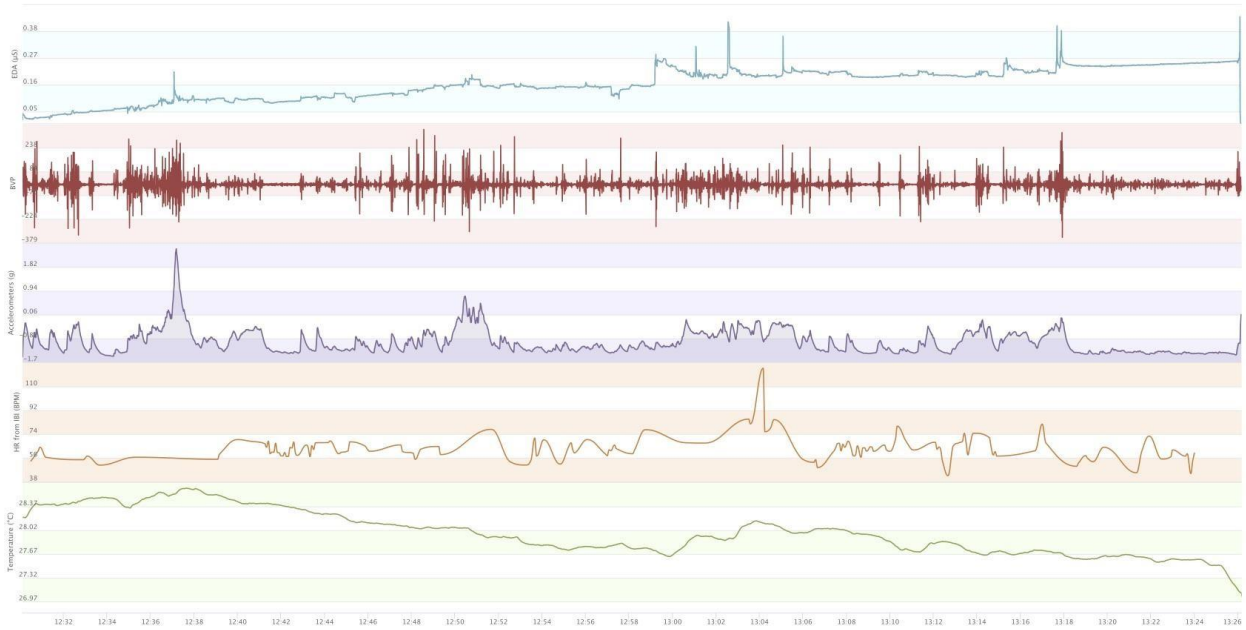
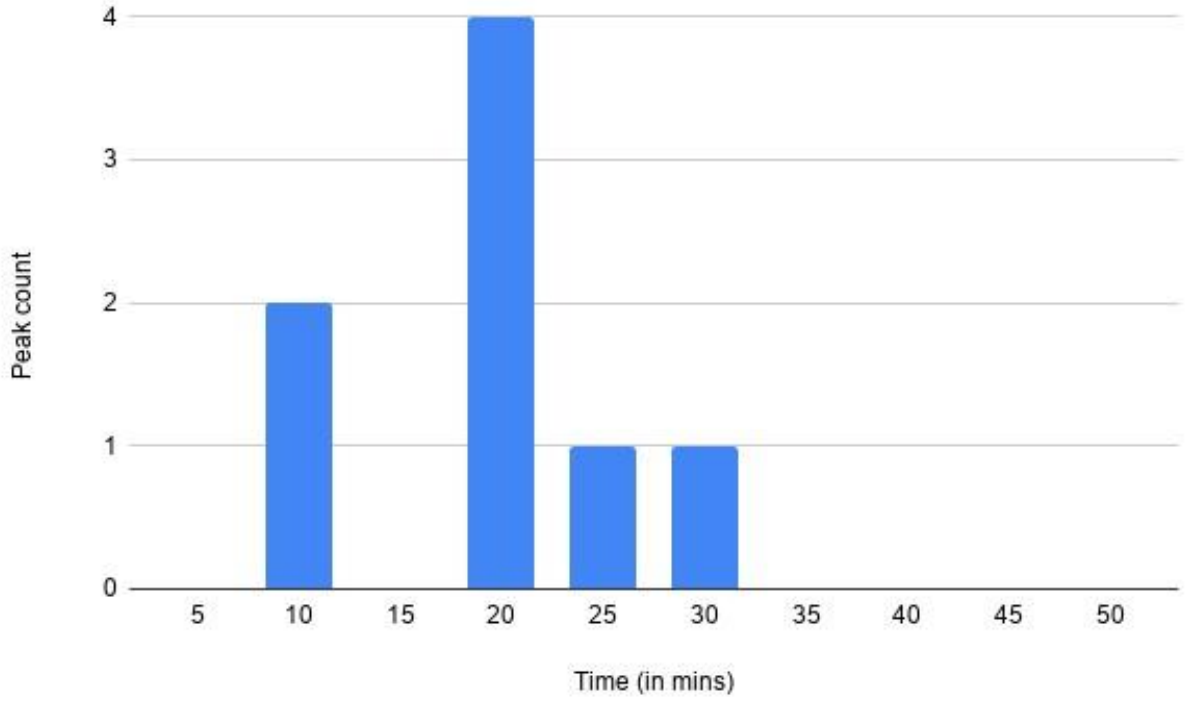


Figure 22: Participant A6's EDA Peak Extraction



Visitor A6 recalls ‘dinosaurs and waterlilies’ as the most memorable part of the experience. The peak graph and GUI representations of this visitor’s EDA data (Figures 22 and 23, respectively) demonstrate activity during the first dinosaur experience and shows several peaks in the Marine Gallery. Despite the visitor mentioning it in self-report, no EDA peaks are detected in the final Impressionist Gallery, where augmented reality overlaid Claude Monet’s garden at Giverny onto the gallery and turned the floor into a pond covered with waterlilies. In Figure 22, one can see that Participant A6 has low levels of electrodermal peaks as per the study’s set parameters for peak detection. Given the appearance of clear, peaked EDA response but at low levels in the visitor’s GUI data (Figure 23), the peak parameters are likely not suitable for this individual. However, other possible conditions may lower EDA in this visitor. The first is the visitor’s visit frequency: this visitor attends more than four times a year. Previous research has suggested that familiarity will reduce EDA and novelty increase EDA (Boucsein 2012). Second, in the latter half of the data, many peaks are visible in the GUI data but omitted by the peak extraction. This omission calls into question the validity of the peak parameters but also requires further investigation. The EDAExplorer programme compares EDA, accelerometer, and temperature data. The temperature data rises by over 2 degrees centigrade over the last twenty minutes of the visit. This temperature rise would cause EDAExplorer’s algorithm to discount peaks in this period. There remains an issue as to whether the robust exclusion protocol of EDAExplorer cause links between self-report and EDA to be missed.

In the survey, the visitor relies on description and historical narratives to identify aspects of the experience. There is no analysis or weaving present in this visitor’s self-report data. The visitor recalls feeling ‘uplifted’ during this final phase of the tour and attributes this feeling to the art collection. In this case, we know there is an identified emotional process occurring for the visitor but that it does not register in the peak count form of the EDA data at the set parameters. As stated in chapter 2, EDA is not a ‘catch-all’ indicator of emotional response. Findings elsewhere claim EDA is a useful marker of concentrated, attentive forms of arousal but offers less insight when exploring subtle or more introspective experiences (Conati 2003; Howell 2018). As a result, moments of calm or reflection often evade EDA, but a low EDA is not an indicator of no affective response. With that in mind, there may be a relationship between the visitor’s low EDA peaks and the feeling of being ‘uplifted’ by the visit. However, this is complicated by the visitor’s GUI data, which shows a greater number of peaks over the whole experience than in Figure 22. Yet, these peaks are not captured by the peak parameters set in EDAExplorer. As a result, while

some increases in EDA can be mapped onto self-report affective experiences, these relationships are far from conclusive.

Figure 23: E4 GUI Data in *Museum ExplorAR* Participant A6

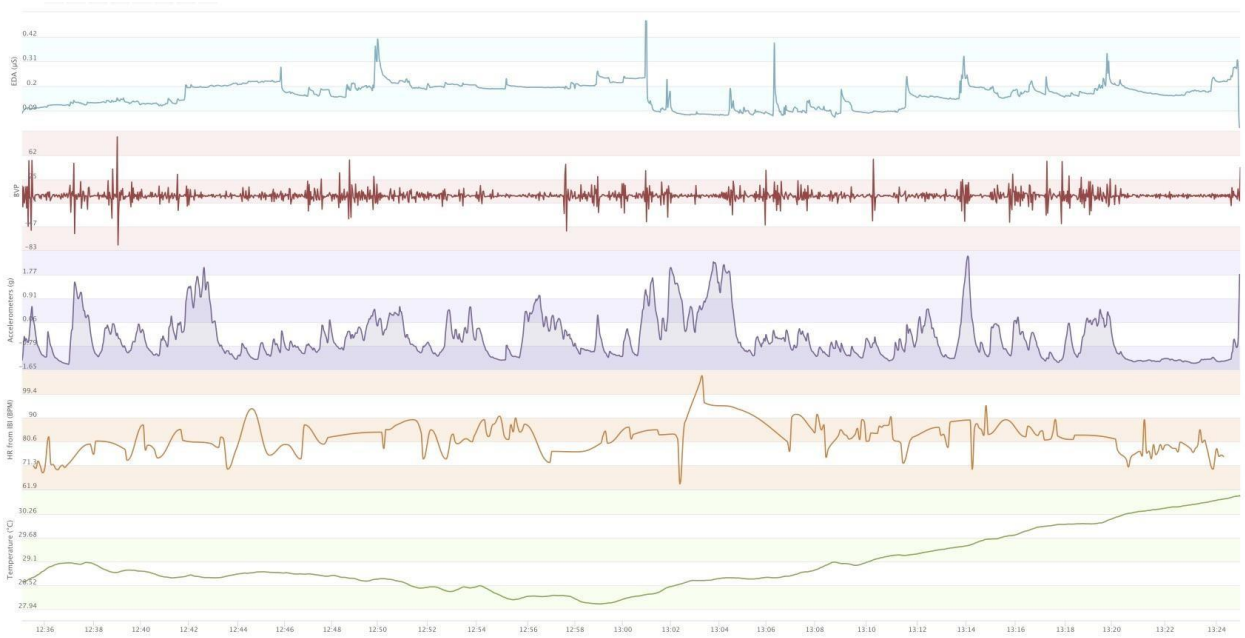


Figure 24: Participant A12's EDA Peak Extraction

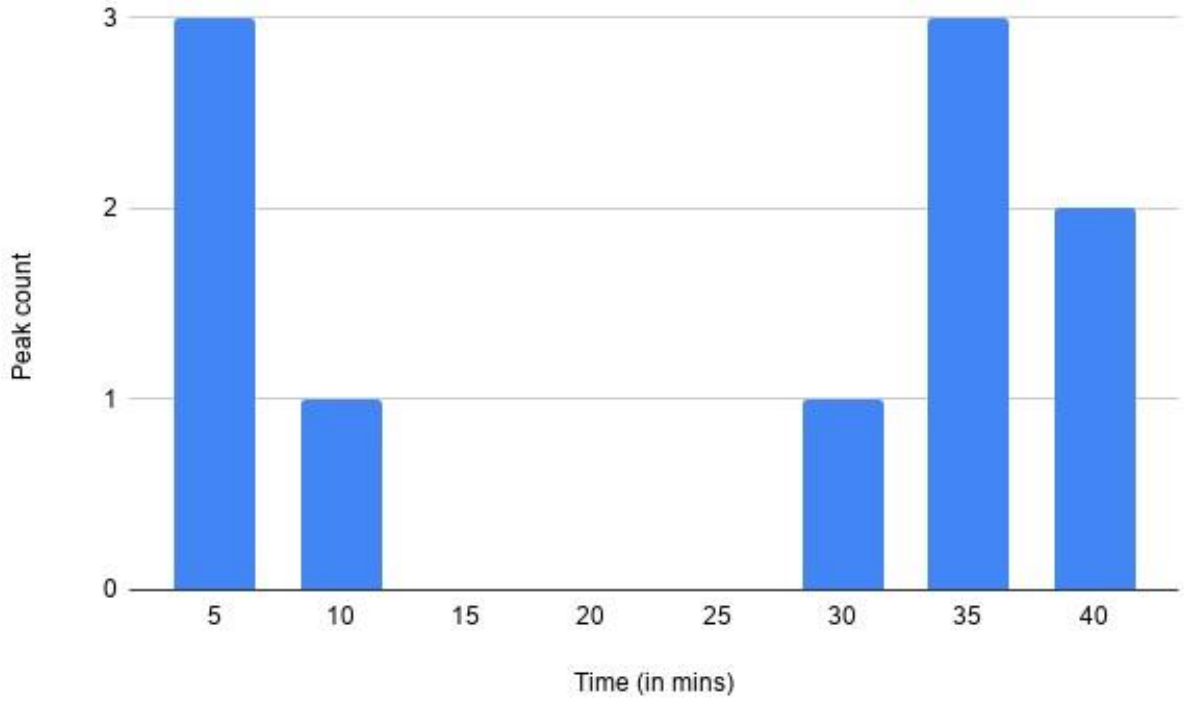


Figure 24 shows two detectable periods of electrodermal peaks within visitor A12 - one at the start of the experience (c. 5-10mins) and another later towards the end in the Impressionist Gallery (c. 30-40 mins). At 5 minutes, the visitor would still be moving through the main hall towards the galleries; a rise here might be attributed to anticipation, concentration on the device or another factor. Without further engagement with the participant, positing any potential cause for this early EDA rise is highly speculative. At 10mins, the visitor would have been in the Prehistoric Gallery, and this gallery is not mentioned in the self-report. The visitor identifies memorable and interesting experiences later in the tour – using description and narrative to share their experience, recalling the 'actors providing insight' in the Impressionist Gallery. The peak data in Figure 24 shows activity over the last ten minutes, which corresponds to the Impressionist Gallery. While EDA peaks do not present in three distinct periods corresponding to the three AR parts of *Museum ExplorAR*, this visitor does demonstrate higher EDA during the period they identified as memorable and interesting. In terms of the low levels of EDA peaks in Figure 24, this visitor attends 3 - 4 times a year; as has been previously stated, familiarity with the museum may reduce EDA response. The visitor described feeling 'relaxed' and 'calm' during their visit and linked this feeling to the museum environment. Again, as discussed earlier in this

chapter, such affective experiences have been associated with lower EDA activity in some individuals, which is another possible factor influencing the analysis of this data. Figure 25 shows Participant A12's GUI data, and here peaks are visible throughout. Still, these are of a very small magnitude - individually calculated parameters would likely bring more accuracy to the analysis of this visitor's data. Overall, while some EDA peaks are present, and there are links between the self-reported data and EDA, a number of caveats have to be considered in this case and indicate a need to proceed with caution and with an awareness of these factors.

Figure 25: E4 GUI Data in *Museum ExplorAR* Participant A12

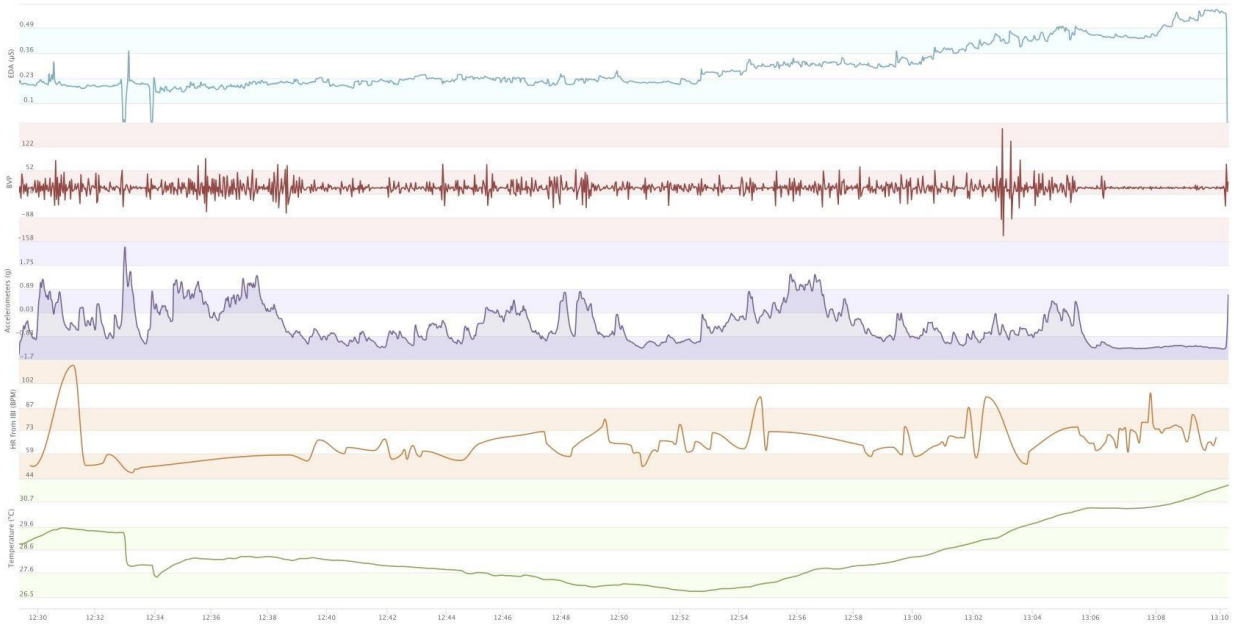
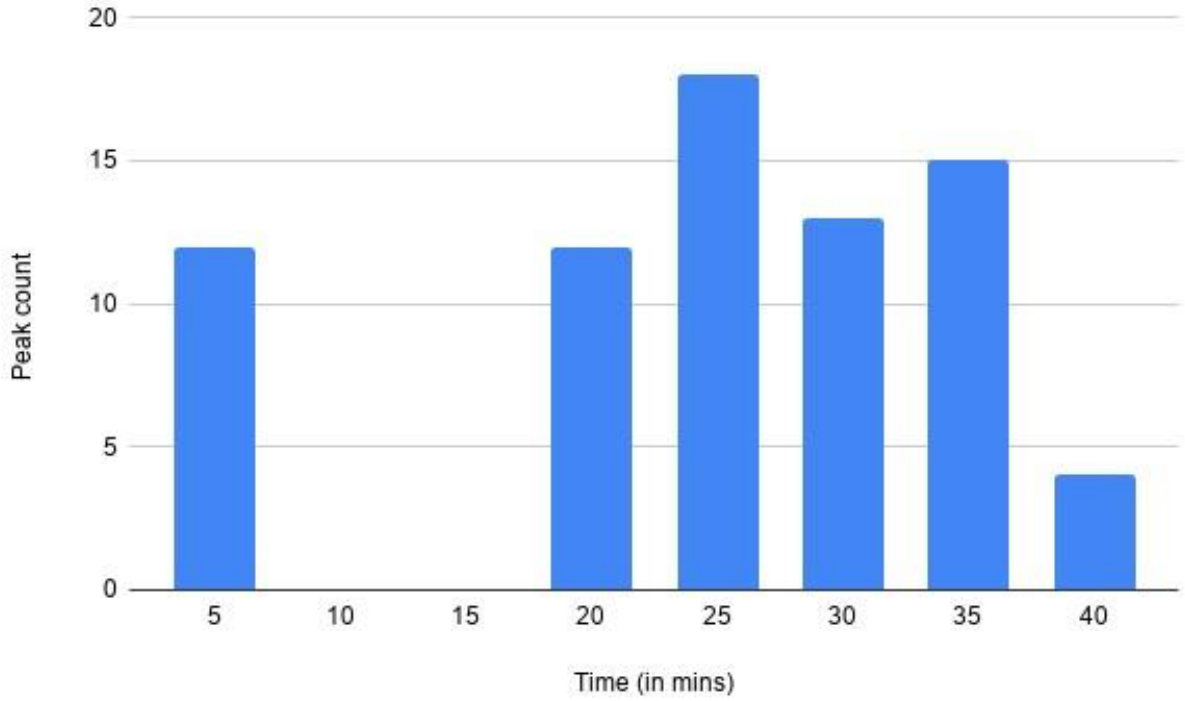


Figure 26: Participant A15 ‘s EDA Peak Extraction



The peak graph for Participant A15, shown in Figure 26, shows EDA peaks at the very start (c.5mins) and a sustained period of EDA peaks from 20 minutes onwards with a drop in the final 5 minutes. The visitor cites the ‘moving AR images of dinosaurs & Marine life’ in the first two galleries as the most memorable part of the experience; this can be linked to the peak graph, which shows peaks at the point this visitor would be in the Marine Gallery (c20-25 minutes). This indicates that some relationship exists between the periods of peak activity and self-reported experience. In this visitor, we do not see three clear periods of EDA that might be seen to correspond to the three augmented reality experiences. However, links are present between aspects of the self-reported experience and higher periods of EDA. This can be seen in Figures 26 and 27, where the higher levels of EDA maps onto the final augmented reality experience in the Impressionist Gallery.

The visitor uses description, narration, and analysis. They recall feeling ‘curious’ about the ‘decisions about the use of AR around paintings & the history of the collection’ in the Impressionist Gallery. In their comments, the visitor focuses on the impact of augmented reality on their experience. The visitor uses analysis to recall their experience – in terms of the cognitive

tools framework, this tool was associated with more explicit forms of affective reflection in chapter 6. In the case of visitor A15, there is a potential rise in EDA during the periods they report having been engaged in these thoughts and affects. This is interesting to note and resonates with Picard's observation that EDA increases with an increase in attention and focus (Picard *et al.*, 2004). Overall, this observation and the observations from the other participants in this chapter point to a potential for EDA as increasing during the periods visitors find memorable or interesting but some visitors who describe a calm or relaxing experience may have lower EDA response overall. This is not to suggest that this is a finding of this chapter - it is an emergent hypothesis arising from the exploratory research that may warrant further investigation. This point is discussed further in the conclusion to part four.

Figure 27: E4 GUI Data in *Museum ExplorAR* Participant A15

Discussion & Research Questions

This section discusses and summarises this chapter's findings within the context of the research questions it set out to address. These were:

5. Is the analysis of individual participants electrodermal data a valid and useful methodological approach to investigating museum visitor experience?
    a. Do relationships exist between visitors' self-reported emotion data collected via surveys and the electrodermal data collected from the Empatica E4?

5. This chapter explored what the combination of EDA and self-report data from six visitors to the *Museum ExplorAR* experience can reveal about visitors' affective experience. The investigation aimed to determine the value and the methodological constraints of analysis EDA at an individual level. It offers a preliminary view on whether an affective practice approach to visitor experience can be combined with an interpretation of individual EDA data. The answer to this research question is most succinctly summarised as a 'partial yes', but with a number of specific caveats (Tröndle *et al.*, 2012, p. 130). The analysis allowed a number of obstacles to surface. In this section, these methodological caveats are acknowledged, discussed, and suggestions offered for how they may be addressed in future research. The limits of this study in answering this question are also considered.

The first caveat relates to the current standards for detecting EDA peaks. This study used two methods to examine individual electrodermal data: automated peak counts via EDA Explorer and a visual inspection of the GUI data. Automatic detection promises a more objective measure, but as this chapter has shown, peak detection parameters are problematic. Half of the sample show signs that the standard peak parameters may not be a good fit for their data. This issue could be addressed through increased engagement with participants and a greater amount of EDA monitoring performed over several days. This would mean individual EDA response could be better understood and parameters for analysis individualised. In such an undertaking, the magnitude of EDA response would first be established in a clinical setting where participants would

be subjected to various activities and their EDA response examined. Subsequently, it would be possible to establish what constitutes a peak for an individual and what is background (also known as tonic level) EDA fluctuation. Following this, ambulatory recordings in different environments would be made for comparison. From these observations, an individualised set of peak parameters where rise and fall times were individually determined. Although this is a considerable undertaking for both researcher and participants, it would benefit the analysis in this chapter and the preceding one through increased accuracy as a result of sensitivity to an individual's physiology. However, increased participant involvement would likely have an impact on the impact of the study, and this would need to be considered.

Additionally, novelty and anxiety are known factors in increased EDA; this chapter has discussed instances where novelty and familiarity could be influencing factors. While none of the visitors examined in this chapter reported feelings of anxiety, this may indicate a bias towards reporting positive emotions. In their meta-analysis of subjective wellbeing surveys, Walker et al. write that people perceive and recall past experiences in their lives as more pleasant than unpleasant. The affect associated with unpleasant events appears to fade faster than the affect associated with pleasant events (Walker et al. 2003). Such a finding is a complicating proposition within the field of emotion research. This study demonstrates that EDA cannot be clearly and routinely linked to experience – without more significant controls throughout the study, which may, in turn, influence the outcome. Any future study may wish to consider this more carefully and, in addition to longer-term participant enrolment, consider alternatives to surveys (for example, semi-unstructured interviews) that might provide the space for more nuanced affective aspects of the experience to surface.

This chapter is limited by being reduced to the *Museum ExplorAR* participants only. The researcher acknowledges this as a limitation of the analysis. Despite the frustrations that attend limitations of such work, exploratory research must be open to failure. The links suggested in this chapter are not compelling. Of course, one would like to offer a greater sense of clarity and precision in any analysis offered, but on reflection, there is an important lesson to be learnt about EDA data and affective practices here. Neither this EDA data nor survey answers provided by visitors offer a complete picture of emotional arousal. The methods chosen in this study effectively

point to the limits of the EDA data when worked through the types of tools that might commonly be associated with quantitative research – this is a purposeful choice. Working in this manner attempts to avoid the criticisms levelled by Picard when they bemoan ‘constructivist theorists' and claim that affect research has been dogged by ‘classical armchair observations’ (Picard et al. 2004 p.264). This study uses tools routinely associated with quantifiable, objective measures (EDA and survey) to demonstrates their limitations within an evidence-based understanding of affect. This is not a wilful dismissal of Picard’s claims but rather a desire to engage with the evidence and the data to determine vital caveats that relate to the use of devices like the Empatica E4.

5.a. Within the context of the caveats discussed above, this chapter has demonstrated that an individual-level analysis of EDA has a contribution to make to the understanding of embodied affective museum experiences. Links between high EDA and self-reported data were established in 5 out of 6 (83%) participants. By examining EDA peaks and GUI data and comparing these to individual visitor survey responses, the chapter supports the view that, in nearly all visitors, there is higher EDA during their engagement with augmented reality and in periods of self-reported interest or emotion. Within an understanding of affect as embodied meaning-making, such meaning-making is occurring during the visit – as evidence by self-report and that in this sample, such practices are likely to be accompanied by increased EDA. The small sample size limits further conclusions, but the mixed methods analysis in this chapter supports the finding that for most visitors to *Museum ExplorAR*, there is a greater presence of electrodermal arousal during periods of self-identified emotional engagement, focus, and interest.

Given the demographic limitations discussed in chapter 7 and caveats outlined above, this chapter ends with a modest finding: that in the majority of those visitors who make it into the sample used in this chapter, electrodermal activity occurs in relation to the augmented reality and in periods that can be linked to instances of self-reported experience. This finding agrees with the principle of ‘general alignment’ of increased EDA to stimuli rather than an absolute and complete relationship between stimuli, self-report and individual EDA data (Barrett 2006a, p.40). In this sense, EDA data has some value in some participants at the individual-level when viewed within the context of participants’ self-reported experience, but links are inconsistent and unreproducible.

Addressing the caveats in this part would enable this finding to be revisited and for the value of EDA to be reviewed.

Part Four: Conclusion

Chapter 7 presents an analysis of the survey data from the *Museum ExplorAR* and *Snakes* exhibitions. The chapter presents the thematic analysis of visitor survey responses to open response questions and results of a closed response emotion scale (the previously mentioned EES). It discusses the open response data within the context of Wetherell's theory of affective practices and Leinhardt et al.'s cognitive tools framework (Leinhardt et al. 2002; Wetherell, 2012). The chapter supports the role of description, analysis, and narrative in retelling affective experiences and demonstrates the visitors' use of these to create individual interpretations from their experiences in the museum.

Other findings in chapter 6 relate to the use of 'engagement' as a widely used term for describing the experience of the museum. The chapter reflects on this as a potential influence of museums policy and practice or the study itself. This chapter also points to issues arising in the use of augmented reality and signposts further research that would be better able to engage with the specifics of these issues. Chapter 7 also demonstrates that open response questions provide greater detail and a more nuanced view of a participant's affective experience. In the open response data, six affective experiences were commonly reported by visitors to both exhibitions. Chapter 7 suggests these might represent some of the core emotions that can be related to museum visitation. The findings in the chapter agree with Feldman-Barrett's assertion that emotions appear in blends rather than discrete packages. Given the breadth of analysis in part four, it is not possible to delve into the affective combinations of these six categories, but this remains a viable avenue for future research.

Chapter 7 examined the distribution of standardised, group-level EDA data; it investigated whether higher or lower EDA levels at the group-level can be determined in aggregated EDA data. This was assessed by histograms and box plots of the aggregated data for each exhibition. The two groups (*Museum ExplorAR* and *Snakes*) were then further broken down into age, gender, and visit frequency demographics. The central claim of this chapter is that group-level EDA data has a limited contribution

to make to the understanding of visitor experiences in the museum. Chapter 7 demonstrates that without self-report, EDA has no context or connection to affective practice. In this respect, the chapter neatly illustrates the arguments put forth about EDA in parts one and two of this thesis. For instance, EDA increases and decreases at different rates within individuals and in response to various stimuli. When data is standardised and aggregated at the group-level, there is a limit to what can be concluded from the analysis. This chapter works to prove that generalised, group-level conclusions cannot be cleanly produced from EDA data. The chapter reveals three limiting factors in using electrodermal data at a group-level to understand visitor experience in museums. These are data quality, demographic caveats, and the appropriateness of lab-specific and exploratory analysis methods. The chapter deals with each of these in turn and illustrates the issues with EDA samples of female and senior visitors. This reinforces why considerations of data validity and demographic issues should take precedent in any research that seeks to deploy novel technologies.

Finally, chapter 8 sought to consolidate an affective practice understanding of visitors experience with a compatible analysis of EDA. The chapter discusses why only *Museum ExplorAR* was compatible with its analysis. The analysis in this chapter demonstrates potential links between EDA and self-reported experience, yet this mixed-methods analysis is a messy process of working through precarious relationships. The chapter draws on the survey analysis in chapter 6 and uses two methods to examine individual electrodermal data: peak counts and a visual inspection of the data represented by Empatica's GUI. The chapter compares survey and EDA data and looks for links between them. While links exist between the self-reported data and EDA, a number of caveats and limitations are established.

The study uses observations of visitors to formulate dwell times and applies these to the visitor data. This was minimally invasive, cost-efficient, and met with the approval of the project's partner, but admittedly such a procedure is limited. The researcher acknowledges this but also has resistance to more comprehensive forms of tracking. There is something methodologically conflicting about pinpointing a visitor in space when working in the affective practice model. Such tracking is reminiscent of studies that home in on causal aesthetic relationships. As Duncan has written, museum architecture and collections are only part of the picture; the museum is a 'dramatic field'

where visitors engage in the performance of visiting (Duncan 2005). It was not the intention of this study to ask: What specific emotions are felt in exact locations / in front of pre-determined objects within the museum? Any attempt to answer that question puts something else in the 'field' on mute. As an alternative, the study worked through its understanding of affective practices via the cognitive tools framework to understand affect in the museum as being formed of individual experience and values meeting with the environment.

As with the other chapters in part four, chapter 8 revealed new research questions. For instance, the EDA differences between visitors reporting more subtle emotions, i.e. forms of calm introspective, and those describing forms of engagement. The six visitors considered in chapter 8 can be split into two groups: those that express feelings of outwards focus, engagement, and emotional connection with the information. In contrast, a second group reflects primarily on the calm atmosphere and comforting environment. Future research may wish to explore the differences between these types of experience in more detail. However, as this work's focus is exploratory and concerned with the validity of the methodological approach, such an endeavour falls beyond the remit of this thesis - in this sense, this thesis lays the groundwork for future research questions. It is a feature and a frustration of exploratory research that interesting questions emerge and cannot be fully explored without working outside the scope of a project's central aims. Furthermore, such investigations would be limited by the study's sample size.

Each of the chapters in this part explores a different approach to affect and visitor data. These analyses work together to form a methodological investigation centred on the validity of the Empatica E4 and the affective practice approach. The latter is shown to work well in chapter 6, whereas chapter 7 and 9 work to deal with the challenges presented by EDA data. At times, it would be fair to question the methods used in the study - particularly the choice of a survey over interviews (either post visits or walking interviews during the visit). The research methods used in this study were chosen in order to undertake exploratory research that sought to explore a particular approach to affect and determine the validity of EDA data collected from ambulatory participants. In choosing a comparative case study design, the study sought to undertake a methodological investigation with two distinct museums experiences. The intention here

was to get a broader sense of the affective practices occurring across displays in National Museum Cardiff and use this comparative data to answer the study's research questions. In this sense, the methodological investigation takes precedent, and via the principles of critical data studies, the study does a significant amount of work establishing the caveats for working with ambulatory EDA data. The trade-off here is that more affective texture could have been brought to the study with different methods, but this would have limited the study's ability to counter the claims made for EDA data – particularly by those in the field of affective computing. While this limits this particular study, the intention is to contribute to the methodological literature and speak to the value of forms of affect research that may be sidelined by privileging technology and quantification without meaningful critique.

CONCLUSION

This study is a novel consideration of the embodied and social presentations of emotion and affect within visitors to two different displays at the National Museum in Cardiff. It considered the methodological approaches associated with these pervasive concepts, and interrogated the value of using wearable EDA monitoring in such a study. This is the first time that such an approach has been taken and this enables the researcher to make the claim that the work represents a novel investigation and an original contrinbution to knowledge.

This thesis comprehensively reviewed a range of debates and approaches in emotion and affect research in parts one and two. Part three navigated the relationship between theory and method to develop a valid, actionable methodology. Part four presented the results of the empirical study and discussed its findings in the context of the thesis' research questions. The result was a study that explored conceptual and methodological approaches to gain insight into museum visitors' experience. In this vein, Chapter 2 posed two questions: can affective practices be reconciled with physiological measures? And, given the evidence against, why are physiological measures so pervasive? This conclusion responds to each of these questions.

A significant amount of this thesis's work is building a pragmatic approach to social research in affect. It roots itself firmly in the evidence on affect, emotion, and physiological monitoring. Through a combination of qualitative and quantitative methods, it creates knowledge about affective visitor experience and EDA data. In its findings, it is able to speak to the psychological evidence, methodological validity, and debates in critical data studies. This positions the study as interdisciplinary and allows for the synthesis of ideas, characteristics, and methods from social psychology, sociology, museum and heritage studies, and critical data studies. As a result, this study has resonance across three phenomena – the ongoing influence of technology on research methods, the technological construction of human experiences, and the study of affective, social processes in museums. This conclusion works through these three areas in relation to the study's findings and the existing literature.

Understanding Affective, Social Processes in Museums.

This thesis adopts Wetherell, Smith, and Campbell's usefully capacious approach to affect that understands it as 'embodied meaning-making' where emotions are motivating or demotivating components within affective experiences. This view has resonance with existing museums research, which although varied in approach, understands the museum as a site of meaning-making (Silverman, 1995; Falk and Dierking, 2000; Schorch, 2014; Smith, 2015, 2017; Hohenstein and Moussouri, 2017; Blakely and Moles, 2019). The choice was made to follow the affective practice approach because it is an evidentiary sound and fruitful route for actionable social research into affective experiences. The approach agrees with a broad range of museological analyses that argue the museum visitors engage with forms of value and bodies of knowledge that have their foundations in society and the individual (Silverman, 1995; Falk and Dierking, 2000; Duncan, 2005; Hohenstein and Moussouri, 2017; Smith, 2017). Put another way, the museum offers opportunities to create, express, affirm and avoid who and what we believe ourselves to be. These aspects of self are dynamically formed and validated in the process of creating meaning out of our experiences and environments.

Through its engagement with the psychological evidence, the study operates with an awareness that any affective experience is not reducible to a single defined and comparable truth. To explore the affective work visitors undertake in museums, the thesis extends the research of Smith, Campbell and Wetherell, taking their conception of affective practice as a means of approaching museum visitors' emotional world; it brings that body of work to bear on a framework for understanding how visitors relay their experience: Leinhardt et al.'s cognitive tools framework (Leinhardt et al. 2002). The study seeks to manage this issue through its concern with *how* visitors described their visit, in addition to what they describe. This should not be seen as a minor point of investigation – it is entirely commensurate with Wetherell's notion of affective practice as a strategic move that aims to rehabilitate discourse within the study of affect. This study offers, via an affective practice approach and the cognitive tools framework, a means for understanding visitor experience that acknowledges that self-report data is collected at a distance, but that distance can be recognised and investigated as a generative place of encounter with the lived experience of participants.

This thesis has sought to navigate affect studies and psychological approaches to emotion to produce knowledge that can offer clear methodological contributions to museum studies and sociological research. The result demonstrates how affective experiences in the museum may be researched and how this can be evidenced and understood through subjective self-report visitor data codified within the cognitive tools framework. The study employed the cognitive tools framework to frame the affective practice of recalling a museum experience to understand how visitors talk about their experiences in the museum. The subjective responses collected in this study were not idiosyncratic and unpatterned - again and again, description, narration, and analysis are used to connect with and recall the affective experience. The patterns in these subjective acts of recall respond to Silverman's question: 'what patterns exist in these "personal" ways of making meaning?'. In the case studies presented in this thesis, visitors provide descriptive feedback, recall information and narrative, and assimilate these forms with personal contexts and existing knowledge, which often results in the visitors' use of forms of critique and analysis. This study uses this framework to identify moments where acts of memory, description and the recall of information and interpretation interweave with personal, sociocultural, and physical contexts. Combined with an approach to affect, which sees it as a form of embodied meaning-making, the cognitive tools model enables a detailed view of the contribution of affect and emotion to meaning-making in museums. The application of this framework is a useful methodological contribution to the understanding of museum visitor experience.

However, this thesis extends beyond identifying affective practices and the processes associated with communicating affect and emotion by investigating methods for asking participants about their experience. As was detailed in chapter 6, visitors to both *Museum ExplorAR* and *Snakes* report six common emotive states (Engaged, Excited, Enjoyment, Calm, Curious, and Connected) in response to the open choice questions. These states play a role in the experiences visitors have in museums across the two different cases. The study demonstrates that open response questions enable visitors to describe multiple, connected forms of emotion should they wish - a total of 61.58% of *Museum ExplorAR* and 79.48% of *Snakes* participants did so. In response to the EES, the closed choice question, all visitor responses are weighted towards emotions that some may perceive as more desirable - these include curiosity, surprise and excitement. In both *Museum ExplorAR* and *Snakes,* boredom, frustration, confusion

and anxiety are present in the EES data with less intensity. The EES responses did not feature dramatic variations between the exhibitions. The study showed a divergence between the emotions present in the open response and those that scored highly in the EES. For example, curiosity was scored highly by participants in the EES (all visitors report experiencing this emotion to some degree in EES). In contrast, it was far less prominent in the open-response (only 7.69% recall it).

The study demonstrated how closed-choice questions might miss and over represent emotions in comparison to open response. This finding speaks to methodological literature and reflects the tensions inherent in the act of eliciting self-report emotion data identified by Scherer (Scherer 2005). With this in mind, this author argues that open response provides greater access to the diverse forms of mental activity that comprise any affective experience. How stimuli are combined and weighted result in a 'myriad of mental events that people give common-sense names to, like perception, cognition, and emotion'. (Barrett, 2009, p. 1292). In this sense, this thesis supports an understanding of emotions as composite 'mental events' or 'states of mind' assembled from a combination of stimuli (Barrett, 2009, p. 1292). This thesis's conclusions support a multi-emotion view of visitor emotion, in line with Barrett's assertion that certain types of experience can be associated with particular affective mixes or 'recipes' (Barrett 2017). The thesis has demonstrated that open response questions expose the synchronous multiplicity of the affective work associated with a museum visit.

Through the cognitive tools framework, one may codify the affective work of describing experiences. The framework was used to identify where forms of description, narrative, analysis and weaving were deployed as tools by the visitors to relay affective experiences. In this manner, the study furthers Wetherell's idea of affective practice as embodied meaning-making by examining the process of communicating and navigating the forms of affect and embodiment Wetherell describes. This study also aligns with Barrett's view on emotions as a combination of an individual's experiences, meeting with external and somatic stimuli. The greater nuance provided by open response reveals further lines of inquiry, which in turn enable the generation of knowledge. In this study, visitors' emotions in open response have revealed a new question relating to how visitor experience and the language associated with it may have changed over time and been influenced by cultural policy. The study raised questions about the term

‘engagement’ and what it means for this type of description of the museum experience to circulate within visitors self-report data. This, in turn, provides greater insight into the processes and relationships involved within the visits.

Research into how feeling and affect shapes and transforms our relationships with the world and each other is always in danger of lapsing into sentimentality or, worse, overly jubilant celebration. For participants in this study, there was an affective texture to their wonder at the natural world or a moment of subtle calm in front of a Monet painting. In this sense, this thesis need not wax lyrical about the potential of connection and meaning-making in museums. Perhaps here, the reader will be able to furnish their own examples that further reiterate the potential for personal meaning-making in museums. As Perry writes, such encounters have the power to:

> stand as seedbeds for human generosity, ethical mindfulness, and care for the world at large… and this affective response can motivate us to act back on the world in constructive, ethically-minded ways (Perry, 2019, p. 354)

Two issues arise here – first, to what extent might emotion motivate behaviours in ethically-minded ways. For instance, if the experience of awe in front of a whale skeleton fosters some affect, once created, where does this go and to what end can these processes be used by museums as resources? What are the ethical considerations of affective resources? Such questions are the remit of a different study. Further issues arise when one considers the more difficult side to affective experience in museums – where affective practices wrestle with colonialism and race issues. Recent reviews of collections in the UK have led to re-hangs at the World Cultures Gallery at the World Museum in Liverpool and 120 items of human remains being removed from display at the Pitt Rivers Museum in Oxford (McGreevy, 2020). The latter is a particularly interesting case, as the museum’s audience research demonstrated that visitors often saw the displays of human remains as a testament to other cultures being ‘savage,’ ‘primitive’ or ‘gruesome’ (Harris, 2020; McGreevy, 2020). In accessing this affective response to their collection, the museum addressed one particular way it propagated racist and stereotypical thinking. Here the affective practice of visitors is clearly a resource for the museums to draw on. The benefits of making space for affect and emotion in visitor research are matched by the potential such work

offers for exploring and intervening in the ways cultural collections create and sustain affective social relations.

In defence of the research presented in this thesis, I have previously written: 'the ability to move and be moved is not a luxury; in recognising this and working with affective practices, we can develop strategies to explore instances of feeling in cultural and heritage experiences' (Hoare 2018, page 2). I stand by this statement and the view that such investigations are essential to understanding the role museums and their collections can play in our lives – both good and bad. It is, however, necessary to provide a little nuance to this claim here. Nowhere am I arguing that the investigation of affect and emotion is treated as a luxury. Instead, the claim I make is for the essential need for such research and, particularly, for research that probes the opportunities and challenges offered by technological tools in a critically minded manner. Such investigations require a keen methodological eye and attention to evidence – two qualities this thesis has worked to retain throughout. Furthermore, this thesis aims to ensure that critique does not become a luxury in the face of technological tools of quantification. As the next section will argue, such devices may profoundly influence our understanding of the human experience.

Technology and Research Methods

This study achieves an investigation of a technological tool within an established, evidenced-based approach to affective experience. One intention of this thesis was, through empirical investigation, to challenge the ways physiological monitoring technology is conceptualised and understood in order to subject these tools to rigorous academic scrutiny. Therefore, in this thesis, scrutiny comes via an exploration of the validity and reliability of the technology, social and ethical considerations, and finally, reflections on the technological construction of human experiences. Each of these matters is given attention below.

Working in an exploratory manner can produce 'valid and insightful findings in the social sciences, if conducted in a transparent and self-reflexive way' (Reiter, 2017, p. 129). Yet, exploratory research? must be flexible and open to failure (Babbie, 2007). Valid research requires a systematic and rigorous approach to the design and implementation of the study, the collection and analysis of data, and the interpretation

and reporting of findings. In the context of this exploratory study, which tests a wearable device, validity and reliability are central concerns. This study reported issues with signal noise, data loss and highlighted potential inequalities introduced by automated noise detection and standard peak parameters. The study questions the validity of noise protocols due to their propensity to exclude females at a much higher rate. A further limitation of the current study is that it cannot speak to issues of race in this regard as the sample is skewed towards white visitors. Chapter 7 highlights EDA issues concerning females, who have been found to have higher EDA fluctuation overall (Román et al. 1989). Such fluctuation could lead to their data being dismissed due to noise. The analysis fails to consistently reproduce findings relating to age (such as Gavazzeni et al. 2008) and visit frequency (Boucsein et al. 2012; Dawson et al. 2007). These issues make conclusive statements about EDA difficult to sustain. Therefore, the current study is limited to the conclusion that there is some alignment with precedents in EDA research in the cases considered here, but this is not uniform between *Museum ExplorAR* and *Snakes* visitors.

EDA distribution does align with patterns described by previous research in some samples when standardised and grouped by each exhibit and sub-divided by demographics. For example, the EDA level declined in ageing populations and increased for visitors for whom the visit was a novel experience. It also noted that more introspective emotions might escape physiological monitoring in line with Conati, who concluded that it is ‘not clear how effectively the sensors can detect emotions that may be expressed more subtly’ (Conati et al. 2003, p.1). Chapter 8 notes the potential for lower overall EDA in visitors who describe low arousal, subtle, or more inward feelings during their visits. This study has demonstrated serious demographic issues and notes that EDA is not representative of all affective experiences; it finds that the contribution of electrodermal data is limited when investigating affective experiences. Overall, this points to the limitations of analysing EDA collected in ambulatory settings.

Through a mixed methods analysis fuelled by an affective practice approach, the study echoes the ‘partial yes’- the conclusion of the eMotion study (Tröndle et al. 2012). Such partiality speaks of a need to understand these methods not as enabling total and fixed forms of knowledge about museums and the embodied emotional experiences that occur within them. This thesis and the programme of exploratory research it describes

make two significant methodological contributions in this vein. First, it demonstrates and defines the limitations of the group-level analysis. Second, it undertakes an individual-level analysis that shows that EDA does rise in conjunction with self-reported emotion arousal, albeit in a limited sample size. Therefore, this thesis agrees with both the precedents of clinical physiology (Boucsein 2012) and some of the ambulatory studies that have used EDA measurement in recent years (Shoval et al. 2017; Kim and Fesenmaier 2015, Resch et al. 2015). EDA data is not well suited to aggregation without the data being adjusted within individual parameters; it is expected that such adjustments would considerably improve the data. However, this has research design implications that were incompatible with the current study. Longer-term monitoring over several days was not possible or desirable in the current study, which aimed to engage with casual visitors to the museum. For some, this disjunction between design and analysis may be a weakness of the study. However, in response to such claims, the author points out that longer-term involvement with the participants may have shaped their affective response in the museum, created far larger data sets, and required significantly more study administration. Such an undertaking, done well, would likely outstrip the resources of a single doctoral researcher. Importantly, it would have also fallen outside the interest of National Museums Wales, who were interested in gaining a more ‘natural’ understanding of their visitors' experience. In this sense, there was a balance to strike between the remit of the exploratory study, the interests of the project's partner and the type of participant engagement and research design. The reasons above also informed the choice of a survey over interview or ethnographic methods.

As this thesis demonstrated in chapter 2, the role of EDA, and more broadly, the ANS system, has been the focus of much research historically and through to the contemporary moment. This thesis speaks to the debates surrounding such measures and aligns with views that argue against ANS specificity. In this respect, this study is in line with Kreibig’s meta-analysis and Barrett’s position on psychological constructivism (Kreibig 2010; Barrett 2006), which is to say that it argues that there is a large degree of variance within emotional activation but relatively good support for the general dimensional relationship between the EDA and emotional arousal in some but not all emotions when examined at the level of the individual (Barrett 2006a; Mauss and Robinson 2009; Kreibig 2010). Given these findings, the thesis argues that limited

evidence exists to support the idea that emotional health and wellbeing can be demonstrated via EDA monitoring. Indeed, the analysis in chapter 7 illustrates the distribution of electrodermal arousal at the group-level in some demographics, but it says nothing about the nature or quality of affective experience. This is not to say that EDA will not be of use in the future. However, the research design and methodological caveats presented in this thesis will need to be addressed.

Critical considerations for EDA Technology and Data

Monitoring technologies, like the Empatica E4, and the quantifiable data it produces are tied, whether explicit or implicitly, to a politics of aggregation and the reduction of human experience to a figure - crucially, this must be one that can be compared with another figure - an act that ultimately promises (but perhaps doesn't deliver) a sense of certitude, to which one might more readily associate and subsequently communicate value. The issue of value belies the appeal of physiological measures. What value does such a measure generate? Technologies of information contain the promise of mechanical objectivity. What their value is and whether it is a useful and valid attribution is another question. Beer writes that before determining whether the ever-expanding range of metrics provide useful social scientific insights, we need 'a more conceptual, contextual, and politically sensitive appreciation of metrics and data' (Beer, 2017, p. 8). This thesis is wholly in agreement with Beer that social scientists should be at the forefront of critiquing emergent data types. In response, it operates through a critical data studies perspective and with a concern for methodological validity. Crucially, it does not separate these aspects of the investigation – they are both vitally important to interrogating EDA data's value in affect research. Both the philosophical, theoretical, and methodological must be contained in this debate. This may make the thesis open to criticisms that it focuses on the validity of measures rather than quantification as a 'sociological phenomenon in its own right' (Espeland and Stevens, 2008, p. 402). However, this thesis finds the provocations set out by Dalton and Thatcher to be a useful framework for a praxis of data critique. This is the route taken in this thesis as a critical data studies approach provides the space for examining quantification but does not settle on this issue alone.

Throughout a critical data studies perspective, this thesis has shown that EDA is most insightful when the data is situated in time and space – that is in combination with self-

report and some locative framing. This finding echoes Dalton and Thatcher's insistence that 'social context is fundamental in both the production and interpretation of meaning' (Dalton and Thatcher, 2014). It has also shown that simple noise detection protocols are demographically biased, and therefore it is imperative that such a process not be seen as neutral. Consequently, it reveals that data may limit our view of human experience. Empirically evidencing such issues is a means of substantiating claims about the social implications of these metrics and the power relationships they engender. In doing this empirical work, the thesis speaks to the need for working with an awareness of the process of datafication when we work with and are worked by technological tools. Furthermore, this thesis works to support the claims made in critical data studies related to the ways in which researchers may 'counter' conventional and assumed understanding of particular data forms (Dalton and Thatcher, 2014). In their claims for a praxis of counter data, Dalton and Thatcher argue for creative approaches to data that challenge the conventions around its value and interpretation. Viewed in this manner, this thesis lays a foundation for future research exploring how the public understanding of physiological data is shaped by our technological imagination, this advances the critical data studies literature by considering the field's potential contribution to the public's digital and data literacy.

Additionally, this thesis demonstrates that the contribution of electrodermal data is limited when subjected to a group-level analysis also probes the usefulness and desirability of some forms of quantification in this particular context. While group-level analysis illustrates the distribution of electrodermal arousal at the group-level, unsurprisingly, it says very little about the emotions being experienced. It remains to be seen what an intergroup analysis can tell us about the types of emotions experienced by museum visitors. In this respect, EDA alone reveals less about visitor emotion than the approaches taken in chapters 6 and 8which revealed aspects of affective meaning-meaning and conceptualised the way visitors share their experience within a framework that responds to affective and cognitive processes. The research presented in this thesis contributes to the literature regarding the validity and reliability of data obtained from these devices. It also demonstrates the conflict between EDA data and the knowledge this data can and cannot enable.

In a broader sense, these debates sit within ‘growing public, academic, and government demands for the quantification of most social phenomena’ (Espeland and Stevens, 2008). Reaching this point in the thesis causes one to wonder what else could be done with EDA data in service to and in opposition to these demands. That is to ask: what other forms of quantification EDA data be *usefully* subjected to? Due to the small sample and demographic exclusions issues, further statistical analyses were avoided in this study. One might wish to argue that the obvious next step would be to scale the project, where the sample size is larger and the number of museum sites expanded. A larger sample size may enable a better view of several demographic issues (age, gender, race, visit frequency) highlighted in this research. However, with respect to scaling, a larger research team would also be required. An increased capacity would also mean that further demographic analysis could be drawn in - social and economic factors, for example. However, such a proposition seems like a somewhat incongruous transition from this thesis's findings and conclusions.

Instead, this researcher looks towards the notion of ‘counter-data’, which rejects the forms of quantification tied to ’surveillance, capital, and other exploitative power geometries’ to explore the ‘possibility of liberatory, revolutionary purposes’ (Dalton and Thatcher, 2014). Thinking through this lens, one might suggest that instead of technological tracking, future research could work with visitors to create their own emotional maps of the museum to use in conjunction with EDA data. In response to the suggestion that such a route could have been followed in this project, the thesis takes the position that exploratory work that engaged with the validity of the tool and methodology constraints in the context of an affective practice approach was required first. That work having now been undertaken, future studies would be well placed to use EDA data to understand visitors affective response (both physiological and self-reported and mapped) via the ‘cognitive tools’ framework. Furthermore, such work could also be designed to increase data literacy among participants – educating visitors on physiology, embodied affects, and what is and isn’t rendered in digital data and the values associated with such monitoring. Such a research programme would represent an intervention in unpacking data assemblages described by Kitchin and Lauriault (Kitchin and Lauriault, 2014). In this endeavour, the technological, social, and economic relations enacted in the capture of biometrics data could become more transparent. Such work would extend critical data praxis and empirical affect research. In turn, it

would enable reflections on the recursive and affective relationships between technology and society.

The Value and Implications of this Thesis

This thesis takes the view that technologies have the potential to reconfigure how we understand disciplines and institutions. It does significant work to demonstrate the issues inherent within the deployment of technologies and data to detect and quantify emotions. Devices like the Empatica E4 and the data it produces represent a form of datafication of human experience. With the increasing use of artificial intelligence to detect emotion, debates about a comparatively archaic physiology measure like EDA might already be outdated. However, I would argue that the common thread between many emergent forms of technologically derived data professing the ability to speak to human experience requires social science to continue to critique such advances from theoretical and methodological perspectives. The work done in this thesis demonstrates that exploratory methodological research can attend to this. This thesis offers a pragmatic understanding of physiological data, its limits, and methodological value. It illustrates how it may and may not be rendered into psychophysiological or social physiological data relevant to museum visitors' experience. The thesis supports the cognitive tools framework's value in enabling a detailed picture of how visitors recall their experience. In demonstrating how visitors recall their affective experience, it produces museological and curatorial knowledge, which illustrates the central role of description and narrative but somewhat more limited scope for analysis and weaving. Understanding the types of experiences visitors can have, how deeper connections are made, and the emotional drives behind such connections is of value to museum professionals and researchers interested in the experience of museums or other heritage sites. The study reaches outside of these concerns to social scientists - particularly those within social psychology and sociology - touching on key components of affective theory and method.

As has been addressed through the thesis, there are three limiting factors for using EDA data to understand visitor experience in museums. These are data quality, demographic caveats, and the appropriateness of lab-specific and experimental analysis methods. Data loss is a limitation of this study. It also enables the study to respond to its research questions, specifically those concerned with EDA data's efficacy

and validity. As a result, this thesis contributes to the literature regarding the validity and reliability of data obtained from these devices. As we have seen, at present, EDA data is most useful when worked through a mixed methods methodology. This speaks to a need for pluralist, methodological approaches to technology that enable creative and insightful knowledge of these tools' value and their interactions in the questions one might seek to have them address. The current study offers future social scientists, museum studies scholars, and culture and heritage professionals an ethically aware and critically engaged view on visitor experience and physiological data. It also clarifies the need for a commitment to the ethical implications and the role of interpretation in engaging with EDA data. Finally, it sets out the need for working with an awareness of the process of datafication when we work with and are worked by technological tools. The exploratory study's contribution in this thesis is that it answers its research questions and sets out how to address the resultant caveats in future research. Based on these caveats, this thesis does not conclude with a definite answer on whether EDA will or will not be of use in the future. Instead, it clearly states that the design, methodological, and ethical caveats presented in the thesis should be robustly addressed through research design, analytical processes, and demographically inclusive technology design and protocols. The path forward requires research that is collaborative, interdisciplinary, and aware of its technologically enabled context.

As this thesis has shown, determining relationships between response and emotions is beyond the reach of what EDA data can provide. The constant flow of stimuli in the museum (or any ambulatory space) means that response to defined stimuli cannot be determined. In tandem with demographic analysis at scale, future research must track visitor movements, either in analogue by a set route or through tracking technology. Such tracking would open the door to new research questions - from those concerned with navigating space to interactions with individual artworks or social interaction. Undoubtedly, some forms of tracking will create very focused research questions and narrow the field of enquiry. There are, however, other approaches that might be considered – particularly methods that fell beyond the exploratory remit of the current study. Future research could work collaboratively with visitors to create their own emotional maps of the museum in conjunction with EDA data. Such a study would be well placed to use EDA data to understand the locative response in tandem with the ‘cognitive tools’ framework and extend the cognitive tools and affective practice overlay

to explore the affective relationship between the visitor, museum, and the digital representation of their experience.

Such an approach would fit entirely with the findings of a ‘general alignment’ of increased EDA to certain stimuli (Barrett 2006a, p.40). This thesis has made a claim for an approach to museum visitors' embodied physiological and affective experience underpinned by the notion of affective practices, supported by the cognitive tools framework and in clear view of the physiological data and psychological evidence. Together these represent an integrated part of the way visitors create forms of personal connection and reflection. Furthermore, in addition to being a good fit, this approach offers the opportunity for a more sustained conversation with the work of Howell and many of the ethical debates on the nature of digital data and its authority (Howell et al. 2018). Future research will also need to reflect developments in affective computing and physiology. There are a number of issues that are dependent on either development in or collaborations with these fields. There is no agreement on the validity of ANS measures, and there are methodological issues to be considered in analysing ambulatory data. Therefore, any future research design will need to note any further advances in the coherence between EDA and self-report and advances in devices and data management (particularly in terms of noise detection and indoor tracking abilities). Furthermore, this thesis has demonstrated links between self-reported data and EDA but clarifies that an individualised calculation for EDA peak parameters would significantly improve any future analysis. Therefore, future research may wish to reflect any revision of EDA peak standards or seek to collect EDA data from participants over a sustained period and calculate individual parameters.

This study’s open response data indicates that six common states (engaged, excited, enjoyment, calm, curious, and connected) play a role in the emotional experiences visitors have in museums regardless of the type of exhibition they attend. Further research might be undertaken to establish which combinations or ‘recipes’ appear frequently and in which context. This analysis would bring greater granularity to the differences in affective response by working with the data to further understand multi-emotion reporting and establish which affective relationships are present. Additionally, visitors' emotions in open response have revealed a new question relating to how visitor experience and the language associated with it may have changed over time and

been influenced by cultural policy. Future research may wish to interrogate how UK cultural policy developments have influenced acceptable behaviours and norms associated with museum visitation. There is value in examining the political, economic and ethical implications of ‘engagement’ as a dominant means of experiencing the museum and what such an investigation might have to say about the museum in the context of late capitalist forms of productivity and consumption, and the attention economy.

There exists much that is shared, but that is perhaps not always explicit, between divergent museological and heritage scholarship from the last thirty years, from Hooper-Greenhill, Duncan and Silverman to Falk and Smith (Falk and Dierking 1992; Silverman 1995; Hooper-Greenhill 1999; Falk and Dierking 2000; Duncan 2005; Silverman 2009; Smith 2010; Smith 2011; Smith and Campbell 2015). Across the field, frames such as civic service, performance, ritual, affective practices or cognitive tools aim to provide strategies for understanding visitor experience. This thesis has sought to establish, from that extant literature, a means to work through the contribution of a technology whose research precedents sits more comfortably in the realm of affective computing or clinical physiology. This has, at times, not been an easy task. This thesis has drawn on a pragmatic, exploratory methodological approach rooted in relevant multi-disciplinary literature in response to this challenge. First and foremost, the thesis is concerned with the relationships between affective visitor experience and what might be termed an emerging form of biometric informatics – in this sense, it is concerned with the interactions between museums, people, technology, and data. Unsurprisingly, and likely because of that sense of ‘emergence’, this work has revealed multiple avenues for future research, as has been detailed above.

Forms of biosensing or physiological data capture mediate the fraught and uncertain relationship between human experience and informatics - where experience is messy, and informatics has challenges when confronting mess. Yet, this is not minor detail or trite reflection. Increasingly, this author has come to think of the corporeal data one might collect from wearable technologies as data for critique and analysis and as a sort of as yet unsettled cultural medium. As Nafus writes, such technologies ‘represent a significant new chapter in the ongoing story of what it is that numbers do for us and do to us’ (Nafus 2016, page xii). In issues of data and personhood, the danger is reducing

experience to the physiological data point. This study's contribution - via the design, demographic and analysis caveats it exposes – demonstrates that while affective embodied experience has a physiological resonance, this is not a complete picture. Located somewhere in the technological promise of these devices, when directed at questions of emotion or affective experience, is the implicit fallacy that presumes full knowledge of this experience could ever be possible or ethical.

Bibliography

Ahmed, S. (2004a) ‘Affective Economies’, *Social Text*. Duke University Press, 22(2), pp. 117–139.

Ahmed, S. (2004b) *Cultural Politics of Emotion*. Edinburgh University Press.

Ander, E. *et al.* (2013) ‘Heritage, health and well-being: assessing the impact of a heritage focused intervention on health and well-being’, *International Journal of Heritage Studies*. Routledge, 19(3), pp. 229–242.

Anderson, K. and Smith, S. J. (2001) ‘Editorial: Emotional geographies’, *Transactions of the Institute of British Geographers*. Blackwell Publishers Ltd, 26(1), pp. 7–10.

Antón, C., Camarero, C. and Garrido, M.-J. (2018) ‘A journey through the museum: Visit factors that prevent or further visitor satiation’, *Annals of tourism research*. Elsevier BV, 73, pp. 48–61.

Archer, M. S. (2000) *Being Human: The Problem of Agency*. Cambridge University Press.

Babbie, E. R. (2007) *The Practice of Social Research*. Cengage Learning.

Barrett, L. F. (2006) ‘Are Emotions Natural Kinds?’, *Perspectives on psychological science: a journal of the Association for Psychological Science*, 1(1), pp. 28–58.

Barrett, L. F. *et al.* (2007) ‘The Experience of Emotion’, *Annual review of psychology*. Annual Reviews, 58(1), pp. 373–403.

Barrett, L. F. (2009) ‘Variety is the spice of life: A psychological construction approach to understanding variability in emotion’, *Cognition & emotion*, 23(7), pp. 1284–1306.

Barrett, L. F. (2016) ‘Functionalism cannot save the classical view of emotion’, *Social cognitive and affective neuroscience*. Oxford University Press, 94(1), p. nsw156.

Barrett, L. F. (2017) *How Emotions Are Made: The Secret Life of the Brain*. Pan Macmillan.

Beer, D. (2017) *Metric Power*. 1st edn. Palgrave Macmillan.

Beer, D. (2018) *The Data Gaze: Capitalism, Power and Perception (Society and Space)*. 1st edn. SAGE Publications Ltd.

Bennett, T. (2004) *Pasts Beyond Memory: Evolution, Museums, Colonialism*. Psychology Press.

Bennett, T. (2005) ‘CIVIC LABORATORIES’, *Cultural studies of science education*. Routledge, 19(5), pp. 521–547.

Bennett, T. (2011) ‘Civic seeing: museums and the organization of vision’, *A companion to museum studies*. books.google.com. Available at: https://books.google.com/books?hl=en&lr=&id=oQ8c6kRgH1IC&oi=fnd&pg=PA263&dq=civic+seeing+museums&ots=ig5Q8P-Hoi&sig=r-y0SwFHpYh_XekQWo5RNCct7kE.

Bermond, B. *et al.* (2007) ‘A cognitive and an affective dimension of alexithymia in six languages and seven populations’, *Cognition and Emotion*. Routledge, 21(5), pp. 1125–1136.

Blackman, L. *et al.* (2008) ‘Creating Subjectivities’, *Subjectivity*, 22(1), pp. 1–27.

Blackman, L. (2012) *Immaterial Bodies: Affect, Embodiment, Mediation*. SAGE.

Blackman, L. and Cromby, J. (2007) ‘Special Issue--Affect and Feeling’, *International Journal of Critical Psychology*, 21, pp. 5–22.

Blackman, L. and Venn, C. (2010) ‘Affect’, *Body & Society*. SAGE Publications Ltd, 16(1), pp. 7–28.

Blakely, H. and Moles, K. (2019) ‘Everyday practices of memory: Authenticity, value and the gift’, *The Sociological review*. SAGE Publications Ltd, p. 0038026119831571.

Boucsein, W. (2012) *Electrodermal activity*. Springer Science+Business Media, LLC, p. 618.

Boucsein, W. *et al.* (2012) ‘Publication recommendations for electrodermal measurements’, *Psychophysiology*, 49(8), pp. 1017–1034.

Boyd, D. and Crawford, K. (2012) ‘CRITICAL QUESTIONS FOR BIG DATA’, *Information, Communication and Society*. Routledge, 15(5), pp. 662–679.

Braithwaite, J. and Watson, D. (2015) *A Guide for Analysing Electrodermal Activity (EDA) & Skin Conductance Responses (SCRs) for Psychological Experiments*, *Birmingham University*. Available at: https://www.birmingham.ac.uk/Documents/college-les/psych/saal/guide-electrodermal-activity.pdf (Accessed: 13 May 2020).

Breen, L. (2007) ‘The researcher “in the middle”: Negotiating the insider/outsider dichotomy’, *The Australian Community Psychologist*. The College of Community Psychologists of the Australian Psychological Society, 19(1), pp. 163–174.

Brooks, S. (2011) ‘Historical Empathy as Perspective Recognition and Care in One Secondary Social Studies Classroom’, *Theory & Research in Social Education*. Routledge, 39(2), pp. 166–202.

Brun, G., Kuenzle, D. and Doguoglu, U. (2008) ‘Introduction: A new role for emotions in epistemology?’ Ashgate. Available at: https://www.zora.uzh.ch/id/eprint/11071/1/Brun-Kuenzle-EE-IntroV2.pdf.

Buck, R., Miller, R. E. and Caul, W. F. (1974) ‘Sex, personality, and physiological variables in the communication of affect via facial expression’, *Journal of personality and social psychology*, 30(4), pp. 587–596.

Byrne, J. and Humble, A. M. (2007) ‘An introduction to mixed method research’, *Atlantic research centre for family-work issues*, pp. 1–4.

Cacioppo, J. T. *et al.* (1997) ‘Psychophysiology of emotion across the life span’, *Annual review of gerontology & geriatrics*. Springer Publishing, 17, pp. 27–74.

Cacioppo, J. T. *et al.* (2000) 'Handbook of emotions'. The Guilford Press, New York.

Cacioppo, John T. *et al.* (2000) 'The psychophysiology of emotion', *Handbook of emotions*, 2, pp. 173–191.

Cacioppo, J. T., Tassinary, L. G. and Berntson, G. (2007) *Handbook of Psychophysiology*. Cambridge University Press.

Carrillo, E. *et al.* (2001) 'Gender differences in cardiovascular and electrodermal responses to public speaking task: the role of anxiety and mood states', *International journal of psychophysiology: official journal of the International Organization of Psychophysiology*, 42(3), pp. 253–264.

Chatterjee, H. and Noble, G. (2016) *Museums, health and well-being*. Routledge.

Conati, C., Chabbal, R. and Maclaren, H. (2003) 'A study on using biometric sensors for monitoring user emotions in educational games', in *Workshop on Assessing and Adapting to User Attitudes and Affect: Why, When and How*. Available at: https://www.cs.ubc.ca/~conati/my-papers/um03affect-camera-conati.pdf.

Creswell, J. W. (2002) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Second Edition. SAGE Publications Inc.

Creswell, J. W. and Plano Clark, V. L. (2011) *Designing and Conducting Mixed Methods Research*. 2nd edn. Sage Publications, Inc.

Cunningham, D. L. (2004) *Professional practice and perspectives in the teaching of historical empathy*. University of Oxford. Available at: https://ora.ox.ac.uk/objects/uuid:5bf95dbe-0fd9-49c2-9cc2-d2893d13da45 (Accessed: 7 May 2019).

Dahl, T. I. *et al.* (2013) 'Is Our Fascination With Museum Displays More About What We Think or How We Feel?', *Visitor Studies*. Routledge, 16(2), pp. 160–180.

Dalton, C. M., Taylor, L. and Thatcher (alphabetical), J. (2016) 'Critical Data Studies: A dialog on data and space', *Big Data & Society*. SAGE Publications Ltd, 3(1), p. 2053951716648346.

Dalton, C. and Thatcher, J. (2014) *What Does A Critical Data Studies Look Like, And Why Do We Care?*, *Society and Space*. Available at: https://www.societyandspace.org/articles/what-does-a-critical-data-studies-look-like-and-why-do-we-care (Accessed: 22 February 2021).

Daum, I., Markowitsch, H. J. and Vandekerckhove, M. (2009) 'Neurobiological Basis of Emotions', in *Emotions as Bio-cultural Processes*. New York, NY: Springer US, pp. 111–138.

Dawson, M. E., Schell, A. M. and Filion, D. L. (2001) 'The electrodermal system', in Cacioppo, J. T., Tassinary, L. G., and Bernston, G. B. (eds) *Handbook of Psychophysiology*. Cambridge, England: Cambridge University Press, pp. 200–223.

De Leur, T., Van Boxtel, C. and Wilschut, A. (2017) '"I Saw Angry People and Broken Statues": Historical Empathy in Secondary History Education', *British Journal of Educational Studies*. Routledge, 65(3), pp. 331–352.

De Rojas, M. del C. and del Carmen Camarero, M. (2006) 'Experience and satisfaction of visitors to museums and cultural exhibitions', *International Review on Public and Non Profit Marketing*. Springer, 3(1), p. 49.

Della Porta, D. and Keating, M. (2008) *Approaches and Methodologies in the Social Sciences: A Pluralist Perspective: Amazon.co.uk: Donatella Della Porta: 8580000723038: Books*. Cambridge University Press.

DeLyser, D. (2001) '"Do you really live here?" Thoughts on insider research', *Geographical review*. Wiley Online Library. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1931-0846.2001.tb00500.x.

Diener, E. (2009) 'Subjective Well-Being', in Diener, E. (ed.) *The Science of Well-Being: The Collected Works of Ed Diener*. Dordrecht: Springer Netherlands, pp. 11–58.

Docter, P. (2015) *Inside Out*. USA: Pixar.

Dodge, R., Daly, A. P. and Huyton, J. (2012) 'The challenge of defining wellbeing', *of wellbeing*. internationaljournalofwellbeing.org. Available at: http://www.internationaljournalofwellbeing.org/index.php/ijow/article/view/89.

Düking, P. *et al.* (2018) 'Recommendations for Assessment of the Reliability, Sensitivity, and Validity of Data Provided by Wearable Sensors Designed for Monitoring Physical Activity', *JMIR mHealth and uHealth*, 6(4), p. e102.

Duncan, C. (2005) *Civilizing Rituals: Inside Public Art Museums*. Routledge.

Ekman, P. (1992) 'An argument for basic emotions', *Cognition and Emotion*. Routledge, 6(3–4), pp. 169–200.

Ekman, P. and Friesen, W. V. (1971) 'Constants across cultures in the face and emotion', *Journal of personality and social psychology*, 17(2), pp. 124–129.

Empatica (2019) *What should I know to use EDA data in my experiment?*, *Empatica*. Available at: https://support.empatica.com/hc/en-us/articles/203621955-What-should-I-know-to-use-EDA-data-in-my-experiment- (Accessed: 9 March 2021).

Endacott, J. L. and Sturtz, J. (2015) 'Historical empathy and pedagogical reasoning', *The Journal of Social Studies Research*, 39(1), pp. 1–16.

Ernst, G. (2017) 'Hidden Signals-The History and Methods of Heart Rate Variability', *Frontiers in public health*, 5, p. 265.

Espeland, W. N. and Stevens, M. L. (2008) 'A Sociology of Quantification', *Archives europeennes de sociologie. European journal of sociology. Europaisches Archiv fur Soziologie*. Cambridge University Press, 49(3), pp. 401–436.

ESRC (2015) *ESRC Research Data Policy*. Available at: http://www.esrc.ac.uk/files/about-us/policies-and-standards/esrc-research-data-policy/.

Eubanks (2019) *Automating Inequality: How High-Tech Tools Profile, Police, and Punish the Poor*. Illustrated edition. Picador.

Everett, M. C. and Barrett, M. S. (2011) 'Benefits Visitors Derive from Sustained Engagement with a Single Museum', *Curator: The Museum Journal*. Blackwell Publishing Ltd, 54(4), pp. 431–446.

Falk, J. H. and Dierking, L. D. (2000) *Learning from Museums: Visitor Experiences and the Making of Meaning*. Rowman & Littlefield.

Falk, J. H. and Dierking, L. D. (2018) *Learning from Museums*. Rowman & Littlefield.

Falk, J. H. and Gillespie, K. L. (2009) 'Investigating the Role of Emotion in Science Center Visitor Learning', *Visitor Studies*. Routledge, 12(2), pp. 112–132.

Foreman-Peck, L. and Travers, K. (2013) 'What is distinctive about museum pedagogy and how can museums best support learning in schools? An action research inquiry into the practice of three regional museums', *Educational Action Research*. Routledge, 21(1), pp. 28–41.

Fredrikson, M. *et al.* (1998) 'Functional neuroanatomical correlates of electrodermal activity: a positron emission tomographic study', *Psychophysiology*, 35(2), pp. 179–185.

Frey, B. (2018) *Observer Effect*. Available at: https://methods.sagepub.com/reference/the-sage-encyclopedia-of-educational-research-measurement-and-evaluation/i14919.xml (Accessed: 16 April 2021).

Gavazzeni, J., Wiens, S. and Fischer, H. (2008) 'Age effects to negative arousal differ for self-report and electrodermal activity', *Psychophysiology*. Wiley Online Library, 45(1), pp. 148–151.

Gendron, M. *et al.* (2014) 'Perceptions of emotion from facial expressions are not culturally universal: evidence from a remote culture', *Emotion* , 14(2), pp. 251–262.

Greene, J. C. (2007) *Mixed Methods in Social Inquiry*. John Wiley & Sons.

Greene, J. C. and Caracelli, V. J. (1997) 'Defining and describing the paradigm issue in mixed-method evaluation', *New directions for evaluation*. Wiley, 1997(74), pp. 5–17.

Greene, J. C. and Caracelli, V. J. (2003) 'Making paradigmatic sense in mixed methods practice', in Teddlie, A. T. A. (ed.) *Handbook of mixed methods in social and behavioral research*. Sage, pp. 91–110.

Greenhalgh, T. *et al.* (2013) 'What matters to older people with assisted living needs? A phenomenological analysis of the use and non-use of telehealth and telecare', *Social science & medicine*, 93, pp. 86–94.

Gregg, M. and Seigworth, G. J. (2010) *The Affect Theory Reader*. Duke University Press.

Halcomb, E. J. (2019) 'Mixed methods research: The issues beyond combining methods', *Journal of advanced nursing*. John Wiley & Sons, Ltd, 75(3), pp. 499–501.

Harmon-Jones, C., Bastian, B. and Harmon-Jones, E. (2016) 'The Discrete Emotions Questionnaire: A New Tool for Measuring State Self-Reported Emotions', *PloS one*, 11(8), p. e0159915.

Harris, G. (2020) '"Racist" gallery in Liverpool museum to be overhauled in light of Black Lives Matter', *The Art Newspaper*, 13 July. Available at: https://www.theartnewspaper.com/news/racist-liverpool-museum-gallery-to-be-reconfigured-in-light-of-black-lives-matter (Accessed: 22 March 2021).

Hein, G. E. (2002) *Learning in the Museum*. Routledge.

Hemmings, C. (2005) 'INVOKING AFFECT', *Cultural studies of science education*. Routledge, 19(5), pp. 548–567.

Hoare, J. (2015) 'Tate Britain is', in Louise, D. (ed.) *The Interpretation Matters Handbook: Artspeak for the Public*. Black Dog Publishing London UK, pp. 20–21.

Hoare, J. (2018) 'Heart on Your Sleeve? Emotion, Wearable Technology and Digital Heritage', in *2018 3rd Digital Heritage International Congress (DigitalHERITAGE) held jointly with 2018 24th International Conference on Virtual Systems Multimedia (VSMM 2018)*, pp. 1–4.

Hoare, J. (2020) 'The practice and potential of heritage emotion research: an experimental mixed-methods approach to investigating affect and emotion in a historic house', *International Journal of Heritage Studies*. Routledge, pp. 1–20.

Hoare, J. and Reddington, C. (2014) 'Towards a Human Internet of Things', *Wired*, US Digital Edition(May), p. n.p.

Hohenstein, J. and Moussouri, T. (2017) 'Museums and the making of meaning', in *Museum Learning*. Abingdon, Oxon ; New York, NY : Routhledge, 2017. |: Routledge, pp. 55–98.

Hooper-Greenhill, E. (1999) *The Educational Role of the Museum*. Psychology Press.

Howell, N. *et al.* (2018) 'Tensions of Data-Driven Reflection: A Case Study of Real-Time Emotional Biosensing', in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. New York, NY, USA: ACM (CHI '18), pp. 431:1-431:13.

Immordino-Yang, M. H. (2015) *Emotions, Learning, and the Brain: Exploring the Educational Implications of Affective Neuroscience*. W. W. Norton, Incorporated.

Izard, C. E. (1991) *The Psychology of Emotions*. Springer Science & Business Media.

James, D. and Davies, G. (2019) 'Awe or Empathy, Fast or Slow? Articulating Impacts from Contrasting Mobile Experiences – MW19 | Boston', in. *MW19*. Available at: https://mw19.mwconf.org/paper/awe-or-empathy-fast-or-slow-articulating-impacts-from-contrasting-mobile-experiences/ (Accessed: 25 February 2020).

James, W. (1884) 'II.—WHAT IS AN EMOTION ?', *Mind; a quarterly review of psychology and philosophy*. Oxford University Press, os-IX(34), pp. 188–205.

James, W. (1890) ‘The Principles of’, *Psychology* , 2. Available at: http://coursecontent.learn21.org/ENG3x-HS-U10/a/unit04/resources/docs/E3HS_4.C_OrgTable_Psychology.pdf.

Juliff, T. (2018) ‘The Battle of Orgreave (1984)’, in Smith, L., Wetherell, M., and Campbell, G. (eds) *Emotion, Affective Practices, and the Past in the Present*. Routledge, pp. 85–102.

Kappeler-Setz, C. *et al.* (2013) ‘Towards long term monitoring of electrodermal activity in daily life’, *Personal and Ubiquitous Computing*. doi: 10.1007/s00779-011-0463-4.

Keltner, D. and Ekman, P. (2015) *The science of ‘inside out’*, *The New York Times*. Available at: https://people.ict.usc.edu/~gratch/CSCI534/Readings/The%20Science%20of%20Inside%20Out.pdf (Accessed: 15 February 2020).

Kember, S. (2012) ‘Notes towards a feminist futurist manifesto’, *Ada: A Journal of Gender, New Media, and*. adanewmedia.org. Available at: http://adanewmedia.org/2012/11/issue1-kember/?utm_source=rss&utm_medium=rss&utm_campaign=issue1-kember.

Kenderdine, S. (2015) ‘Embodiment, Entanglement, and Immersion in Digital Cultural Heritage’, in Schreibman, S., Siemens, R., and Unsworth, J. (eds) *A New Companion to Digital Humanities*. Chichester, UK: John Wiley & Sons, Ltd, pp. 22–41.

Kidd, J. (2015) ‘Gaming for Affect: Museum Online Games and the Embrace of Empathy’, *Journal of Curatorial Studies*, 4(3), pp. 414–432.

Kim, J. (jamie) and Fesenmaier, D. R. (2015) ‘Measuring Emotions in Real Time: Implications for Tourism Experience Design’, *Journal of Travel Research*. SAGE Publications Inc, 54(4), pp. 419–429.

Kirchberg, V. and Troendle, M. (2015) ‘The Museum Experience: Mapping the Experience of Fine Art’, *Curator-The Museum Journal*. 111 River St, Hoboken 07030-5774, Nj USA: Wiley-Blackwell, 58(2), pp. 169–193.

Kirchberg, V. and Tröndle, M. (2012) ‘Experiencing Exhibitions: A Review of Studies on Visitor Experiences in Museums: Experiencing Exhibitions: A Review of Studies on Visitor Experiences in Museums’, *Curator: The Museum Journal*, 55(4), pp. 435–452.

Kirchberg, V. and Tröndle, M. (2015) ‘The Museum Experience: Mapping the Experience of Fine Art’, *Curator: The Museum Journal*, 58(2), pp. 169–193.

Kitchin, R. and Lauriault, T. (2014) ‘Towards Critical Data Studies: Charting and Unpacking Data Assemblages and Their Work’. Available at: https://papers.ssrn.com/abstract=2474112 (Accessed: 16 February 2021).

Kleinginna, P. R. and Kleinginna, A. M. (1981) ‘A categorized list of emotion definitions, with suggestions for a consensual definition’, *Motivation and emotion*, 5(4), pp. 345–379.

Kohlmeier, J. (2006) '"Couldn't she just leave?": The Relationship Between Consistently Using Class Discussions and the Development of Historical Empathy in a 9th Grade World History Course', *Theory & Research in Social Education*. Routledge, 34(1), pp. 34–57.

Krapp, A. (2002) 'Structural and dynamic aspects of interest development: theoretical considerations from an ontogenetic perspective', *Learning and Instruction*, 12(4), pp. 383–409.

Kreibig, S. D. (2010) 'Autonomic nervous system activity in emotion: a review', *Biological psychology*, 84(3), pp. 394–421.

Laine, M. de (2000) *Fieldwork, participation and practice : ethics and dilemmas in qualitative research*. SAGE, p. 231.

Lane, R. D. *et al.* (2009) 'Neural correlates of heart rate variability during emotion', *NeuroImage*, 44(1), pp. 213–222.

Laundav, D. K. *et al.* (2014) 'Your heart might give away your emotions', in *2014 IEEE International Conference on Multimedia and Expo Workshops (ICMEW)*, pp. 1–6.

Laurier, E. and Philo, C. (2006) 'Possible Geographies: A Passing Encounter in a Café', *Area*. [Royal Geographical Society (with the Institute of British Geographers), Wiley], 38(4), pp. 353–363.

Leach, D. B. (2011) 'Children's Recollections of a Historic House Visit: Recall of Experiences and Use of Cognitive Tools', *Visitor Studies*. Routledge, 14(1), pp. 34–47.

LeDoux, J. E. (2000) 'Emotion circuits in the brain', *Annual review of neuroscience*, 23, pp. 155–184.

Leiner, D., Fahr, A. and Früh, H. (2012) 'EDA Positive Change: A Simple Algorithm for Electrodermal Activity to Measure General Audience Arousal During Media Exposure', *Communication methods and measures*. Routledge, 6(4), pp. 237–250.

Leinhardt, G. and Crowley, K. (1998) *Museum learning as conversational elaboration: A proposal to capture, code, and analyze talk in museums*. Learning Research & Development Center University of Pittsburgh. Available at: http://www.lrdc.pitt.edu/mlc/documents/mlc-01.pdf.

Leinhardt, G., Tittle, C. and Knutson, K. (2002) 'Talking to oneself: Diaries of museum visits', *Learning conversations in museums*. Lawrence Erlbaum Associates Mahwah, NJ, pp. 103–133.

Levenson, R. W. (1988) 'Emotion and the autonomic nervous system: a prospectus for research on autonomic specificity', in Wagner, H. L. (ed.) *Social Psychophysiology and Emotion: Theory and Clinical Applications*. Wiley, pp. 17–42.

Levenson, R. W. (2014) 'The Autonomic Nervous System and Emotion', *Emotion review: journal of the International Society for Research on Emotion*. SAGE Publications, 6(2), pp. 100–112.

Leys, B. R. (2011) ‘The Turn to Affect: A Critique’, *Critical inquiry*. journals.uchicago.edu, 37(3), pp. 434–472.

Lindgren, S. (2019) ‘Hacking Social Science for the Age of Datafication’, *Journal of Digital Social Research*, 1(1), pp. 1–9.

Lindquist, K. A. *et al.* (2012) ‘The brain basis of emotion: a meta-analytic review’, *The Behavioral and brain sciences*, 35(3), pp. 121–143.

de Looff, P., Didden, R., *et al.* (2019) ‘Burnout symptoms in forensic mental health nurses: Results from a longitudinal study’, *International journal of mental health nursing*, 28(1), pp. 306–317.

de Looff, P., Noordzij, M. L., *et al.* (2019) ‘Changes in heart rate and skin conductance in the 30 min preceding aggressive behavior’, *Psychophysiology*, 56(10), p. e13420.

Lupton, D. (2016) *The Quantified Self*. John Wiley & Sons.

Lynch, B. T. (2017) ‘The Gate in the Wall: Beyond Happiness-making in Museums’, in Onciul, B., Stefano, M. L., and Hawke, S. (eds) *Engaging Heritage, Engaging Communities*. Boydell Press (Heritage Matters), pp. 11–30.

Mason, R. *et al.* (2018) ‘Experiencing mixed emotions in the museum’, in Smith, L., Wetherell, M., and Campbell, G. (eds) *Emotion, Affective Practices, and the Past in the Present*, pp. 124–148.

Massaro, S. and Pecchia, L. (2019) ‘Heart rate variability (HRV) analysis: A methodology for organizational neuroscience’, *Organizational research methods*. SAGE Publications, 22(1), pp. 354–393.

Massumi, B. (1995) ‘The Autonomy of Affect’, *Cultural Critique*. University of Minnesota Press, (31), pp. 83–109.

Massumi, B. (2002) *Parables for the Virtual: Movement, Affect, Sensation*. Duke University Press.

Mauss, I. B. *et al.* (2005) ‘The tie that binds? Coherence among emotion experience, behavior, and physiology’, *Emotion* , 5(2), pp. 175–190.

Mauss, I. B. and Robinson, M. D. (2009) ‘Measures of emotion: A review’, *Cognition & emotion*, 23(2), pp. 209–237.

Mauss, I., Wilhelm, F. and Gross, J. (2004) ‘Is there less to social anxiety than meets the eye? Emotion experience, expression, and bodily responding’, *Cognition and Emotion*. Routledge, 18(5), pp. 631–642.

Maxwell, J. (1992) ‘Understanding and Validity in Qualitative Research’, *Harvard educational review*. Harvard Education Publishing Group, 62(3), pp. 279–301.

May, S., Todd, K. and Paneto, S. (2018) ‘Measuring and Designing for a Range of Meaningful Emotions in an Informal Learning Environment’, in *2018 3rd Digital Heritage International Congress (DigitalHERITAGE) held jointly with 2018 24th International Conference on Virtual Systems Multimedia (VSMM 2018)*, pp. 1–8.

May, T. (2011) *Social research : issues, methods and process*. McGraw Hill, Open University Press, p. 332.

McGreevy, N. (2020) *Oxford Museum Permanently Removes Controversial Display of Shrunken Heads*. Available at: https://www.smithsonianmag.com/smart-news/oxford-museum-moves-controversial-human-remains-storage-180975805/ (Accessed: 22 March 2021).

Message, K. (2009) 'New directions for civil renewal in Britain: Social capital and culture for all?', *International Journal of Cultural Studies*. SAGE Publications Ltd, 12(3), pp. 257–278.

Michaelson, J. *et al.* (2009) 'National Accounts of Well-being: bringing real wealth onto the balance sheet'. London: New Economics Foundation. Available at: https://repository.uel.ac.uk/item/863zv (Accessed: 2 November 2020).

Morton, A. (2009) 'Epistemic Emotions', in Goldie, P. (ed.) *The Oxford handbook of philosophy of emotion*. Oxford: Oxford University Press, pp. 385–399.

Nafus, D. (2016) *Quantified: Biosensing Technologies in Everyday Life*. MIT Press.

Nakahara, H. *et al.* (2009) 'Emotion-related changes in heart rate and its variability during performance and perception of music', *Annals of the New York Academy of Sciences*, 1169, pp. 359–362.

Neumann, E. and Blanton, R. (1970) 'The early history of electrodermal research', *Psychophysiology*, 6(4), pp. 453–475.

Noble, S. U. (2018) *Algorithms of Oppression: How Search Engines Reinforce Racism*. Illustrated edition. NYU Press.

Nold, C. (2009) *Emotional cartography : technologies of the self*. CC, p. 96.

Notarius, C. I. and Levenson, R. W. (1979) 'Expressive tendencies and physiological response to stress', *Journal of personality and social psychology*, 37(7), pp. 1204–1210.

Odell, J. (2019) *How To Do Nothing: Resisting the Attention Economy*. 1st edn. Melville House Publishing.

O'Neil, C. (2017) *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy*. 1st edn. Penguin.

Packer, J. and Bond, N. (2010) 'Museums as Restorative Environments', *Curator: The Museum Journal*, 53(4), pp. 421–436.

Pekarik, A. J., Doering, Z. D. and Karns, D. A. (1999) 'Exploring Satisfying Experiences in Museums', *Curator: The Museum Journal*, 42(2), pp. 152–173.

Pekrun, R. *et al.* (2017) 'Measuring emotions during epistemic activities: the Epistemically-Related Emotion Scales', *Cognition & emotion*, 31(6), pp. 1268–1276.

Perry, S. (2019) ‘The Enchantment of the Archaeological Record’, *European Journal of Archaeology*. Cambridge University Press, 22(3), pp. 354–371.

Picard, R. W. *et al.* (2004) ‘Affective learning — a manifesto’, *BT Technology Journal* •, 22(4). Available at: https://www.media.mit.edu/publications/bttj/Paper26Pages253-269.pdf.

Picard, R. W., Fedor, S. and Ayzenberg, Y. (2016) ‘Multiple Arousal Theory and Daily-Life Electrodermal Activity Asymmetry’, *Emotion review: journal of the International Society for Research on Emotion*. SAGE Publications, 8(1), pp. 62–75.

Pijeira-Díaz, H. J. *et al.* (2016) *Investigating collaborative learning success with physiological coupling indices based on electrodermal activity*, *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge - LAK ’16*. doi: 10.1145/2883851.2883897.

Pile, S. (2010) ‘Emotions and affect in recent human geography: Emotions and affect in recent human geography’, *Transactions of the Institute of British Geographers*, 35(1), pp. 5–20.

Pollatos, O. and Schandry, R. (2008) ‘Emotional processing and emotional memory are modulated by interoceptive awareness’, *Cognition and Emotion*. Routledge, 22(2), pp. 272–287.

Poole, S. (2018) ‘Ghosts in the Garden: locative gameplay and historical interpretation from below’, *International Journal of Heritage Studies*. Routledge, 24(3), pp. 300–314.

Posner, J., Russell, J. A. and Peterson, B. S. (2005) ‘The circumplex model of affect: an integrative approach to affective neuroscience, cognitive development, and psychopathology’, *Development and psychopathology*, 17(3), pp. 715–734.

Quintana, D. S. *et al.* (2012) ‘Heart rate variability is associated with emotion recognition: direct evidence for a relationship between the autonomic nervous system and social cognition’, *International journal of psychophysiology: official journal of the International Organization of Psychophysiology*, 86(2), pp. 168–172.

Reiter, B. (2017) ‘Theory and Methodology of Exploratory Social Science Research’, *International Journal of Science and Research Methodology*, 5(4), p. 129.

Resch, B. *et al.* (2015) ‘Urban Emotions—Geo-Semantic Emotion Extraction from Technical Sensors, Human Sensors and Crowdsourced Data’, in Gartner, G. and Huang, H. (eds) *Progress in Location-Based Services 2014*. Springer International Publishing (Lecture Notes in Geoinformation and Cartography), pp. 199–212.

Robson, C. (2002) *By Colin Robson - Real World Research: A Resource for Social Scientists and Practitioner-researchers (2nd (second) edition)*. 2nd Edition. John Wiley & Sons.

Rogoff, B. (1990) ‘Apprenticeship in thinking: Cognitive development in social context’. New York, NY, US: Oxford University Press Apprenticeship in thinking, 242. Available at: https://psycnet.apa.org/fulltext/1990-97332-000.pdf.

Román, F. *et al.* (1989) ‘Sex differences and bilateral electrodermal activity: a replication’, *The Pavlovian journal of biological science*, 24(4), pp. 150–155.

Russell, J. A. (1980) ‘A circumplex model of affect’, *Journal of personality and social psychology*. American Psychological Association, 39(6), p. 1161.

Russell, J. A. (1989) ‘Measures of emotion’, *The measurement of emotions*. Elsevier. Available at: https://www.sciencedirect.com/science/article/pii/B9780125587044500104.

Russell, J. A. (2003) ‘Core affect and the psychological construction of emotion’, *Psychological review*, 110(1), pp. 145–172.

Russell, J. A. and Barrett, L. F. (1999) ‘Core affect, prototypical emotional episodes, and other things called emotion: dissecting the elephant’, *Journal of personality and social psychology*. American Psychological Association (APA), 76(5), pp. 805–819.

Russell, J. and Barrett, L. F. (1999) ‘Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant’, *Journal of personality and social psychology*. American Psychological Association, 76(5), pp. 805–819.

Ryff, C. D. and Keyes, C. L. (1995) ‘The structure of psychological well-being revisited’, *Journal of personality and social psychology*, 69(4), pp. 719–727.

Samur, D. *et al.* (2013) ‘Four decades of research on alexithymia: moving toward clinical applications’, *Frontiers in psychology*, 4, p. 861.

Sandell, R. (1998) ‘Museums as Agents of Social Inclusion’, *Museum Management and Curatorship*. Routledge, 17(4), pp. 401–418.

Sandell, R. and Nightingale, E. (2013) *Museums, Equality and Social Justice*. Routledge.

Sara Ann Taylor (2016) *Characterizing Electrodermal Responses during Sleep in a 30-day Ambulatory Study*. Massachusetts Institute of Technology. Available at: http://affect.media.mit.edu/pdfs/16.SaraTaylor_MSThesis.pdf.

Savenije, G. M. and de Bruijn, P. (2017) ‘Historical empathy in a museum: uniting contextualisation and emotional engagement’, *International Journal of Heritage Studies*. Routledge, 23(9), pp. 832–845.

Sayer, A. (2005) ‘Class, Moral Worth and Recognition’, *Sociology*. SAGE Publications Ltd, 39(5), pp. 947–963.

Scherer, K. R. (2000) ‘Emotion’, in Hewstone, M. (ed.) *An Introduction to Social Psychology*. John Wiley & Sons, pp. 151–191.

Scherer, K. R. (2005) ‘What are emotions? And how can they be measured?’, *Social sciences information. Information sur les sciences sociales*. SAGE Publications Ltd, 44(4), pp. 695–729.

Schorch, P. (2014) ‘Cultural feelings and the making of meaning’, *International Journal of Heritage Studies*. Routledge, 20(1), pp. 22–35.

Sedenberg, E., Wong, R. and Chuang, J. (2017) 'A Window into the Soul: Biosensing in Public', *arXiv [cs.CY]*. Available at: http://arxiv.org/abs/1702.04235.

Sedgwick, E. K. and Frank, A. (1995) 'Shame in the Cybernetic Fold: Reading Silvan Tomkins', *Critical inquiry*. University of Chicago Press, 21(2), pp. 496–522.

Sedgwick, E. K. and Frank, A. (2003) *Touching Feeling: Affect, Pedagogy, Performativity*. Duke University Press.

Sedgwick, E. K., Frank, A. and Gullickson, T. (1996) 'Shame and Its Sisters: A Silvan Tomkins Reader', *Psyccritiques*. insights.ovid.com, 41(9). doi: 10.1037/003173.

Seligman, M. E. P. *et al.* (2011) 'Doing the Right Thing: Measuring Well-Being for Public Policy', *International Journal of Wellbeing*. doi: 10.5502/ijw.v1i1.15.

Shaffer, F. and Ginsberg, J. P. (2017) 'An overview of heart rate variability metrics and norms', *Frontiers in public health*, 5, p. 258.

Shoval, N., Schvimer, Y. and Tamir, M. (2018) 'Real-Time Measurement of Tourists' Objective and Subjective Emotions in Time and Space', *Journal of Travel Research*. SAGE Publications Inc, 57(1), pp. 3–16.

Silverman, L. H. (1995) 'Visitor meaning-making in museums for a new age', *Curator: The Museum Journal*. Wiley Online Library, 38(3), pp. 161–170.

Silverman, L. H. (2009) *The Social Work of Museums*. Routledge.

Silvia, P. J. (2006) 'Exploring the psychology of interest'. books.google.com. Available at: https://books.google.com/books?hl=en&lr=&id=YxhnDAAAQBAJ&oi=fnd&pg=PA1&dq=Silvia+P+J+(2006)+Exploring+the+psychology+of+interest+Oxford+UK+Oxford+University+Press&ots=NNY_Wn__OW&sig=89F3xrOkjpMkecTUxh1Xn14lnTY.

Simmons, J. E. (2016) *Museums: A History*. Rowman & Littlefield.

Simon, N. (2010) *The Participatory Museum*. Museum 2.0.

Smith, L. (2010) '"Man's inhumanity to man" and other platitudes of avoidance and misrecognition: an analysis of visitor responses to exhibitions marking the 1807 bicentenary', *Museum and Society*, 8(3), pp. 193–214.

Smith, L. (2011) 'Affect and Registers of Engagement: Navigating Emotional Responses to Dissonant Heritages', in Smith, L. et al. (eds) *Representing Enslavement and Abolition in Museums: Ambiguous Engagements*. Routledge, pp. 260–303.

Smith, L. (2015) 'Theorizing museum and heritage visiting', *The International Handbook of Museum Studies: Museum Theory*, (Smith 2006), pp. 459–484.

Smith, L. (2017) '"We are… we are everything": the politics of recognition and misrecognition at immigration museums', *Museum and Society*. journals.le.ac.uk. Available at: https://journals.le.ac.uk/ojs1/index.php/mas/article/view/663.

Smith, L. and Campbell, G. (2015a) 'The Elephant in the Room', in *A Companion to Heritage Studies*. John Wiley & Sons, Inc, pp. 443–460.

Smith, L. and Campbell, G. (2015b) 'The Elephant in the Room: Heritage, affect and emotion', in Logan, W., Craith, M., and Kockel, U. (eds) *A Companion to Heritage Studies*. Wiley-Blackwell, pp. 443–461.

Smith, L., Wetherell, M. and Campbell, G. (2018) *Emotion, Affective Practices, and the Past in the Present*. Taylor & Francis Group.

Soren, B. J. (2009) 'Museum experiences that change visitors', *Museum Management and Curatorship*. Routledge, 24(3), pp. 233–251.

Sung-Nien Yu and Shu-Feng Chen (2015) 'Emotion state identification based on heart rate variability and genetic algorithm', *Conference proceedings: ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference*, 2015, pp. 538–541.

Swan, M. (2012) 'Sensor Mania! The Internet of Things, Wearable Computing, Objective Metrics, and the Quantified Self 2.0', *Journal of Sensor and Actuator Networks*. (The Black Swan: The Impact of the Highly Improbable), 1(3), pp. 217–253.

Tashakkori, A. M. and Teddlie, C. B. (eds) (2002) *Handbook of Mixed Methods in Social & Behavioral Research*. First edition. SAGE Publications, Inc.

Taylor, G. J. and Bagby, R. M. (2004) 'New trends in alexithymia research', *Psychotherapy and psychosomatics*, 73(2), pp. 68–77.

Taylor, S., Jaques, N., Weixuan Chen, W., *et al.* (2015) 'Automatic identification of artifacts in electrodermal activity data', in *2015 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*. IEEE, pp. 1934–1937.

Taylor, S., Jaques, N., Chen, W., *et al.* (2015) 'Automatic identification of artifacts in electrodermal activity data', *Conference proceedings: ... Annual International Conference of the IEEE Engineering in Medicine and Biology Society. IEEE Engineering in Medicine and Biology Society. Conference*, 2015, pp. 1934–1937.

Thomson, L. J. *et al.* (2018) 'Effects of a museum-based social prescription intervention on quantitative measures of psychological wellbeing in older adults', *Perspectives in public health*, 138(1), pp. 28–38.

Thrift, N. (2000) 'Still life in nearly present time: The object of nature', *Body & society*. SAGE Publications, 6(3–4), pp. 34–57.

Thrift, N. (2004) 'Intensities of Feeling: Towards a Spatial Politics of Affect', *Geografiska annaler. Series B, Human geography*. Blackwell Publishing Ltd, 86(1), pp. 57–78.

Thrift, N. (2008) *Non-Representational Theory: Space, Politics, Affect*. Routledge.

Tomkins, S. (1962) *Affect Imagery Consciousness: Volume I: The Positive Affects*. Springer Publishing Company.

Tröndle, M. *et al.* (2011) 'The entanglement of arts and sciences: On the transaction costs of transdisciplinary research settings', *Journal for Artistic Research*, 1(1).

Tröndle, M. *et al.* (2012) 'An Integrative and Comprehensive Methodology for Studying Aesthetic Experience in the Field: Merging Movement Tracking, Physiology, and Psychological Data', *Environment and behavior*. SAGE Publications Inc, 46(1), pp. 102–135.

Tröndle, M., Kirchberg, V. and Tschacher, W. (2014) 'Is This Art? An Experimental Study on Visitors' Judgement of Contemporary Art', *Cultural Sociology*. SAGE Publications, 8(3), pp. 310–332.

Tschacher, W., Greenwood, S. and Kirchberg, V. (2012) 'Physiological correlates of aesthetic perception of artworks in a museum', *of Aesthetics* …. psycnet.apa.org. Available at: http://psycnet.apa.org/journals/aca/6/1/96/.

Tsunetsugu, Y. *et al.* (2007) 'Physiological effects of Shinrin-yoku (taking in the atmosphere of the forest) in an old-growth broadleaf forest in Yamagata Prefecture, Japan', *Journal of physiological anthropology*, 26(2), pp. 135–142.

Wac and Tsiourti (2014) 'Ambulatory Assessment of Affect: Survey of Sensor Systems for Monitoring of Autonomic Nervous Systems Activation in Emotion', *IEEE Transactions on Affective Computing*, 5, pp. 251–272.

Wallentin, M. *et al.* (2011) 'Amygdala and heart rate variability responses from listening to emotionally intense parts of a story', *NeuroImage*, 58(3), pp. 963–973.

Watson, D., Clark, L. A. and Tellegen, A. (1988) 'Development and validation of brief measures of positive and negative affect: the PANAS scales', *Journal of personality and social psychology*, 54(6), pp. 1063–1070.

Weil, S. E. (1999) 'From Being about Something to Being for Somebody: The Ongoing Transformation of the American Museum', *Daedalus*. The MIT Press, 128(3), pp. 229–258.

Wertsch, J. V. (1997) 'Narrative Tools of History and Identity', *Culture & Psychology*. SAGE Publications Ltd, 3(1), pp. 5–20.

Wertsch, J. V. (2009) *Voices of the Mind: Sociocultural Approach to Mediated Action*. Harvard University Press.

Wetherell, M. (2012) 'Affect and Emotion: A New Social Science Understanding'. doi: 10.4135/9781446250945.

Wetherell, M. (2013) 'Affect and discourse – What's the problem? From affect as excess to affective/discursive practice', *Subjectivity*, 6(4), pp. 349–368.

Wetherell, M. (2014) 'Trends in the Turn to Affect: A Social Psychological Critique', *Body & Society*. SAGE Publications Ltd, 21(2), pp. 139–166.

Wierzbicka, A. (1999) *Emotions Across Languages and Cultures: Diversity and Universals*. Cambridge University Press.

Wierzbicka, A. (2009) ‘Language and Metalanguage: Key Issues in Emotion Research’, *Emotion review: journal of the International Society for Research on Emotion*. SAGE Publications, 1(1), pp. 3–14.

Wilhelm, F. H. and Grossman, P. (2010) ‘Emotions beyond the laboratory: theoretical fundaments, study design, and analytic strategies for advanced ambulatory assessment’, *Biological psychology*, 84(3), pp. 552–569.

Witcomb, A. (2013) ‘Understanding the role of affect in producing a critical pedagogy for history museums’, *Museum Management and Curatorship*. Routledge, 28(3), pp. 255–271.

Witcomb, A. (2015) ‘Toward a pedagogy of feeling: Understanding how museums create a space for cross-cultural encounters’, *The International Handbooks of Museum Studies*. Oxford, UK: John Wiley & Sons, Ltd. doi: 10.1002/9781118829059.wbihms116.

Witcomb, A. and Mulcahy, D. (2018) ‘Affective practices of learning at the museum: children’s critical encounters with the past’, in Smith, L., Wetherell, M., and Campbell, G. (eds) *Emotion, Affective Practices, and the Past in the Present*. Routledge, pp. 213–229.

Woodworth, R. S. and Schlosberg, H. (1954) *Experimental psychology*. Oxford and IBH Publishing.

Wundt, W. M. (2009) *Principles of Physiological Psychology*. General Books LLC.

Xia, V. *et al.* (2015) ‘Active learning for electrodermal activity classification’, in *2015 IEEE Signal Processing in Medicine and Biology Symposium (SPMB)*. IEEE, pp. 1–6.

Appendix A: *Snakes* Demographics

Q2 - Which of these age groups do you belong in?

Answer	%	Count
18-24	15.38%	6
25-34	17.95%	7
35-44	20.51%	8
45-54	10.26%	4
55-64	7.69%	3
65-74	10.26%	4
16-18	10.26%	4
75+	7.69%	3
Total	100%	39

Q3 - Do you think of yourself as belonging to a particular ethnic group?

Answer	%	Count
White - British, Irish, other	92.31%	36
Prefer not to say	0.00%	0
Other	0.00%	0
Mixed race - please describe your ethnicity if you wish:	0.00%	0
Middle Eastern / Middle Eastern British	0.00%	0
Chinese / Chinese British	0.00%	0
Black / Black British	0.00%	0
Asian / Asian British	7.69%	3
Total	100%	39

Q4 - Which of the following describes how you think of yourself?

Answer	%	Count
Female	69.23%	27
Male	30.77%	12
In another way; please describe yourself if you wish:	0.00%	0
Prefer not to say	0.00%	0
Total	100%	39

Q7 - Is this your first visit to this museum?

Answer	%	Count
No	56.41%	22
Yes	43.59%	17
Total	100%	39

Q7 (a) - How often do you visit this museum?

Answer	%	Count
1 - 2 times in the last 12 months	54.55%	12
Less than once a week but more than 4 times a year	22.73%	5
3 - 4 times a year	22.73%	5
At least once a week	0.00%	0
Total	100%	22

Appendix B: *Museum ExplorAR* Demographics

Q2 - Which of these age groups do you belong in?

Answer	%	Count
18-24	0.00%	0
25-34	23.08%	3
35-44	46.15%	6
45-54	30.77%	4
55-64	0.00%	0
65-74	0.00%	0
16-18	0.00%	0
75+	0.00%	0
Total	100%	13

Q3 - Do you think of yourself as belonging to a particular ethnic group?

Answer	%	Count
Black / Black British	0.00%	0
Asian / Asian British	0.00%	0
White - British, Irish, other	92.31%	12
Prefer not to say	0.00%	0
Other	7.69%	1
Mixed race - please describe your ethnicity if you wish:	0.00%	0
Chinese / Chinese British	0.00%	0
Middle Eastern / Middle Eastern British	0.00%	0
Total	100%	13

Q4 - Which of the following describes how you think of yourself?

Answer	%	Count
Female	30.77%	4
Male	61.54%	8
In another way; please describe yourself if you wish:	7.69%	1
Prefer not to say	0.00%	0
Total	100%	13

Q4_4_ In another way; please describe yourself if you wish:

In another way; please describe yourself if you wish: - Free Text Entry:
Enby

Q7 - Is this your first visit to this museum?

Answer	%	Count
Yes	7.69%	1
No	92.31%	12
Total	100%	13

Q7 (a) - How often do you visit this museum?

Answer	%	Count
At least once a week	0.00%	0
Less than once a week but more than 4 times a year	16.67%	2
3 - 4 times a year	16.67%	2
1 - 2 times in the last 12 months	66.67%	8
Total	100%	12

Appendix C: Descriptive Statistics for Chapter 5

Table 11: Descriptive Statistics for Z-scored EDA Data in All *Museum ExplorAR* Participants

Measure	Value
mean	-0.001078873
median	0.112934836
std	0.95732436
skew	-0.18378948
kurtosis	-0.46670065

Table 12: Descriptive Statistics for Z-scored EDA Data in All *Snakes* Participants

Measure	Value
mean	-0.003631104
median	-0.179659175
std	0.94594814
skew	1.91276223
kurtosis	9.71185324

Table 13: Descriptive Statistics for Z-scored EDA Data in Male *Museum ExplorAR* Participants

Measure	Value
mean	-0.001361186
median	0.104605026
std	0.954599228
skew	-0.25258017

kurtosis	--0.42762078

Table 14: Descriptive Statistics for Z-scored EDA Data in Male *Snakes* Participants

Measure	**Value**
mean	-0.006223277
median	-0.111134305
std	0.882707683
skew	1.42718166
kurtosis	7.29783518

Table 15: Descriptive Statistics for Z-scored EDA Data in Female *Snakes* Participants

Measure	**Value**
mean	0.001018784
median	-0.1577846
std	0.93306743
skew	1.31359521
kurtosis	4.06423488

Table 16: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participant Identifying as Non-binary

Measure	**Value**
mean	0.012209173
median	0.997413357
std	0.997413357
skew	0.16692873

kurtosis	-0.73438465

Table 17: Descriptive Statistics for Z-scored EDA Data *Snakes* Participants Aged 18-24

Measure	**Value**
mean	0.054583884
median	0.12812931
std	0.128129305
skew	-1.96197658
kurtosis	4.82665465

Table 18: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Aged 25-34

Measure	**Value**
mean	-0.004379999
median	0.03892229
std	1.003450216
skew	-0.48733864
kurtosis	-0.71431607

Table 19: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Aged 25-34

Measure	**Value**
mean	0.02818073
median	-0.0035101
std	0.99552832
skew	0.44640447
kurtosis	-0.66200653

Table 20: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Aged 35-44

Measure	**Value**
mean	0.015550134
median	0.101255807
std	0.969736047
skew	0.22578833
kurtosis	-0.62985083

Table 21: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Aged 35-44

Measure	**Value**
mean	-0.010479487
median	-0.162162548
std	0.916397468
skew	3.51753228
kurtosis	21.77561683

Table 22: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Aged 45-54

Measure	Value
mean	0.036354218
median	0.170695393
std	0.842495619
skew	-0.39000171
kurtosis	-0.74687656

Table 21: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Aged 45-54

Measure	Value
mean	-0.008470877
median	-0.195076825
std	0.989456947
skew	0.65381758
kurtosis	-0.16413648

Table 22: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Aged 55-64

Measure	Value
mean	0.004523496
median	-0.224605786
std	0.93485715
skew	0.29602839
kurtosis	-1.16536152

Table 23: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Aged 65+

Measure	Value
mean	0.052025078
median	-0.226320442
std	1.003649766
skew	1.90678308
kurtosis	5.1285206

Table 24: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Visiting for the
First Time

Measure	Value
mean	0.000651977
median	-0.084181042
std	0.963915982
skew	0.15017962
kurtosis	-0.44788697

Table 25: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Who Have Visited 1-2 Times in the Last 12 Months

Measure	Value
mean	-0.007432683
median	0.164619564
std	1.00038901
skew	-0.51875766
kurtosis	-0.78071079

Table 26: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Who Have Visited 1-2 Times in the Last 12 Months.

Measure	Value
mean	0.0005414
median	0.0005414
std	0.936699058
skew	3.2863381
kurtosis	17.82442945

Table 27: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Visiting for the First Time

Measure	Value
mean	0.084010167
median	0.211230192
std	0.811707399
skew	-0.4760753
kurtosis	-0.07116092

Table 28: Descriptive Statistics for Z-scored EDA Data in *Museum ExplorAR* Participants Who Have Visited 3 or More Times in the Last 12 Months

Measure	Value
mean	0.012441308
median	0.012441308
std	0.932478031
skew	0.33200691
kurtosis	-0.59402973

Table 29: Descriptive Statistics for Z-scored EDA Data in *Snakes* Participants Who Have Visited 3 or More Times in the Last 12 Months.

Measure	**Value**
mean	-0.002847063
median	0.052666499
std	0.941190756
skew	0.47443185
kurtosis	1.23904276