Teaching Children and Computers: Computational Models of Cognition and

Behaviour in Literature and Culture, 1830 to the Present

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Abstract

This thesis explores an intellectual tradition that represents cognitive-behavioural flexibility in terms of a flexible arrangement of inflexible units. It aims to show that during the period 1830 to the present, the influence of models derived from computing technology resulted in this tradition attaining a specific expression. This thesis offers an explanation of how the mechanical computers designed by the British polymath Charles Babbage (1791-1871) enabled this computational model of cognition and behaviour to emerge in the mid-nineteenth century. A primary purpose of this thesis is to highlight and explore representations of this model in nineteenth-century literature and culture, focusing upon its significance for the portrayal of pedagogical methodologies in this era. This thesis gives particular consideration to depictions of this model in the fiction of George Eliot (1819-1880), with the aim of revealing how this computational model was freighted with cultural meaning. This thesis seeks to make an intervention in nineteenth-century studies by tracing the role of Babbage and Eliot in shaping the literary and sociocultural representation of computing technology.

This thesis also argues that a comparable model characterises twentieth- and twenty-first-century attachment theory as a result of twentieth-century computers similar to those invented by Babbage. It is the intention of this thesis to situate the models of mental processing studied as corresponding instances of an intellectual tradition. I hope to show that attending to the representation of this computational model in Eliot's fiction can allow us to reflect upon the cultural implications of this model in the twentieth and twenty-first centuries, especially as regards pedagogical methodologies. This thesis seeks to illustrate that these correspondences can provide a historical and critical framework for applying attachment theory to nineteenth-century texts.

Keywords: Computing; Attachment Theory; Pedagogy; George Eliot; Charles Babbage

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Acknowledgements

Author's Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for an award at this, or any other, University. All sources are acknowledged as References.

Introduction

This thesis explores an intellectual tradition that represents cognitive-behavioural flexibility in terms of a flexible arrangement of inflexible units. This thesis aims to show that during the period 1830 to the present, the influence of models derived from computing technology resulted in this tradition attaining a specific expression. A primary purpose of this thesis is to consider how this computational model of cognitive-behavioural flexibility has shaped understandings of theories and practices relating to the education of children. These include models of child development in twentieth-century psychoanalysis and attachment theory, and the pedagogical methodologies associated with systems of popular education in the nineteenth century.

As well as highlighting various instances of this tradition, this is an interdisciplinary thesis that seeks to draw comparisons between examples of this tradition across the period studied. This model of a flexible arrangement of inflexible units within modular hierarchies offers a definite set of criteria that a cognitive-behavioural model must satisfy before it can be considered as an instance of this tradition. This thesis is intended to show that this model can provide a rigorous basis with which to draw comparisons between the different historical periods and fields of inquiry discussed in this thesis.

Although it would be tempting to introduce the term "analogy" into this discussion, the interdisciplinary scope of this thesis and the comparisons it makes between various fields makes it difficult to draw the precise functional and structural parallels that an analogy would require. I hope to show that a comparison of models that foreground a flexible arrangement of inflexible units within modular hierarchies can provide theoretical rigour whilst still offering scope to read across different periods and disciplines. For these reasons, I would suggest that the interdisciplinary aims of this thesis are better served by speaking in terms of rigorous comparisons rather than analogies.

In addition to the term comparison, this thesis makes use of a cluster of terms to draw attention to comparable instances of this tradition. These terms are correspondence, parallel, and similarity.[1] The *Oxford English Dictionary* would appear to consider these terms to be largely synonymous: "similarity" is listed as a meaning of both "correspondence" and "parallel", whilst "to represent as similar or corresponding (to)" is listed as a meaning of "parallel". The *OED* also associates these terms with the process of formulating comparisons. This is exemplified by the definition of "parallel", which is defined as a "[c]lose *correspondence* . . . a point of *comparison* or *similarity*" (*OED*, emphasis added). These terms are therefore used interchangeably in this thesis to draw attention to corresponding instances in which cognitive or behavioural flexibility has been represented in terms of a flexible arrangement of inflexible units.

This thesis does not seek the origin of this tradition, but instead aims to trace how computing led to manifestations of this tradition in the science and culture of the nineteenth, twentieth and twenty-first centuries. As indicated above, it is the intention of this thesis to situate the models of mental processing studied as comparable instances of an intellectual tradition. Historian Alan Richardson writes that although it is essential to remain cautious of "false parallels . . . and imaginary lines of descent", an "informed comparison with models, findings and controversies from the present" has the capacity to bring certain historical "developments and debates into focus" (*Romanticism* 3).

The primary contribution to knowledge that this thesis therefore seeks to make is to show that an understanding of the ways in which computing has shaped a tradition of conceptualising cognition and behaviour can offer a historically sensitive perspective with which to reflect upon correspondences in thinking across the period 1830 to the present, particularly as regards models of mental processing and their impact upon pedagogical theory and practice. Pedagogy is interpreted in this thesis as any activity undertaken by

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[1] This thesis also uses cognates of these terms such as "corresponding" and "similar".

individuals or institutions that has the aim of influencing the cognitive-behavioural development of another. This definition is informed by the historical meaning of "pedagogy" as "instruction, discipline, training . . . a means of guidance" (*OED*).

This introductory chapter begins with an overview of the aims and scope of this thesis. The sections which follow survey the existing literature relating to three key areas addressed by this thesis: the computational origins and literary uses of attachment theory; the computational origins and literary uses of cognitive science; and the cultural, scientific and literary impact of computing technology in the nineteenth century. This introductory chapter then concludes with a discussion of the organisation of the thesis and a brief summary of the content of each chapter.

Overview of Thesis

A key purpose of this thesis is to highlight and explore computational expressions of this tradition in the twentieth and twenty-first centuries. This thesis considers how in the mid-twentieth century flexibility in computers was formalised as a flexible arrangement of inflexible units of machine behaviour, tracing this model in the work of the British computer scientist Alan Turing (1912-1954) and the American computer scientists Allen Newell (1927-1992), John Clifford Shaw (1922-1991), Herbert Simon (1916-2001) and Marvin Minsky (1927-). I focus upon the work of these particular individuals in order to assess their impact upon one of the most influential texts of mid-century cognitive science, *Plans and the Structure of Behaviour* (1960). This text was written by three American cognitive scientists, George Miller (1920-2012), Eugene Galanter (1924-) and Karl Pribram (1919-2015). Through close reference to features of mid-century computing, I hope to reveal previously overlooked parallels between this text and computing technology.

This thesis seeks to trace how computational models transformed attachment theory in the late 1960s as a result of the influence of Miller, Galanter and Pribram upon the work of the British psychologist John Bowlby (1907-1990), known as the "father of attachment theory" (Wallin 11). In this thesis I aim to contribute to the historicization of this theoretical framework by offering an interpretation of how the attachment model of cognitive-behavioural flexibility derives from mid-twentieth-century computers that enact flexibility as a flexible arrangement of inflexible units. This thesis argues that although the computational origins of this model have been obscured through its dissemination into attachment theory via *Plans*, a computational understanding of the structure of cognition and behaviour has been a consistent feature of attachment thinking since the 1960s. I wish to illustrate that the manner in which the child in attachment theory is understood to learn strategies for flexibly arranging inflexible units from its caregivers is similar to the manner in which a computer is "taught" by its programmers to flexibly arrange machine instructions. As far as I am aware, the correspondences that this thesis identifies between computing and attachment theory have never before been suggested. Computational cognitive science has in recent decades been regarded as largely obsolete, having been ostensibly supplanted by neurobiological approaches (Herman 156; McConachie x). I seek to question this view by illustrating that computing continues to influence thinking regarding child development via attachment theory.

The other aspect of my researches seeks to highlight similar relationships between computing and models of mental processing in the nineteenth century. It is my contention that during the period 1830-1840 the British polymath and inventor Charles Babbage (1791-1871) developed a model of computational flexibility comparable to that found in twentieth-century computing. I hope to show that Babbage subsequently suggested correspondences between this computational model and human cognition and behaviour in his 1864 text *Passages from the Life of a Philosopher*. The computers that Babbage

designed were meant to replace human "computers", a term used in this period to describe persons employed to perform calculation. These machines, known as the "Engines", can therefore be described without anachronism as mechanical computers (*OED*; Schaffer, "Intelligence" 203). The ability of the Engines to automatically execute a set of stored procedural rules means that they are also describable as computers in a modern sense.

Through close reference to the technical specificities of the Engines, this thesis seeks to demonstrate that flexibility in computers consists of a movement between states of *total* but *temporary* inflexibility and *partial* fragmentation. I want to show that in the nineteenth century, this model resulted from the evolution of the flexible "Analytical Engine" (c. 1834-1846) from its predecessor, the inflexible "Difference Engine" (c. 1822-1833). This thesis proposes that by drawing parallels between this model of computational flexibility and flexible cognition and behaviour, Babbage gave a tradition of thinking about mental processing a highly specific expression. This analysis of *Passages* is designed to show that computing is not only responsible for bringing a traditional model of mental processing to the forefront of cultural consciousness, but that it has also actively determined the manner in which this tradition has been expressed in science and culture.

This thesis also argues that Babbage in *Passages* foregrounds a computational model of human cognitive-behavioural development that parallels the evolution of his computing machines. This is, to my knowledge, the first time that a computational model of cognitive-behavioural development has been identified in the nineteenth century. This thesis also reflects upon the pedagogical aspects of this model, arguing that the narrative of cognitive-behavioural development in *Passages* has an additional basis in similarities that Babbage perceived between teaching children and computers.

This thesis claims that the computational mode of representing flexible cognition and behaviour that characterises *Passages* corresponds to the pedagogical narrative of

human development found in attachment theory. These similarities are attributed to correspondences between the architecture of the Engines and the architecture of mid-century computing. In computing, the term "architecture" is used to refer to the structure of a computer's instruction set (Belzer, Holzman and Kent 289). I seek to justify these parallels between nineteenth- and twentieth-century models of cognition and behaviour via a detailed engagement with the computing technology of both periods.

There remains much critical controversy regarding the extent to which Babbage influenced mid-twentieth-century computing, with historians typically renouncing direct lines of descent (Clayton 118; Wilkes "Pioneer" 416). This thesis, however, represents the mid-nineteenth and mid-twentieth centuries as two historical moments in which computing technology intersected with a traditional model of the structure of cognition and behaviour. This approach is designed to shift emphasis away from narrow questions of genealogy onto what I hope is a much more productive field of enquiry: that is, the discussion of similarities between computationally-inflected instances of this tradition and their articulation in the literature and culture of their respective historical moments.

This thesis seeks to offer new readings of the fiction of George Eliot (1819-1880) as a means of reflecting upon the cultural and social implications of this computational model. I give particular consideration to how Eliot traces the impact of computational models upon dominant pedagogical institutions and practices. I hope to make a critical intervention in nineteenth-century studies by tracing Eliot's role in shaping the sociocultural representation of computing technology. This thesis also focuses upon Eliot's fiction as a means of exploring the tensions and paradoxes contained within this computational model. For instance, this thesis argues that comparing Eliot's novels with the work of the Hungarian psychologist Sándor Ferenczi (1873-1933) can reveal that this computational model portrays states of cognitive inflexibility arising from trauma as similar to those that enable flexible cognition and behaviour.

Further to this, I wish to illustrate that this comparison of Eliot and Ferenczi can reveal similar correspondences between normative and pathological pedagogies. This thesis aims to show that comparing Eliot and Ferenczi's writings can offer an indication of the extent to which this model foregrounds correspondences between incest trauma and play, and factory labour and "enabling" forms of learning. I want to show that it is important to address the troubling parallels generated by this model in order to comprehend its historical significance.

I wish to pause a moment here to discuss my reasons for selecting certain terminologies with which to speak about the type of processes that this computational model foregrounds. This thesis situates "psyche" and "cognitive" as allotropes, simply different languages for speaking about mental processing. I hope to show in what follows that the various languages of mind through which instances of this tradition are expressed do not alter its fundamental expression. Viewing these disciplines as engaging with a traditional model of representing cognition and behaviour will, I hope, enable me to read across the boundaries of psychoanalysis and cognitive science and identify previously overlooked correspondences in these models.

The linguistic registers aligned with optimal development in childhood constitute another area in which terminologies have historically been diverse, ranging from "agency" to "versatility". The decision to foreground a language of "flexibility" in this thesis is a conscious one, reflecting the fact that this term is used in attachment theory to describe processes whose structure I argue derives from computing technology (see Kobak et al. 232; Lewis-Morrarty et al. 19). It is the case, however, that no comparable terminology exists in the nineteenth century for the optimal developmental outcome presupposed by this model. Therefore, in consideration of the correspondences that this thesis identifies between nineteenth-century models and the attachment model, and for the sake of clarity

and continuity, I have chosen to foreground the language of cognitive-behavioural

flexibility throughout this thesis.

I have also exercised critical selectivity in my decision to use the architecture of

twentieth-century computing to reflect upon the architecture of nineteenth-century

computing, and to use the cultural meanings of this computational model in the nineteenth

century to consider similar meanings in attachment theory. In the case of the former, I

hope to show that drawing parallels between features of twentieth-century computing and

the Engines, when grounded in an understanding of the computing technology of both

periods, can elucidate previously overlooked aspects of Babbage's thinking as regards his

computing machines. In the latter case, this thesis aims to illustrate that nineteenth-

century critique of this computational model can reveal hidden facets of the attachment

model that have influenced our current thinking about child development. In both cases,

my intention in assuming a particular critical and chronological stance has been to afford

the most illuminating perspectives upon the sources and objects I discuss.

The Computational Origins and Literary Uses of Attachment Theory

As indicated above, a primary purpose of this work is to contribute a computational

perspective to the project of writing a cultural, literary and social history of attachment

theory. This thesis undertakes to show that the cognitive-behavioural models that Bowlby

introduced at mid-century are determined by computing to an extent that is insufficiently

acknowledged in current histories of this field. Although psychologists Peter Fonagy and

Mary Target identify a "metaphor of the mind as an information-processing mechanism" in

Bowlby's writings, no detailed reading of attachment theory in relation to *Plans* or specific

features of mid-century computing yet exists (421).

Clinician Inge Bretherton credits Miller, Galanter and Pribram with introducing the concept of "behavioural systems organised as plan hierarchies" into attachment theory, but does not trace the origin of this concept to computing technology (766). Computing is entirely overlooked in major studies such as Jeremy Holmes' *John Bowlby and Attachment Theory* (1993)*,* David Wallin's *Attachment in Psychotherapy* (2007), Richard Bowlby and Pearl King's *Fifty Years of Attachment Theory* (2004) and the volume *Attachment Theory: Social, Developmental and Clinical Perspectives* (1995)*.* I would suggest that Bowlby's claims regarding the evolutionary stability of the attachment model have made it difficult to think critically about technological approaches to this subject (*Attachment* 39-40, 54, 61). I would also surmise that these difficulties have been compounded by the unfamiliarity of computing to historians whose expertise lies in ethology and psychology. This thesis seeks to address these gaps in existing scholarship by providing a detailed account of how the model of cognitive-behavioural flexibility foregrounded by attachment theory parallels specific features of mid-twentieth-century computers.

This thesis also seeks to contribute to scholarship by highlighting correspondences between the computational aspects of attachment thinking and nineteenth-century mental science. There have as yet been no studies that identify computational concepts similar to those found in attachment theory before the mid-twentieth century. Historians tracing nineteenth-century precedents of attachment theory have focused upon Darwinism, a theory which provided the theoretical basis for the twentieth-century science that informed the ethological and evolutionary facets of Bowlby's thinking (Carroll 436; Grossman 106).[2] I hope to illustrate that it is also useful to consider the influence of

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[2] For histories of the relationship between ethology and attachment theory, see C.P van der Horst, *John Bowlby from Psychoanalysis to Ethology* (2011) and Marga Vicedo, *The Nature and Nurture of Love: From Imprinting to Attachment in Cold War America* (2013)*.*

computing technology when identifying comparisons between historical models and the structures of cognition and behaviour posited by attachment theory.

There has also been growing critical interest in historiographies that locate attachment thinking in relation to various social and political contexts. Historian Mathew Thomson has explored the influence of Bowlby's thinking upon the post-war formation of a welfare state, whilst the studies *The Politics of Attachment: Towards a Secure Society* (1996) and *The Politics of Uncertainty: Attachment in Private and Public Life* (2003) examine the influence of attachment thinking upon recent social and economic policy. There have also been several studies that have established a critical stance upon the notion that "Bowlbyism" functioned to normalise a patriarchal family structure and to situate women solely in terms of their role as mothers (Eyer 78; Franzblau 93-94). This focus on the social, political and ethnographic has also dominated the work of historians tracing antecedents of attachment thinking in previous centuries, as in the discussions of familial structure in Colin Heywood's *Growing Up in France: From the Ancien Régime to the Third Republic* (2007) and in scholarship by Klaus E. Grossman (Heywood 116-18, 132; Grossman 85-86, 93-100).

Largely absent from these histories, however, is a consideration of the role of pedagogy in the formation and reception of attachment theory and its historical antecedents. Historians Suzan van Dijken, Réne van der Veer, Marinus van Ijzendoorn, and Hans-Jan Kuipers have claimed that Bowlby's experience as a teacher in progressive schools contributed to his belief that "the impulses children have are right & should be allowed to find expression" (qtd. Dijken et al. 252). Thomson mentions the influence of Bowlbyism upon the provision of free meals and milk in post-war schools, but does not discuss any comparable influence upon actual pedagogical practice (81). This thesis aims to focus scholarly attention upon pedagogical models as a key context in which ideas associated with attachment theory have achieved expression in culture.

In addition to offering a scientific and social history of ideas associated with the computational aspects of attachment theory, I also wish to investigate their relationship to literary culture. I have been encouraged in this approach by scholars such as Gillian Beer, Laura Otis and Sally Shuttleworth, who have demonstrated that far from being a passive conduit for scientific ideas, literature plays an integral role in shaping these concepts. There are, however, currently few studies that consider how attachment concepts and their historical precedents were shaped by their representation in literature and the popular press. Grossman has argued that the foundations of attachment theory are traceable to an eighteenth-century concern with human interiority that was informed by the literary works of Goethe (101), whilst historians Ellen Boucher and Michal Shapira have documented the role of the British media in mediating the claims of attachment theory as regards familial and institutional care (Boucher 183-86; Shapira 211-12, 229-235). Historians have also discussed how a Bowlbian conception of women's roles was disseminated in the mid-twentieth century via publications expressly aimed at women (Carter 19; Stockman, Bonney and Sheng 166). As far as I am aware, however, there has been no link forged between models corresponding to this computational understanding of attachment theory and the literature and popular press of the nineteenth century.

This thesis sets out to examine the role of Eliot's literary *oeuvre* in shaping the representation of this computational model. This thesis seeks to accord Bowlby and Eliot a comparable function in perceiving the wider social and pedagogical implications of this computational model in their respective centuries. I also consider whether Eliot can be regarded as a more incisive critic of the computational expression of this tradition than Bowlby and his followers, who, I argue, often seem blinkered to the cultural and sociological tensions inherent in this model. This thesis seeks to illustrate that Eliot's critique of the ramifications of this type of computational thinking can suggest how these tensions affect attachment theory in a similar manner.

I hope that the interpretations of Eliot's novels contained in this thesis will illustrate that situating attachment theory as part of a computational tradition of representing cognition and behaviour can offer new possibilities for literary study. It is the intention of this thesis to strengthen the claim of attachment theory to be an appropriate framework with which to interpret nineteenth-century literature and culture. This application of attachment theory is still in its infancy, with only a handful of studies applying attachment concepts to nineteenth-century texts. The major contributions to this emergent field are Peggy Johnstone's *The Transformation of Rage: Mourning and Creativity in George Eliot* (1997)*,* and Jillmarie Murphy's *Monstrous Kinships: Realism and Attachment Theory in the Nineteenth- and Early Twentieth-Century Novel* (2011)*.*

These studies use a range of concepts from attachment theory as tools for literary analysis, including the dual phenomena of attachment and exploratory behaviour, and the spectrum of behaviours associated with separation from caregivers. Yet neither study makes a sustained attempt to trace comparable models in the nineteenth century. Murphy briefly refers to nineteenth-century constructions of the mother-child relationship as anticipating the focus of attachment theory upon the caregiver-child relationship (11, 39), and aligns the concern demonstrated by the nineteenth-century realist novel for "empirical knowledge" with the emphasis upon observational studies in attachment theory (16). She does not, however, offer any further analysis of the nineteenth-century antecedents of specific attachment concepts.

In a critical counterpoise to the current lack of interest in historicizing attachment theory within nineteenth-century studies, I want to show that such a historical consideration would enable literary and cultural critics to legitimise their use of this theoretical framework in relation to nineteenth-century texts and to apply its concepts with greater precision. This thesis seeks to ground its application of attachment theory to

nineteenth-century literature in an understanding of corresponding nineteenth-century

models of mental processing.

The Computational Origins and Literary Uses of Cognitive Science

Because of their theoretical correspondences, in historicizing attachment theory I also hope

to deepen our historical understanding of the computationally-based cognitive science that

emerged at mid-century. As a basis for the more comprehensive historicization of

attachment theory that this thesis performs, this can be regarded as a second-order project

within my thesis. This thesis nevertheless aims to contribute to existing scholarship in this

field by tracing the afterlife of computational cognitive science in twentieth-century

attachment theory, particularly as regards the influence of computational concepts upon

recent play theory.

This thesis can therefore be aligned with studies that trace how ideas associated

with computational cognitive science were mediated in twentieth-century culture and

society. These include Margaret Boden's *Mind as Machine: A History of Cognitive Science*

(2006) and Bradd Shore's *Culture in Mind: Cognition, Culture and the Problem of Meaning*

(1996)*.* Boden considers various scientific cultures that share theoretical orientations with

computational cognitive science, including ethology and linguistics (275, 428, 627), whilst

Shore addresses contexts such as the composition of texts using computer software, and

the technologically-inflected desire for modularised and reconfigurable consumer products

(134, 142-43). This thesis seeks to contribute a new strand to this cultural, social and

intellectual history.

One of the purposes of this thesis is to provide for this incarnation of cognitive

science a cultural and literary history comparable to that which Richardson produces for

recent cognitive neuroscience in *British Romanticism and the Science of the Mind* (2001)

and *The Neural Sublime: Cognitive Theories and Romantic Texts* (2010). In these texts

Richardson interleaves original histories of neural science in the Romantic period with literary analysis of images of cognitive processing in Romantic texts. Deftly woven through this analysis are concepts derived from recent neurobiological studies, which are used by Richardson to highlight parallels with cognitive science in the Romantic texts and cultural phenomena he studies. Richardson's work demonstrates that comparing the cognitive concerns of different historical periods can provide fascinating new avenues for both literary and historical analysis. Other notable contributions to this field include the volumes *The Artful Mind: Cognitive Science and the Riddle of Human Creativity* (2006) and *Embodiment and Cognition in Culture* (2007) and monographs by Mary Thomas Crane, Antonina Harbus, Elaine Scarry and Ellen Spolsky.

By formulating these comparisons between computational aspects of cognitive science and their expression in pre-twentieth-century culture, I seek to address a gap in the existing literature. In his history of cognitive science Howard Gardner identifies nineteenth-century researches into the possibility of chess-playing automata as constituting a type of proto-artificial intelligence, but does not proceed to draw any detailed parallels with cognitive science (142). Historian George Mandler has observed that William James "informed us about the distinction between retention (storage) and recollection (retrieval) long before anyone dreamed of the computer metaphor" (69). There is no suggestion, however, that computing influenced James in formulating this distinction: the parallel is figured as coincidental. Historian Christopher Green has broached the subject in greater depth, but he concludes that there is insufficient evidence to justify the claim that models similar to those of computational cognitive science existed in the nineteenth century ("Cognitive Science" 149-50). This thesis proposes that attending to the computational expression of a tradition of conceptualising cognition and behaviour can reveal new evidence of this type of cognitive thinking in the nineteenth century.

It has been stated previously that this thesis seeks to offer a historical framework for the application of the attachment model to literary texts. I hope that the historical work performed by this thesis will also help to advance the use of computational cognitive science in literary studies. In recent decades there has been emergent movement in the humanities referred to as "cognitive literary studies", in which scholars interpret literary texts and explore the reader-text dynamic using concepts from cognitive theory. A focus upon concepts drawn from computational cognitive science, however, is far from being the predominant approach in this discipline.

The vast majority of scholars working in this field, including Mary Thomas Crane, Rachel Giora, Antonina Harbus, Alan Richardson, Elaine Scarry, Ellen Spolsky, Mark Turner, Kay Young and Lisa Zunshine, base their literary analysis upon concepts from recent cognitive psychology and cognitive neuroscience. Although Zunshine has written of the need to ground cognitive literary studies in a cultural historicist approach ("Cultural Historicism" 122), there has been an overwhelming reluctance on the part of literary critics to utilise an ostensibly outmoded "first generation" computational cognitive science as a framework for textual analysis (Herman 156; McConachie x).

Although there have been some notable exceptions, the trend towards neurobiological approaches has relegated computing to the margins of cognitive literary studies. In his monograph *Between Literature and Science: Poe, Lem and Explorations in Aesthetics, Cognitive Science and Literary Knowledge* (2001) Peter Swirski applies both cognitive and computational models to literary texts, but does not make any significant effort to foreground the literary uses of the computational cognitive science that I discuss in this thesis. Swirski's nearest approach to this subject is to discuss the potential for computers to compose literary works (94). Although Swirksi briefly mentions the Analytical Engine as part of this discussion, it is only to emphasise that it lacks the type of creativity that he is interested in (100).

The marginality of computational concepts in cognitive literary studies is also evident in Zunshine's consideration of the obstacles facing software attempting to attribute mental states to characters in literary texts ("Social to the Literary" 186-88). Although Zunshine references computing here, the thrust of her argument is that the neurobiological processes that underlie human cognition result in a registering of affect infinitely more nuanced than anything achievable in a computer. This thesis is intended to show that there is the potential for a cognitive literary studies that uses as an interpretative framework computational forms of representing cognition belonging to the period in which a particular literary work was composed. I hope to illustrate that embracing the computational in the cognitive concerns of earlier periods can enable us to identify how authors have historically represented the processes underlying cognition, and in doing so, to uncover previously overlooked aspects of our own thinking.

The Cultural, Scientific and Literary Impact of Computing in the Nineteenth Century

As well as advancing our understanding of twentieth- and twenty-first century modes of representing the structure of cognition and behaviour, this thesis seeks to investigate the literary and scientific impact of computing technology in the nineteenth century. This thesis aims to contribute to nineteenth-century studies by tracing the role of the Engines in shaping the nineteenth-century expression of a tradition of representing flexible cognition and behaviour as a flexible arrangement of inflexible units. I hope to show that this approach has the potential to enrich our comprehension of the scientific and sociocultural significance of these computing machines in the era in which they were designed.

This thesis draws upon various technical descriptions, drawings and diagrams in an effort to provide the most detailed discussion of the Engines yet included in a work whose primary purpose is to consider their cultural and literary significance. As my own

background is in literary and cultural studies, I can understand how intimidating these technically complex machines can appear. Through patient study, however, I have gradually familiarised myself with their design. It is my intention that this thesis should offer detailed yet accessible technical descriptions of the Engines to scholars working in nineteenth-century literary and cultural studies, thus providing the conceptual framework for a renewed appreciation of the significance of these machines as cognitive objects.

By attending to these mechanisms in detail, I hope to draw attention to the specificity of Babbage's thinking about human mental processing and to make detailed and substantiated claims regarding his status in nineteenth-century mental science. As discussed in this thesis, several historians including William Ashworth, Harro Maas, Simon Schaffer, Dorothy Stein and Herbert Sussman have made intelligent and plausible suggestions as to how Babbage perceived the relationship between the Engines and human mental processing. Otis has also approached the Engines from a neurobiological perspective, arguing that the modular construction of these computers has affinities with the cell theory of the physician Hermann von Helmholtz (1821-1894) (33).

Yet despite this scholarship, there still remains much scepticism as to whether the Engines can be ascribed cognitive significance: Boden denies the possibility outright (131), whilst Green claims that comparisons between the Engines and mental processing "were simply a matter of verbal shorthand for Babbage" ("Mechanical Model" 42). By presenting new analysis of texts written by Babbage in conjunction with new interpretations of the architectural evolution of the Engines, I seek to provide an explanation of how Babbage used these computers to conceptualise the structure of mental processing that is technically precise and grounded in his writings. I hope that this approach will support the argument that these machines represent significant nineteenth-century resources for thinking about mental processing.

As far as I am aware, this computational model of the structure of cognition and behaviour has never before been discussed in scholarly writing concerning nineteenth-century mental science. Detailed and accomplished historiographies of various aspects of nineteenth-century mental science can be found in the work of historians such as Jenny Bourne-Taylor, William Cohen, Nicholas Dames, Michael Davis, John Gordon, Adela Pinch, Alan Richardson, Vanessa Ryan, Rick Rylance and Sally Shuttleworth. Particular attention is given in these accounts to associationism, phrenology, evolutionary psychology, faculty psychology, epiphenomenalism, and the influence of physiological models of mind.

Rather than revisit models that have already been given extensive and admirable treatment in existing scholarship, I seek to focus scholarly attention upon a computational model of mind not yet explored in these histories. As many historians have observed, in the nineteenth century this field was speculative, interdisciplinary, and experimental in its use of explanatory metaphor. It is not the object of this thesis to discount any of the models foregrounded in previous historiographies, but rather to further exploit the metaphorical and conceptual richness of mental science in this period. This thesis proposes that this computationally-derived model of a flexible arrangement of inflexible cognitive-behavioural units represents another strand of a vibrant and experimental nineteenth-century science of the mind.

Because of its emphasis upon an dynamically adaptive model of cognition and behaviour, this thesis can be aligned with studies documenting nineteenth-century attempts to foreground a more dynamic view of the psyche than those afforded by the relatively static models of mental structure- permanent associations and cerebral localisation- foregrounded by associationism and phrenology. These include Dames' account of dynamically constituted aggregates of sensory perceptions (179-80), and the dissociation into a multiplicity of self-states that Kay Young detects in Thomas Hardy's fiction (180). Dames' vision of the dynamic psyche is strongly biologized, reflecting the

emphasis placed upon depictions of the embodied mind in histories of nineteenth-century mental science. Dames traces the existence of a "unit" of consciousness as a concept in nineteenth-century mental science, where each unit represents a unit of sensory data (177-79). These "units" or "bits" of sensory data form a stream of consciousness that is more accurately read as a string of discrete units: "the sound of the constant combination and recombination of individual elements or 'simple sensations'" (178). Although Dames does not consider the structure of these units beyond the idea of a bit-stream, the existence of a model of mind as an organisation of discrete units indicates that models corresponding to the one I describe were not only present in nineteenth-century mental science, but were being used to comprehend the flexible nature of mind. It is the intention of this thesis to show that computing in this period resulted in a tradition of representing the dynamic psyche achieving a specific expression.

This thesis also seeks to offer new perspectives upon the representation of mental pathology in this period. Historians Jill Matus, Mark Micale, Andrew Scull and Sally Shuttleworth have traced a constellation of nineteenth-century registers within which psychopathology was comprehended, including moral insanity, psychic shock and hysteria. This thesis aims to show that computing also influenced how cognitive-behavioural disturbance was conceptualised in the nineteenth century. This thesis also seeks to illustrate that computing sharpened perceptions of correspondences between mental processes regarded as normative and mental processes regarded as pathological. This type of slippage has been identified by Matus in relation to automatic mental functioning, where similar neurobiological mechanisms could either allow an individual to commit a crime unconsciously or to act automatically according to "established moral principles" (35-36). I want to show that the model Babbage derived from computing depicts states figured as normative and those figured as pathological as sharing correspondences.

At this point I wish to explain my decision to use the language of trauma in relation to the pathological polarity of this model. The significance of "trauma" for nineteenth-century studies has been much discussed, with historians Ruth Leys and Jill Matus stressing the need to apply this term in a manner that is sensitive to historical and contextual specificities. Although I appreciate this concern, I hope to illustrate that the models of mental pathology discussed in this thesis share correspondences across the period studied. Because the Ferenczian model of incest trauma foregrounds psychopathologies similar to those I argue are depicted in Eliot's fiction, it is my contention that using the language of trauma foregrounded by Ferenczi can function as a means of highlighting and exploring these correspondences.

It is also my contention that considering the status of the Difference Engine as a physical embodiment of the model of cognitive-behavioural pathology foregrounded by this tradition can justify the appropriateness of this term in this particular nineteenth-century context. As illustrated in this thesis, the materiality of this machine appears to have caused the computational expression of this tradition to feature a highly physicalized model of mental pathology, one which conceptualises psychic damage in terms of material shatter and inflexibility. This thesis seeks to illustrate that these cognitive-behavioural pathologies are made visible in nineteenth-century texts via images of physical trauma. This would appear to be a computational expression of a mode of representation at mid-century in which "emotion, internal feeling, is rendered bodily and physical, read through its corporeal manifestations" (Matus 58). This thesis aims to show that this conflation of physical trauma with corresponding psychic processes makes the language of psychic trauma appropriate in this context.

I want to show that the Engines also reveal correspondences between "technophobic" and "technophilic" understandings of the cognitive significance of machinery in this period. According to historian and literary critic Tamara Ketabgian, a

technophobic figuration of machines as an alienating and dehumanising force has until recently dominated accounts of the psychological significance of machinery in this period (2). In her monograph *The Lives of Machines: The Industrial Imaginary in Victorian Literature and Culture* (2011), Ketabgian offers compelling evidence for the presence of an alternative register in nineteenth-century literature and culture. This technophilic register embraces the machine as a metaphor for the circulation of affect, instinctual behaviours, intersubjectivity, and aesthetic sensibilities (3, 49, 98, 111, 145, 160). In the course of my researches I have encountered insightful readings of the psychically vital machine in the nineteenth century in the work of historians and literary critics including Joseph Bizup, Deidre Coleman, Nicholas Daly, Hilary Fraser, Richard Menke, Allison Muri and Laura Otis.

This thesis seeks to reinforce Ketabgian's claims in *The Lives of Machines* for the coexistence of technophobic and technophilic attitudes to machinery in this period, such as the synergistic relationship she identifies between "technical precision viewed as repetitive, automatic and coldly mechanical" and "the strong emotional aura of performers" such as the pianist Franz Listz (1811-1886) (150). This thesis argues that the manner in which Babbage derived the structures of computational flexibility from his first, inflexible machine led him to posit a model of flexible cognition and behaviour predicated upon states of cognitive-behavioural inflexibility. I want to illustrate that, as regards nineteenth-century computing, correspondences exist between technophobic and technophilic attitudes to machinery. I hope to show that in this instance "technophilic" and "technophobic" approaches are not separate modes of interpreting the nineteenth-century machine, but that each is integral to the expression of the other.

This thesis also sets out to show that the cognitive-behavioural models suggested by computing technology also played a role in shaping nineteenth-century thinking regarding models of child development. In her important work *The Mind of the Child: Child Development in Literature, Science and Medicine, 1840-1900* (2010) Sally Shuttleworth

documents the burgeoning of scientific discourses related to child development in the mid-late nineteenth century. To the best of my knowledge, however, there has been no discussion of the role of computing in shaping the conceptualisation of child development in this period. This thesis aims to contribute to this field of study by pointing attention to nineteenth-century computers that were understood to develop in a similar manner to children, and children who were understood to develop in similar ways to computers.

It is a core premise of this thesis that the study of computing technology has the potential to enrich our understanding of models of mental processing and cognitive development in the nineteenth century. Babbage is generally omitted from accounts of mental science in this period, but this thesis aims to show that he gave a tradition of thinking about cognitive-behavioural structure a concrete expression in his Engines. Furthermore, this thesis seeks to illustrate that Babbage also considered the implications of this model in relation to a range of cultural, economic, social and technological practices.

I want to show that a key aspect of the sociocultural significance of this model that Babbage helps us to perceive is the influence of computing upon the attitudes of nineteenth-century educationalists towards the "half-time" system in mid-century textile factories. This thesis offers an explanation of how Babbage derived from the Difference Engine an understanding of the types of pedagogy necessary to cultivate the cognitive-behavioural traits necessary for efficiency in nineteenth-century factories. I suggest that a result of the success of the text in which Babbage communicated his computational ideas regarding the training of workers, *The Economy of Machinery and Manufactures* (1834), these ideas gained appreciable currency in discussions of half-time education in the mid-nineteenth century.

As discussed in this thesis, several historians including Ketabgian, Schaffer and Andrew Zimmermann have presented analyses of specific disciplinary technologies that Babbage foregrounds in *Economy*. They have identified the symbolic representation of each

component of the labour process, the use of machinery for paring off extraneous actions in the worker, and the practice of limiting the worker's autonomy by locating part of the skill necessary to complete a given task in a mechanical object. This thesis seeks to extend this scholarship by illustrating that the architecture of the Difference Engine led Babbage to attribute to the factory worker cognitive-behavioural pathologies similar to those that Ferenczi associated with incest trauma. This thesis also considers the role of computationally-derived pedagogies in Babbage's disciplinary schemas. Although Zimmermann briefly mentions Babbage's conviction that "systems of machinofacture could become true only to the extent that workers were trained to accept these systems", there has as yet been no attempt to trace the influence of computing upon the portrayal of the half-time system that by mid-century determined the educational experiences of thousands of child textile workers (19).

Due to its social and cultural importance there have been numerous studies of the impact of the half-time system, including work by historians Peter Kirby, Clark Nardinelli and Harold Silver. In this thesis I refer to a range of mid-nineteenth-century sources to trace the impact of computing upon the thinking of factory inspectors, educationalists and commentators. I hope that by grounding my approach in the study of nineteenth-century computing I will be able to offer new perspectives upon contemporary portrayals of this pedagogical scheme, uncovering a technophobic narrative in which the factory worker is taught to function in similar manner to Babbage's Difference Engine.

This thesis accords Eliot a comparable status to Babbage as a key nineteenth-century interpreter of the computational expression of this tradition. I hope to show that Eliot in her fiction depicts correspondences between principles associated with the Engines and nineteenth-century factories. As a critique of how the factory system was represented in the nineteenth-century novel, this reading of Eliot can be aligned with recent work in this field by Carolyn Lesjak, Chris Louittit and Ketabgian. Lesjak examines the tensions between

depictions of work and leisure in nineteenth-century fiction, whilst Louittit considers how Victorian novelists represented the relationship between factory labour and working-class masculine identity. Ketabgian, meanwhile, considers the relationship between instinctual nature and the operation of industrial machinery in the fiction of Charles Dickens. It is my intention that the computational approach taken in this thesis should offer new insights into the novelistic representation of the factory system and its pedagogies in this era.

In addition to its influence upon cultural perceptions of the half-time system, I argue that computing technology was integral in shaping nineteenth-century perceptions of the didactic value of play. In his monograph *The World in Play: Portraits of a Victorian Concept* (2011) cultural historian Matthew Kaiser identifies a dominant logic in nineteenth-century culture that he terms "play as paideia": "that children and young animals in particular learn, adapt, and develop through life-enabling play" (30). This thesis seeks to ask questions about the role of computing in shaping nineteenth-century perceptions of the role of play in education. As far as I am aware, this is the first time that these correspondences between play, pedagogy and computing have been identified in the nineteenth century. This critique of parallels between pedagogy and computing in the nineteenth century is therefore not only intended to advance our understanding of pedagogical theory and practice in the twentieth and twenty-first centuries, but is also offered as a contribution to nineteenth-century cultural studies.

As indicated above, I wish to contribute to nineteenth-century literary studies by giving critical consideration to the portrayal of computational models in Eliot. As far as I have been able to ascertain, I am the first to suggest that Eliot played a role in shaping the representation of computing technology. This thesis offers three new interpretations of Eliot's novels that seek to draw attention to this facet of her thinking. Ketabgian has argued against the perception of Eliot's organicist worldview as distanced from machine culture, claiming that Eliot in her writing "integrat[es] mechanical and ontologically hybrid features"

(109). To explain how this hybridity is expressed in Eliot's fiction, Ketabgian focuses upon how the steam engine operates as a model for the circulation of "affective energy" and "emotional spontaneity" (13, 14). This thesis seeks to further deepen our understanding of the extent to which Eliot in her novels parallels the structures of human experiencing with technological advances, bringing into focus her engagement with concepts derived from nineteenth-century computing. I wish to highlight the specific manner in which Eliot deploys these concepts in her work, comparing this with a wider tradition of representing cognition and behaviour in computational terms.

By formulating claims for the relevance of computing to a tradition of representing cognition and behaviour, this thesis seeks to provide new grounds for reassessing the relevance of computing for literary study beyond the twentieth- and twenty-first century text. Several detailed explorations of the relationship between computational concepts and the literary text exist, including the work of David Ferro, Katherine N. Hayles, Matt Kirschenbaum, Loss Pequeño Glazier and Eric Swedin. Many of these studies examine how computing has transformed our relation to the literary text, particularly regarding the structure of literary language, the status of authorship, and the status of the text-as-object. The work of these critics is characterised by a sensitive applications of computational concepts, but the scope of their analysis is limited to twentieth- and twenty-first century literature. This thesis proposes that an understanding of how computing shaped cultural perceptions of the structure of cognition and behaviour can provide a framework for tracing computational models in nineteenth-century literature.

Organisation of Thesis

This introductory chapter concludes with an overview of the organisation of this thesis, whose structure consists of two distinct but intimately connected sections. It can be

thought of as a type of diptych, the two hinged wings of the thesis folding together the images that they contain to form a continuous yet segmented object. The first two chapters explore the mechanisms of pathology foregrounded by this tradition, whilst the third and fourth examine the structures of normative flexible cognition that it posits. Central to the construction of each panel is the design of a mechanical computer, with the inflexible Difference Engine corresponding to the mechanism of pathology, and the flexible Analytical Engine corresponding to that of normative cognition and behaviour. The reason these two sections are placed in this order is to parallel the argument of this thesis that this tradition figures normative flexible cognition and behaviour as having its structural foundation in inflexible units. This thesis argues that because this model simultaneously associates inflexibility with cognitive-behavioural pathologies, correspondences exist between normative and pathological states. It examines how, by extension, this has historically meant coming to terms with similarities between concepts that appear opposed to one another: for instance, between incest trauma and play behaviours.

The opening chapter, "Fragmentation, Inflexibility and Pedagogical Incest(s): Reading Trauma in *Daniel Deronda* and Sándor Ferenczi", explores how a model of pathology predicated upon psychic fragmentation and inflexibility is used to portray the effects of incest trauma in the work of Sándor Ferenczi and in Eliot's 1876 novel *Daniel Deronda*. This chapter also draws attention to Ferenczi's claim that repressive pedagogical methods could result in psychopathologies similar to those caused by incest perpetrated by a caregiver or an adult *in loco parentis*. This chapter argues that Eliot makes a similar claim in *Deronda*, comparing the psychopathologies generated by incest trauma with those arising from nineteenth-century pedagogical methods.

The second chapter of this thesis, "The Difference Engine and Incestuous Pedagogies: Babbage, Eliot and the Factory System", considers how the architectural principles of Babbage's first computer informed his theories of labour organisation in

Economy. Referring closely to the architecture of this computer, I offer an explanation of how Babbage utilised fragmentation and inflexibility in units of machine behaviour to achieve computational efficiency. This chapter argues that *Economy* associates efficiency in factories with workers that function in a similar manner to a Difference Engine, with cognitive-behavioural "habits" premised on the performance of fragmented and inflexible tasks**.** I also want to illustrate that the factory worker depicted in *Economy* acquires these cognitive-behavioural habits as a result of pedagogical methods.

The second half of this chapter seeks to illustrate that by mid-century these "habits" were figured as cognitive-behavioural pathologies resulting from methods used in half-time education. This chapter proposes that the half-time system as depicted in these sources generates cognitive-behavioural effects comparable to those produced by the incestuous pedagogies discussed in the first chapter. This chapter also begins to explore the paradoxes that I argue characterise this model. This chapter claims that pedagogies similar to those described in *Economy* cause the factory system in these sources to appear fragmented and inflexible from the perspective of the worker. I hope that this approach can offer new perspectives upon the impact of computing technology in this period, highlighting its influence upon portrayals of the factory system and its pedagogies at mid-century. This chapter concludes with a reading of George Eliot's novel *Silas Marner* (1861). This interpretation seeks to show that *Marner* critiques the role of concepts associated with computing technology in shaping an emergent factory system.

The transition between chapters two and three constitutes a hinging point in this thesis. Having reflected in the first half of this thesis upon correspondences between the architecture of the Difference Engine and depictions of cognitive-behavioural pathologies, in the second half I offer an account of how states characterising flexible cognition and behaviour came to be depicted as comparable to pathological states as a result of computers that enact flexibility as a flexible arrangement of inflexible units.

The chapter "Teaching Children and Computers: Constructing Flexible Behaviour from Babbage to Bowlby" seeks to trace how Babbage during the 1830s and 1840s developed a more sophisticated computer, the Analytical Engine, capable of enacting computational flexibility as a flexible arrangement of inflexible units within modular hierarchies. This chapter aims to illustrate that this model of computational flexibility has its basis in the architecture of the Difference Engine as an inflexible arrangement of inflexible units within modular hierarchies. This chapter also seeks to show that this model of computational development was used by Babbage in his 1864 text *Passages from the Life of the Philosopher* to construct narratives of human development with cognitive-behavioural flexibility as their goal. This chapter argues that the developmental narrative described in *Passages* therefore foregrounds correspondences between the cognitive-behavioural effects of incest trauma and states that characterise flexible cognition and behaviour. The new interpretation of the design evolution of the Engines contained within this chapter underpins its argument that computing in the nineteenth century resulted in correspondences between technophobic and technophilic attitudes regarding the cognitive-behavioural significance of technology.

A primary purpose of this chapter is to show that the model of cognitive-behavioural flexibility that Babbage foregrounds in *Passages* corresponds to the attachment models foregrounded by Bowlby in the 1960s. This chapter attributes these correspondences to similarities in the architecture of nineteenth- and twentieth-century computing, arguing that in both periods computing technology enabled a traditional model of conceptualising cognition and behaviour to be articulated and elaborated. This chapter claims that these historical moments are not only comparable in terms of the visibility of this tradition, but also in the computational mode of its expression.

This chapter aims to show that another point of comparison between the developmental narrative in *Passages* and that foregrounded by attachment theory is that

both are pedagogical narratives of child development. Having previously argued that the design evolution of the Engines led to correspondences being foregrounded between normative and pathological states, this chapter seeks to identify parallels between the incestuous pedagogies of earlier chapters and the normative pedagogies depicted in *Passages*. This chapter also argues that similar correspondences between states figured as normative and states figured as pathological characterise attachment theory as a result of the computational origins of this model. I want to show that reflecting upon how these correspondences were negotiated in the nineteenth century can suggest ways in which attachment theory has dealt with the paradoxes of this computational model.

The fourth chapter of this thesis, "The Child-Machine at Play: Child Development and Computational Models in Babbage, Eliot, Turing and Attachment Theory", seeks to determine how Turing's concept of a "child-machine" has influenced recent thinking about the developmental significance of play. Turing theorised that his hypothetical computer, the "child-machine", might learn strategies for the flexible organisation of behavioural units by playing games such as chess and GO. It would then subsequently apply these techniques not only to additional gameplay situations, but also to a wider range of behavioural contexts. Turing's thought-experiment therefore parallels the child-machine's ability to flexibly implement play behaviours with its general capacity for behavioural flexibility and sophistication. This chapter seeks to assess the impact of this computational model upon the "playful pedagogies" described by recent attachment theory.

This chapter also seeks to highlight and explore similarities between developmentally significant machine and child play in the mid-nineteenth century. This chapter accounts for these similarities by suggesting that Babbage was able to consider the role of play in human development through study of the Engines and a hypothetical tic-tac-toe machine named "Automaton". I want to show that Babbage's own writings depict a computational logic of play of progress similar to that found in attachment theory. Building

upon my analysis of *Passages* in the third chapter of this thesis, this chapter seeks to give additional consideration to the developmental narratives contained within this text. I hope to show that comparing *Passages* with the models of playful pedagogy discussed in this chapter can reveal new aspects of the pedagogical narratives in this text.

This chapter aims to illustrate that this computational logic of play as progress views play as a means by which to learn how to negotiate the partial fragmentation and partial inflexibility required for flexible cognition and behaviour on this model. This implies, however, that cognitive-behavioural states generated as a result of play share correspondences with states that this model understands to be pathological- such as those generated by incest trauma and factory pedagogies. I want to show that these parallels are explored in Eliot's novel *The Mill on the Floss* (1860), a text which I argue theorises the developmental significance of play in comparable ways to Babbage and Turing. Instead of consigning these correspondences to the past, this thesis seeks to ask questions about the implications this intellectual tradition might have for our own cultural assumptions about play. I want to show that examining how these tensions have been negotiated in earlier periods can suggest means by which our own culture has tried to disavow the more unsettling aspects of this tradition.

This thesis seeks to show that the meanings ascribed to this cognitive-behavioural model in the mid-nineteenth and mid-twentieth century continue to influence our comprehension of developmental norms. The conclusion of this thesis suggests that the recent film *The LEGO® Movie* (2014) illustrates that the pathological consequences of factory pedagogies identified in the 1860s continue to provide a stimulus for our cultural emphasis upon developmentally significant play. This interpretation of *The LEGO® Movie* reads across nineteenth-century, twentieth-century and twenty-first century models of child development with the aim of illuminating their corresponding basis in computing technology and their similar cultural implications. In its intention to draw long historical

relationships between manifestations of a computationally-inflected tradition of

conceptualising the structure of cognition and behaviour, this reading helpfully

encapsulates the conceptual work that this thesis is designed to perform.

Fragmentation, Inflexibility and Pedagogical Incest(s): Reading Trauma in *Daniel Deronda* and Sándor Ferenczi

This chapter seeks to illustrate that pathologies of psychic fragmentation and inflexibility form the core of George Eliot's representation of incest trauma in her 1876 novel *Daniel Deronda.* By conceptualising the psychic damage caused by incest in terms of these specific pathologies, this chapter argues that Eliot foregrounds a model of trauma similar to that found in the work of the Hungarian psychologist Sándor Ferenczi (1873-1933). I want to show that comparing the physicality of Ferenczi's descriptions of trauma with the depiction of psychic injury in *Deronda* can reveal the manner in which Eliot encodes the processes of incest trauma in images that evoke corresponding material and structural registers. Through the use of this interpretative framework, I hope to advance our understanding of how incest trauma operates in this novel.

Louise Penner and Judith Wilt were the first to suggest that psychopathology in *Deronda* could be aligned with incest trauma, with Margaret Loewen Reimer subsequently elaborating Penner and Wilt's analysis by providing further evidence of an incest theme in the novel. Yet despite Ferenczi's importance as a theorist of incest trauma and significant critical interest in this aspect of the novel, this is the first time a Ferenczian reading of the text has been attempted. By situating the text within a Ferenczian framework, this chapter seeks to highlight and explore the cultural and societal scope of Eliot's depiction of incest trauma*.* This chapter argues that Eliot foregrounds parallels between trauma caused by incest and trauma caused by certain types of pedagogy in a similar manner to Ferenczian theory. Whereas existing criticism of the incest theme in *Deronda* has confined itself to a discussion of the sufferings of Gwendolen Harleth, this chapter seeks to illustrate that the incestuous pedagogies suffered by Daniel Deronda play a key role in revealing the wider societal implications of Eliot's representation of incest trauma. This chapter suggests that it

is by paralleling the experiences of Gwendolen and Daniel that Eliot portrays incest trauma as an endemic feature of the treatment of children in her society.

This chapter concerns a specific type of incest: a child raped by a parent or an adult *in loco parentis.* This requires clarification, as incest is today generally conceptualised as an act between consenting adults. Mariam Alizade has termed this "symmetrical" incest, occurring between two individuals whose relationship is characterized by an equal balance of power and mutual consent; for instance, two adult siblings (106-107). In contrast, in "asymmetrical" incest an individual uses physical force or intimidation to compel another individual to perform a sexual act (107-108). When this occurs between an adult and a child, this has been more commonly termed in recent clinical practice as child abuse. However, in this chapter I conflate Ferenczi's terms for asymmetrical incest, "incestuous seductions" and "rape", to create the designation of "incestuous rape" ("Confusion" 161). I do so in the hope of maintaining a terminology appropriate for both the nineteenth and the early twentieth century.

Incest during the nineteenth century was not prohibited by secular law. A parent discovered to have perpetrated a sexual act upon their child could still be indicted for the crime, but the charge would be "rape" or "unlawful carnal knowledge", not incest (Jackson 14). For instance, Alfred Swaine Taylor's authoritative medico-legal text *The Principles and Practice of Medical Jurisprudence* (1865) cites "A man charged with a rape upon his own child" (441). Another charge that could be brought in lieu of a charge of incest was "indecent assault" (Jackson 14). This was a category that "could encompass all sexual acts not based on vaginal penetration" (14). Incest eventually became illegal in Britain in 1908 under the Punishment of Incest Act. The introduction of the Act created a terminological shift, leading to a situation in which both terms were maintained. As well as continuing to use the designation "rape", Ferenczi also consciously uses the term *incest* in a manner not possible in Eliot's nineteenth-century medico-legal discourse (*Diary* 209). For this reason I

wish to foreground the term *incestuous rape*, in recognition of the terminology of both periods and their historical continuity.

Part of the elusiveness of a stable definition of incest is that despite the canonical definition of incest as between those related by blood, incest also possesses an extrafamilial dimension. Prohibitions against symbolic incest are present in Leviticus, where sexual relations between persons related by marriage are compared with incest between close kindred (King James Version, Leviticus 18. 8-18). Ferenczi goes even further, comparing seductions by adults placed *in loco parentis* with incestuous familial seductions ("Confusion"161). According to Ferenczi, any adult that undertakes a parental role to a child and then forces them into sexual relations perpetrates an act of incest. As I wish to avoid the word abuser, as a derivative of abuse and therefore a terminological discrepancy, I will use Ferenczi's term "aggressor" in this chapter (*Diary* 103).[3]

A final terminological note relates to the use of the word "trauma" in this chapter. As historian Jill Matus has noted, the use of the word trauma to describe psychic as opposed to physical injury was first recorded in 1894, several years after the publication of *Deronda* (59). Matus argues that despite the absence of this term, an "emergent cultural discourse of psychic wounding" allowed Eliot to "represent in Gwendolen the hallmarks of a traumatised subject" (60). Whereas Matus draws upon the work of psychologists such as Alexander Bain and George Henry Lewes to explain how Eliot is able to foreground this particular mode of representation, this thesis aims to show that Eliot's representation of trauma shares correspondences with computational models. A primary purpose of this chapter is to prepare the ground for this argument by illustrating that psychopathologies of fragmentation and inflexibility play a key role in Eliot's representation of trauma. Although my understanding of trauma in Eliot's fiction is embedded in a very different set of

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[3] Although the phrase "sexually abused" is recorded in the nineteenth century, its usage was rare (Jackson 3).

historical contexts to those cited by Matus, my analysis in this thesis is indebted to her claim that Eliot's cultural milieu enabled her to depict the processes of trauma *avant-la-lettre*. This chapter also seeks to illustrate that the term "trauma" is appropriate in this context because of the highly physicalized understanding of psychic injury in *Deronda.*

Sándor Ferenczi

Sándor Ferenczi was born in Hungary in 1873, and began his career as a neuropsychologist in Budapest (Rachman 10). Ferenczi later became one of Sigmund Freud's (1856-1939) most intimate colleagues, although their relationship suffered from tensions arising from their divergent psychoanalytic theories (Haynal 27; Kelley-Lainé 167). One of Ferenczi's best known contributions to psychoanalysis is his 1933 paper "The Confusion of Tongues Between Adults and the Child". The genesis of this paper is visible in Ferenczi's *Clinical Diary*, written principally between January and August 1932 with some significant entries added in October of the same year. The *Diary* stands as a collection of Ferenczi's most original and uninhibited thoughts, in which he synthesises his decades of clinical experience in an extraordinary period of analytic creativity and insight. One of the insights that emerged from the analytic maelstrom of the *Diary* was a new interpretation of the processes of incest trauma, one which forms the core of Ferenczi's 1933 paper. Other papers relevant to this discussion are "Psycho-Analysis and Education" (1908), "Introjection and Transference" (1909), "Trauma and Striving for Health" (1930) and "Child-Analysis in the Analysis of Adults" (1931). This purpose of this section is to show that the Ferenczian model of incest trauma foregrounds psychopathologies of fragmentation and inflexibility. I will conclude this section by situating Ferenczi in the context of other notable theorists of incest trauma, with the aim of explaining my selection of Ferenczian theory as an object of study in this thesis.

Ferenczi claims that incest trauma begins with the aggressor having "'simulated' a close emotional relationship with the child" (*Diary* 50). Ferenczi believed that children possess a natural tendency to identify and intensify behaviours eliciting a positive response from caregivers ("Introjection" 77). In the case of incest trauma this leads the child to offer examples of sexualised behaviour to the aggressor as if they were giving them a "present" (Ferenczi, *Diary* 165). Ferenczi observed that through this mechanism, adults are able to "project their own passionate character onto children" (165). Ferenczi stressed that children want only "passive object-love or . . . tenderness" ("Confusion" 163): if "love of a different kind from that which they need is forced upon children . . . it may lead to pathological consequences" (164). He emphasised that the child, wishing only to elicit passive tenderness, is unaware of the sexual implication of their actions: "what they wanted to seduce the adults to is something quite different to what happened to them" (*Diary* 191). The incestuous rape by the aggressor is therefore utterly unprecedented and overwhelming.

Ferenczi argued that faced with such a devastating occurrence, the child can only secure psychic survival through fragmentation. Splintering away traumatised parts of the psyche from consciousness enables "the cessation of the interrelation of pain fragments" (Ferenczi, "Striving for Health" 230; see also "Confusion" 165). Ferenczi's descriptions of psychic fragmentation are replete with material images, ranging from lacerated skin to crystalline shatter. It transpires from the *Diary* that this physicalized imagery derives from the testimony of Ferenczi's analysands, who compared their trauma to a force that "smashes everything inside" (66). These analysands also drew comparisons with being hacked to pieces with a saw (135), or being "torn to pieces" until they existed only as a "lacerated soul" (107, 155): "the painful part of the psyche is represented in this instance materially, as a substance" (107).

Corresponding to the imagination of the pain fragment as material, Ferenczi observes that analysands would attempt to mitigate their trauma by visualising a "strong, impenetrable covering" sealing up painful fragments of the psyche (107): "the greater part of her personality freezes over, like a crust of ice, protect[ing] her from the breaking through of the repressed material hidden deep inside and sealed hermetically" (176). In an image which corresponds to the dermal register of psychic lacerations, this encrustation is also described in the *Diary* as "*scars of shocks*" (111, emphasis in original). Because of the seal that forms around these psychic fragments, it becomes "extremely difficult to maintain contact without confusion with all the fragments, each of which behaves as a separate personality" (Ferenczi, "Confusion" 165). Ferenczi claims that an encrusted fragment could even be experienced as a separate self, who, in their hermetic isolation, would bear the agony of the trauma: "regarding myself no longer as the suffering person but looking at myself, or someone who resembles me, from the outside" (*Diary* 180).

Ferenczi indicates that psychic fragmentation is aggravated by the fact that "the child's faint references are ignored or even rejected" (25). Ferenczi claimed that the incestuously traumatised child feels "innocent and culpable at the same time", a feeling exacerbated by "the harsh behaviour of the adult partner tormented and made angry by remorse" ("Confusion" 162). This loss of any certainty regarding the implication of their own behaviours, coupled with the aggressor's denials of their reality, means that their "confidence in the testimony of their own senses is broken" (162). This splintering of the child's reality contributes to the ongoing fragmentation of the child's psyche: "When the child recovers from such an attack, he feels enormously confused, in fact, split" (162). Another way in which the aggressor fractures the child's psyche is by effectively removing themselves as a caregiver. Ferenczi observes that once the relationship turns "passionate" the child is psychically orphaned, having lost its source of passive tenderness (*Diary* 79, 201). Ferenczi believed that being deprived of the external psychic scaffolding provided by

a caregiver accelerated the child's internal fragmentation: "Without this support the psychic and organic component mechanisms diverge, explode" (210).

Ferenczi depicts this fragmentation coexisting with areas of pathological inflexibility within the psyche. He claims that faced with the threat of psychic fragmentation, the child generates an artificial psyche by "subordinat[ing] themselves like automata to the will of the aggressor" ("Confusion" 162). Although this tactic secures immediate survival by restoring structure to the psyche (Ferenczi, *Diary* 10), the ersatz psyche formed in this manner exists in a "state of rigidity" (198). Ferenczi articulates the inflexibility of this "artificial psyche" by describing it as "a little too precisely- regulated mechanism" (10). He states that "the misused child changes into a mechanical, obedient automaton" ("Confusion" 163).

Ferenczi observes that this attempt to completely inhabit the desires of the aggressor can lead to the formation of another form of artificial psyche: "completely oblivious of themselves they identify with the aggressor" (162). This identification is conceptualised in the *Diary* as a physical imprinting: "the violent force imprints its own features on the person" (18). In an image that can be compared with the cutaneous and bodily registers used to describe psychic fragmentation, the idiom of the aggressor is described by Ferenczi as a "grafted-on element" (75). Following this imprinting of the idiom of the aggressor, the child's psychic functioning is once again characterised by a mechanical inflexibility: "The insane 'superego', being or becoming imposed upon one's own personality, transforms the previous irony into automatism" (50).

Ferenczi visualised incest trauma as generating a psychic topography in which isolated fragments of the child's original psychic structures exist alongside an "artificial psyche" inflexible in its functioning. It is this omnipresent, multifaceted tension between fragmentation and inflexibility that makes Ferenczi's writings so nuanced and powerful. Yet Ferenczi would make even more radical claims still. Ferenczi cited both "passionate love

and passionate punishment" as a "method of helplessly binding a child to an adult";

specifically, the passionate punishments dispensed by educators ("Confusion" 165).

Ferenczi suggested that pedagogues are able to generate psychopathologies similar

to those caused by incest trauma by forcing children to accept inflexible structures of

thought and behaviour. Achieved through the stimulus of fear, this parallels the imposition

of the aggressor's idiom: "The man thus educated . . . impairs considerably his own ability

for action, because he breeds in his unconscious another- a parasitic- person" ("Education"

288).

> Here we get light, of some significance for education . . . instead of . . .
>
> going on using the great power which grownups have over children to
>
> *stamp upon their plastic minds our own rigid rules as something externally*
>
> *imprinted*, we might fashion that power into a means of educating them to
>
> greater independence and courage. ("Child-Analysis" 134, emphasis added)

These pathological forms of pedagogy are conceptualised as "imprinting" and "stamping"

upon "plastic minds", paralleling the "violent force" which imprints the idiom of the

incestuous aggressor. These correspondences in material registers operate to underscore

correspondences in pathological experience. In a similar manner to how the imprinting of

the idiom of the aggressor generates an inflexible psychic organisation in the raped child,

the inflexible psychic structure that results from such incestuous pedagogies ("*stamp[ing]*

upon plastic minds our own *rigid* rules") cannot replace the flexible psychic organisation

that emerges from an optimal process of development.

According to Ferenczi, susceptibility to incestuous pedagogies was even more

marked in children previously exposed to incest trauma. Ferenczi believed that complexes

established by incest trauma could be reawoken by individuals perceived to have a

similarity to the primary aggressor, including those undertaking a pedagogical role towards

the child ("Child-Analysis" 134; "Introjection" 71, 80). Ferenczi also claimed that the child

would respond to a new aggressor using strategies similar to those used to bear the original trauma, including psychic fragmentation: "this same fright is at work still, keeping the torn apart contents of the psyche still divided" (*Diary* 203).

To conclude this section I wish to explore the relation of Ferenczian theory to models of incest trauma foregrounded by other theorists. I also want to explain my selection of Ferenczian theory as an object of study. In the early stages of his career Ferenczi's mentor Freud described a model of psychopathology predicated upon the experiencing of sexual attacks in early childhood, known as the "seduction theory" (Izenberg 25). This is articulated in the papers "Heredity and the Aetiology of the Neuroses" (1896), "Further Remarks on the Neuro-Psychoses of Defence" (1896), and "The Aetiology of Hysteria" (1896). Freud also developed the seduction theory via correspondence with the physician Wilhelm Fleiss (1858-1928), notably in the 1896 "Draft K". Freud's 1894 paper "The Neuro-Psychoses of Defence" represents another key context for the seduction theory, as it describes the mechanism of repression that Freud would subsequently apply to incest trauma. Although Freud would later abandon the seduction theory in favour of theories concerning the role of childhood sexuality, its significance continues to be discussed by analysts and cultural historians alike (Fletcher 35, 79; Rachman and Klett 18, 23-27). In what follows, I seek to explain my choice of theorist by drawing distinctions between Freud's "hydraulic" model and the "structural" model found in Ferenczi. I also compare the Freudian and Ferenczian models of incest trauma to those found in the work of the psychoanalysts Karl Abraham (1877-1925) and Annie Reich (1902-1971).

Freud's seduction theory traces the aetiology of hysteria and obsessional neurosis to a "*passive sexual experience before puberty*" ("Heredity" 152, emphasis in original). As discussed above, this belief in the asexuality of the child is central to the Ferenczian model of incest trauma. In the "Heredity and the Aetiology of the Neuroses" paper Freud claims that obsessional neurosis arises from guilt about "act[s] of aggression inspired by desire" in

childhood, but explains this by attributing the child's sexual impulses to precocious sexual stimulation (155). As historians Arnold Rachman and Susan Klett have shown, Freud also parallels Ferenczi's emphasis upon "real sexual experiences in childhood as causative in psychological disorders" (17). Another comparison with Ferenczi is that Freud emphasises the physicalized articulation of the trauma, with sensations "correspond[ing] to the sensory content of the infantile scenes" ("Hysteria" 214). Freud also described the asymmetrical character of incestuous rape, highlighting the grossly uneven distribution of power between the aggressor and the incestuously raped child (Fletcher 84).

There are even similarities between Freud and Ferenczi's description of the psychical processes triggered by asymmetrical incest, as Freud describes splits in the psyche caused by ideas that the ego is unable to process by conscious means ("Defence" 46-47).[4] Freud in the "Aetiology of Hysteria" paper describes "*infantile sexual scenes*" as resulting in "an incompatible idea setting in action a *defence* on the part of the ego and calling up a demand for repression" (210-211, emphasis in original). Difficulties arise, however, when this splitting proves incomplete or unsuccessful. I would suggest that it is here that the "hydraulic" Freudian model diverges from the "structural" model foregrounded by Ferenczi. Whereas Ferenczi is concerned with the organisation of discrete psychic fragments, Freud depicts the formation of channels for affective discharge.

As Freud scholar Simon Boag has noted, Freud believed that an idea must possess a certain affective potency in order for it to become available to consciousness (15). Freud in "The Neuro-Psychoses of Defence" paper claims that if the initial splitting of consciousness is unsuccessful, then the power of the incompatible idea can be diminished by "robbing it of the affect-the sum of excitation- with which it is loaded" (48). As Boag observes, this weak idea is subsequently "incapable of becoming conscious" (15). In the case of hysteria, discharged excitation is directed into the soma, where it takes the form of a motor

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[4] I will use the shortened form "Defence" to designate the 1894 paper, and "Further Remarks" to designate the paper published in 1896.

innervation or a sensory hallucination ("Defence" 49). Freud describes "*a passive sexual experience before puberty*" as "the specific aetiology of hysteria" ("Heredity" 152, emphasis in original).

In the case of obsessional neurosis, the excitation stays within the psyche, but is transferred to another idea that "has certain relations to the incompatible idea which make it seem as though it could serve as a surrogate for it" ("Defence" 54). This idea then becomes an obsessional idea (52). Freud in the "Further Remarks" paper applies this concept of "compromise symptoms" to incest trauma (172), observing that

> what becomes conscious as obsessional ideas and affects, and take the
>
> place of the pathogenic memories so far as conscious life is concerned, are
>
> structures in the nature of a *compromise* between the repressed ideas and
>
> the repressing ones . . . First, something contemporary is put in the place
>
> of something past; and secondly, something sexual is replaced by
>
> something analogous to it that is not sexual.
>
> (170, emphasis in original)

These compromise symptoms, however, are ultimately felt to be unsatisfactory as a defence: "the ego seeks to fend off the derivatives of the initially repressed memory, and in this defensive struggle it creates symptoms which might be classed together as '*secondary defence*'" (172, emphasis in original). Chains of symptoms are thus formed that are traceable to the sexual trauma in early infancy ("Heredity" 151): "These cases . . . give one the impression of a displacement having occurred along a chain of inferences . . . as soon as the first link in the chain is repressed, the obsession jumps to the second or third link" ("Draft K" 93).

As Freud scholar John Fletcher has observed, this model of affective discharge informs Freud's chronology of incest trauma (79-80). Although Freud claimed that the child experiences revulsion and fright as an immediate result of the trauma ("Hysteria" 208), he

argued that they would not experience hysterical or obsessional symptoms until puberty ("Heredity" 154). This is because the child does not fully experience the significance of the events in early childhood until puberty brings a development in the "capacity of the sexual apparatus for reaction" ("Further Remarks" 167). This leads to the memory possessing "a far stronger excitatory effect than the experience did at the time it happened", resulting in the need for affective discharge and repression (166-67). In Ferenczian theory, having been immediately fragmented by the incestuous rape, the child's psyche defends itself not through the discharge of affect, but by providing structure for its fragmented psyche by operating on the psychic model of the aggressor. The primary reason, then, for selecting Ferenczi rather than Freud as an object of study is because this thesis is concerned with psychological models based upon the arrangement of discrete units, rather than models that describe symptoms linked through a requirement for hydraulic discharge. The psychoanalyst John Bowlby, whose work I discuss in subsequent chapters, explicitly rejected the model of "energy discharge" described by Freud (*Attachment* 14).

Reich's case history "Analysis of a Case of Brother-Sister Incest" (1932) presents an interesting comparison with Ferenczi's account of incest trauma. Reich describes the case history of an analysand, Herta, who entered treatment after suffering "a severe anxiety neurosis" (1). The immediate cause of Herta's symptoms appears to have been the death of her child, born as a result of symmetrical incest between Herta and her brother (2-4). Yet Reich also records that Herta was repeatedly subjected to asymmetrical incest traumas during childhood (5-6). Reich describes splits in the psyche occurring as a result of these traumas, but the split she describes is between "a reactive personality, created by guilt feelings, and a hidden, wild, instinctual personality" (16). I would therefore suggest that Reich in this paper is not describing a psychic fragmentation of the kind described by Ferenczi. Reich compares Herta's violent behaviour towards her brothers with the behaviour of her violent and sexually aggressive father (19), yet unlike Ferenczi, Reich

regards these behaviours as "compensating for her many frustrations" rather than a means of restoring structure to a fragmented psyche (10).

Also, despite Reich's sympathetic description of the lack of passive tenderness in Herta's childhood (4-5), Reich's language would appear to attribute to Herta a degree of longing for asymmetrical incest: "Herta's anxiety arose mainly in situations which awakened the wish to be raped" (8); "Later on, Herta probably looked for such situations, but originally, it was her social situation that exposed her to such temptations" (6). A further reason I have for distancing myself from these Freudian and post-Freudian accounts of incest concerns their claim that the child experiences gratification from either the original sexual attack or its hysterical repetition.

Historian Gerald Izenberg has drawn attention to Freud's suggestion, communicated to Fleiss in December 1896, that the aim of the hysterical attack was to experience a species of pleasure retrospectively associated with the infantile experience: "the adult (or older child) . . . reproduced the memory of the seduction in order to relive the pleasurable contact with the beloved father" (Izenberg 37-38). As Izenberg notes, however, this established a conflict in the theory: "if symptoms were largely fantasies, that is, hallucinatory wish-fulfilments, the metapsychological model of the *Project* [*for a Scientific Psychology*] demanded that they have been preceded by prior experiences of gratification. And such childhood experiences in turn required a conception of infantile sexuality" (38).

In 1907 Freud's pupil Abraham published a paper entitled "The Experiencing of Sexual Traumas as a Form of Sexual Activity", in which he claimed that children who suffer psychopathologies as a result of sexual trauma do so because they were desirous of sexual stimulation (53). He argues that psychic disturbance arises from the guilt that the child subsequently suffers: "This fact of a pleasure-gain is the secret which the child guards so anxiously. It alone explains its sense of guilt and the psychological events which follow

upon a sexual trauma" (53). I hope to show in this chapter that this attribution of culpability to the child for either the original trauma or the psychopathologies it engenders is antithetic to the response that Eliot wishes to cultivate towards Gwendolen in *Deronda.* I therefore have two principle reasons for selecting Ferenczi as an object of study in this thesis, as opposed to the other theorists discussed in this section. The first is his emphasis upon the child's desire for passive tenderness. The second and most significant reason I have for foregrounding Ferenczian theory in this thesis concerns its description of a psychic model based upon the organisation of discrete units.

Gwendolen

Although Gwendolen's incestuous stepfather has no physical presence in the novel, having died some years before the commencement of the narrative, several critics have observed that the behaviour of Gwendolen's husband, Mallinger Grandcourt, parallels his sexual aggression and assailing coercion: "The novel has fashioned this nightmare form out of two figures, stepfather and husband, the analogous and repetitive structure of whose lives makes them one continuing presence" (Wilt 314); "Grandcourt is a 'reincarnation' of the dead stepfather" (Herzog 42). This interpretation is commensurate with a Ferenczian reading of the text, as Ferenczi argued that complexes established by an archaic aggressor could subsequently be reawakened by other figures. This section seeks to elaborate upon this scholarship by illustrating that the physicalized representation of Gwendolen's relationship with males who operate in the guise of the incestuous aggressor reveals the constituent elements of her trauma to be fragmentation and inflexibility.

Paralleling Ferenczi's chronology of incest trauma, during the early phases of their relation Grandcourt encourages Gwendolen to view him as an alternative caregiver: "I should like to have the right always to take care of you" (Eliot, *Deronda* 117). Yet Eliot

suggests that an inflexible pattern of relating has already been established: Gwendolen understands her situation regarding Grandcourt to be "like a dance set beforehand", entirely predetermined (420). I want to show that the origin of this incestuous "dance" is visible in an exchange between Gwendolen and her mother. Mrs Davilow is described as "not indifferent to the display of her pet" (22), feeling a "tingle" of pleasure when Gwendolen presents to her the "attitude" with which she intends to please Grandcourt (85). Gwendolen readily recognises and gratifies her mother's desire for eroticised display, indicating that she is accustomed to responding to pressure from caregivers to incorporate sexualised elements into her behaviour. This scene conflates a display towards a caregiver with a display that could be interpreted as directed towards a potential sexual partner, opening up a space in which, as Ferenczi observed, the child's behaviour can be mistaken for adult sexual desire: Grandcourt interprets Gwendolen's anxiety regarding his advances as "all coquetting" (121). Ferenczi asserted that the moment a child is exposed to the passion of their caregiver, "she is in effect made into a wife" (*Diary* 64). Similarly, an ill-comprehended marriage is for Gwendolen is the tragic consequence of being exposed to the passion of her "caregivers".

Ferenczi claimed that owing to the fragmentation of the psyche, there was the potential for structural distortions caused by incest trauma to be manifested both physically and psychically: "at a loss of consciousness, changes in the shape of the body (being stretched strained, bent, compressed to the limit of physical elasticity) appear to be possible" ("Striving for Health" 230). This chapter aims to illustrate that a similar model of psychic distortion can be traced in *Deronda,* with internal fragmentation and inflexibility expressed through violent modification to physical structures. The images of physical shatter used by Gwendolen indicate a corresponding psychic fragmentation: "I must *break my arm or my collar-bone*. I must make something happen; unless you will go into Switzerland and take me up the *Matterhorn*" (Eliot, *Deronda* 9, emphasis added). Ferenczi

recorded that victims of incestuous rape frequently somatised their distress as feelings of physical compression, corresponding to the sensation of being crushed by the adult aggressor (*Diary* 6). This may explain why Gwendolen draws parallels between her psychic experiences and the shattering of bone.

It is possible to perceive that Gwendolen's fragmented psyche achieves a pathological type of structure through an incursion that extrudes it to a phallic point. One of Ferenczi's analysands experienced the incursion of her aggressor's psychic structure in the following terms: "a fantasy: a gigantic male genital penetrates her and smashes everything inside her" (66). As suggested by the fact that Gwendolen discusses the Matterhorn in the same breath as her internal fragmentation, it would appear that such violent restructuring can only be effected by shattering existing psychic structures.

In a move that parallels the depiction of trauma in Ferenczian theory, Eliot depicts these processes as manifest in physical distortions to the body of the incest victim. It is my contention that the internal imposition of a phallic structure is traceable from the tips of Gwendolen's "taper fingers" to the point of her *nez retroussé* (Eliot, *Deronda* 5, 8). More subtly, her close-fitting drapery- as Eliot reminds us, in defiance of the prevailing fashion for the crinoline- renders visible the corsetry of the 1860s Anna Silver has described as moulding the body into two conical shapes (*Deronda* 72; Silver 30). Again, this shaping is effected through compression by an external force, one which acts upon the structuring "bones" of Gwendolen's psyche and soma.

Mary Wilson Carpenter writes that "in the words of Lacan's theory, she [Gwendolen] lives in the belief that she herself is the Phallus, for she *is* what her mother desires" (7, emphasis in original). I would argue, however, that Gwendolen's phallic aspect derives from the internalisation of the idiom of a powerful male aggressor. Eliot associates this incursion of phallic structures with Grandcourt when he coerces Gwendolen to climb to the highest point of a knoll during one of their early encounters (*Deronda* 119). Earlier in

the novel it is regretted that Gwendolen's home is not raised upon a knoll, a tacit acknowledgment that this would be more commensurate with her extruded internal structures (19). This restructuring of her psyche is contingent upon the psychic fragmentation that Grandcourt is able to engender: "[it] came back vividly, *yet in fragments*, all that she had gone through in relation to Grandcourt" (271, emphasis added). After reaching the highest point of the knoll Gwendolen stands "perfectly silent . . . like a statue", an image that conveys the psychic inflexibility produced by his forcible restructuring of her shattered psyche (119).

This material register of stone, of which the Matterhorn image is another example, resurfaces in an episode in which Gwendolen is assigned the part of Hermione as the statue in a Shakespearian tableau (53). At the very moment at which Gwendolen is signalled to transform from stone to flesh, part of the panelling of the room flies open to reveal a portrait of a "dead face and . . . fleeing figure" (54). Seeing this, "She looked like a statue into which a soul of Fear had entered . . . Gwendolen fell on her knees and put her hands before her face. She was still trembling" (54). Reimer claims that "the picture has released the memory of a childhood trauma" (45), whilst for Penner, it "insinuates that a memory, suppressed from both Gwendolen's mind and, to an extent, Eliot's text, lies at the root of her distress" (90).

I would argue that what disturbs Gwendolen about this painting is the way in which it parallels the mechanics of her trauma. The fleeing figure can be interpreted as the remains of the child's real (traumatised) self, violently tearing themselves from the scene in such a manner that the idiom (or face) of the aggressor comes to dominate the internal landscape. Ferenczi's *Diary* indicates that the image of an "an evil, peering face" figures frequently in the testimony of incestuously raped analysands (22), with one individual describing "a man oppressing her with his face" (242). This interpretation lends support to

Matus' claim that this image forms "part of Gwendolen's psychic vocabulary, speaking for her in ways she cannot consciously articulate" (67).

The materiality of this scene has yet to be addressed in existing scholarship. Gwendolen here is a statue carved from the inside out by an alien "soul", her statuesque rigidity corresponding to the inflexibility within her psyche. Carolyn Dever claims that whilst portraying Hermione Gwendolen is struck by the realisation that "wives and mothers are turned into statues . . . for the functional use of their husbands and children": "the immediate effect of this revelation is to make Gwendolen into an actual statue" (166). It is my contention that situating the materiality of this episode in the context of Ferenczian theory can reveal the manner in which Eliot associates this statuesque inflexibility with violent shatter. Gwendolen appears to splinter- rather than her collapse being flaccid, she fragments into angular shards, knees and elbows protruding. This splintering stone emerges as the parallel of Gwendolen's shattered bones: despite her "dread[ing] giving way", there is no protection for her even in mineral hardness (Eliot, *Deronda* 246).

I want to show that these images of fragmentation and inflexibility also reveal the psychic consequences of Gwendolen's strategies to mitigate her trauma, strategies corresponding to those depicted in Ferenczi. Her defensive desire to anticipate a hostile or punitive reaction to her behaviour allows the aggressor's idiom to restructure her psyche. As Annabel Herzog observes, "Gwendolen has no independent point of view . . . she answers according to what she 'imagines' or 'interprets' or 'recalls' or 'wonders' or 'speculates' might seduce her interlocutor" (53). Gwendolen's behaviour can be compared with that of the incestuously raped child described by Ferenczi, who attempts to "to divine each one of his [the aggressor's] desires and gratify these" ("Confusion" 162):

> 'Am I altogether as you like?'
>
> . . .
>
> 'No.', said Grandcourt.

. . .

> 'Oh, mercy!' she exclaimed, the pause lasting until she could bear it no
>
> longer. 'How am I to alter myself?' (Eliot, *Deronda* 397)

Paralleling the behaviour of the incestuously traumatised child, Gwendolen's cognitive-

behavioural restructuring ("alter *myself*") is a defensive reaction: she alters herself because

she can "bear it no longer". Gwendolen realises that whatever the outcome of such a

question, "Her husband would have power to compel her" (561).

As Ferenczi observes, this defensive strategy is associated with a defence in which

the child internalises the aggressor's idiom. Citing Gwendolen's tendency to behave in a

similar manner to the "unscrupulous male" (Eliot, *Deronda* 36), Wilt identifies Gwendolen's

"solution to the problem of powerlessness before the primal man in her life" as "not only

to surrender, to evade, but more tragically, to imitate him" (327-28). Wilt, however,

represents this as an "additional basis for rage and self-loathing" rather than a direct

consequence of incestuous rape (327). Eliot throughout the novel emphasises similarities in

the demeanour and appearance of Grandcourt and Gwendolen (*Deronda* 291, 503): in the

early stages of their relationship, Gwendolen observes prophetically that "We shall match

each other" (287). This causes a further splintering of the parts of her psyche associated

with the painful reality of her experiences: "she would *match* her husband in *ignoring any*

ground for excitement" (560, emphasis added). To ensure that the reader understands the

thrust of this declaration, Eliot compares this "excitement" to psychic and physical agonies:

"strong excitement, which will sometimes come even from pain" (326).

As a result of the testimony of his analysands, Ferenczi situates the physicality of

incest trauma in a number of material registers. Sometimes it is experienced as shatter

comparable to that of splintering bone, and at other times it is compared with a tear in a

continuous surface, such as fabric or skin. Psychic fragmentation in *Deronda* is also

compared with tears in fabric and skin, images which allow Eliot to elaborate her

representation of trauma in the novel by articulating the scarification of psychic fragments. One of Gwendolen's earliest memories is a desire to "rescue drowning insects and watch their recovery", delighting in the possibilities of wing-repair (20). Because all membranes were once termed hymens (Blank 44), even the wings of insects (Derrida 165), Gwendolen's interest in such healing can be interpreted as a reparative image of her delicate hymen, damaged in another form of structural attack. It was claimed that hymens had a remarkable capacity to heal from trauma: physician William Cummin wrote in 1836 that "it is generally known the sexual parts have an amazing facility in throwing off, after a time, the semblance of lesions" (326). I would suggest that the physicality of Gwendolen's psychic experiencing is intimated to be the result of real physical attacks. This would appear to offer another comparison between Eliot's depiction of psychic trauma and the portrayal of incest trauma in Ferenczi.

Gwendolen is described in the novel as resembling a Nereid or Lamia (7, 8). Reimer, referring to the mythological "snake-temptress who uses her sexuality to lure men to their downfall", writes that this image signifies the role of the "desirable woman . . . she [Gwendolen] inherited as a child" (37). I would suggest that these images attribute to Gwendolen a toughened skin: watching her, one observer notes that "she has got herself up as a sort of serpent" (Eliot, *Deronda* 8). As Steven Connor notes, there are imaginative correspondences between scaled and scarred skin. He observes that tattoos frequently "display images of reptiles, shields or metal to suggest a kind of cicatrisation, a toughening through the ordeal of exposure" (63). A similar dynamic can be traced in *Deronda*: as a result of her internal cicatrisation, Gwendolen develops a psychic carapace that can be sensed by other characters.

Referencing the work of Michael Serres, Connor illustrates that skin possesses a corresponding "physics of the imagination" to textiles (40, 47). I want to show that the "physics of the imagination" that Eliot ascribes to textiles in this novel is the physicality of

cicatrized skin. Gwendolen develops a sudden interest in needlework after her engagement to Grandcourt, perhaps seeking comfort in the reintegration-through-incursion this dramatizes (Eliot, *Deronda* 299). In a similar manner to how scar tissue "stitches" together points at which incursions have been made in the body, Gwendolen's stitching thickens and stiffens the surface of the cloth at the point at which it has been penetrated.

This depiction of Gwendolen's auto-scarification corresponds to the psychic "scars of shocks" described by Ferenczi. Gwendolen is described as possessing a "hidden wound", a phrase which has been interpreted as alluding to psychic injuries caused by incest (Reimer 36; Penner 90-91). What has been overlooked, however, is the extent to which this wounding is "hidden" by the process of forming a psychic crust or seal over the wounded fragment. Gwendolen is described as seeking a "hardening effect . . . that would make her indifferent to her miseries" (Eliot, *Deronda* 394). This quote suggests that this encrustation of Gwendolen's trauma is intended to diminish its felt intensity: as Connor writes, "The armoured skin is anaesthetised" (54).

Eliot also indicates that this psycho-physical hardening is in Gwendolen's case seized upon as a protection against sexual attack: the advances of one of her suitors are described as making her "curl up and harden like a sea-anemone" (Eliot, *Deronda* 73). Reimer writes that "an obvious sign of Gwendolen's early sexual abuse is her violent reaction to a man's touch", but she makes no allusion to the specific material registers surrounding this rejection of tactility (41). Wilt observes that Gwendolen reacts to being touched by "trying to turn herself to stone", but an absence of evidence prevents this assertion from developing into a serious commentary upon the text (329-30).

As both Reimer and Penner have noted, Gwendolen attempts to articulate her painful experiences to her mother through vague references such as "Why did you marry again, mamma?" (Eliot, *Deronda* 20; Reimer 38, 40; Penner 90): "These scenes dance painfully around the issue of abuse" (Reimer 40). Her mother's distress at such questions

ensures that such "collisions" are avoided whenever possible: "Not that the collisions had

often been repeated at the same point; for in the memory of both they left an association

of dread" (Eliot, *Deronda* 87). Penner identifies this "inability to ask questions" as a factor

contributing to Gwendolen's "psychic repression" (90). This chapter is intended to show

that attending to the physicality of various encounters in *Deronda* can enable us to

determine their psychic significance with greater precision. Unable to make contact with

these sites of "collision" and shatter, Gwendolen effectively establishes a cicatrized "seal"

by avoiding contact with the sensitive point: Gwendolen's mother laments to her that "You

have no feeling, child", a "no feeling" that is depicted as both psychic and cutaneous (Eliot,

Deronda 20). This can be compared with the statement of one of Ferenczi's analysands that

"I know that there is a pain there, but I cannot feel it" (*Diary* 23).

There is evidence of a similar defence being deployed in Gwendolen's relationship

with Grandcourt. With his lips and fingers searching out her intimate crevices, Gwendolen

reacts by violently severing herself from the experience. This separation is depicted as both

cutaneous and psychic: "he [Grandcourt] had kissed not her cheek but her neck a little

below her ear; and Gwendolen . . . started up with a marked agitation" (Eliot, *Deronda*

299). This defence can be observed several times in the novel: "holding the garment close

to Gwendolen, he said 'Pray, permit me?' But she, wheeling away from him . . . glided onto

the ottoman" (108).

If this line of defence is obstructed, Gwendolen employs a skin-defence that

parallels the mechanics of her archaic trauma. Unable to deflect Grandcourt's touch any

longer, she subsumes herself in such "febrile . . . excitement" that when "her husband . . .

for the first time kissed her on the lips, she hardly knew of it" (328, 329). Gwendolen's

reaction can be compared with Ferenczi's description of "a child whose self-defence is

paralysed by fright . . . so sensitive to the emotional impulses of the person it fears that it

feels the passion of the aggressor as its own" (*Diary* 91). Gwendolen identifies so

completely with Grandcourt's sexual excitation that she is able to circumvent the perception of an external stimulus. However, this lack of differentiated sensation only underscores the fragmentation occurring within her psyche: when Grandcourt touches her for the first time in an overtly sexual manner, her psychic defences mean that she "*hardly kn[ows]* of it". I want to suggest that the complexity of skin-sensation in *Deronda* can reveal the manner in which Gwendolen severs psychically from painful fragments of her experience through identification with the aggressor.

The Lamia and Nereid images provide a further indication that a "grafting on" of the aggressor's idiom and sensations forms part of Gwendolen's psychic experience. Hers is a hybrid psyche in which at least two distinct idioms have been joined together, a state expressed through the image of a contiguous skin: Gwendolen understands herself to possess a kind of "centaur-power" (Eliot, *Deronda* 63). Gwendolen tentatively articulates the damage to the integrity of her own idiom that this has caused when she states "*I* was like *two creatures- I* could not speak" (574, emphasis added). This image of a continuous skin is invoked in relation to Grandcourt: one of the onlookers at Gwendolen's wedding comments that the similarity in the appearance of their skins makes the "match . . . the more complete" (325). Gwendolen also dreams her future husband with the "extraordinary face of a magnified insect" (86), and Grandcourt is described as a "handsome lizard" and "serpent" (122, 626). Reimer claims that these images are intended to "kee[p] before the reader the realm of brute sexuality" (40), but their significance appears to me to be more subtle. The hardened or scaled skin evoked by these images indicates that the hardened carapace that putatively defends Gwendolen corresponds to the perceived materiality of the aggressor.

Eliot emphasises that Gwendolen's appearance as "Nereid" is heightened by her garments (*Deronda* 7). Reinforcing the effects of the drapery that reveals her psychic moulding and suggests the presence of toughened skin, the fabric veils she wears cause her

silhouette to resemble the phallus (566). These parallels in her experience of textile and skin are again invoked when Eliot observes that the "meshes" that entrap Gwendolen are "woven within more closely than without" (622). Gwendolen realises to "insist on separation" from Grandcourt would be as impossible as giving him a "pliant disposition" (561). It appears that the elements of Grandcourt's idiom are too enmeshed with her own to tease them apart, their psychic components too "closely" interwoven to "insist on separation". This does not produce a supple psychic fabric, but a *mesh*, suggesting something far more inflexible. Although Grandcourt has an adamantine will, I would argue that it is Gwendolen's internalisation of his idiom that ultimately cannot be given a "pliant disposition": as Eliot emphasises, these are meshes that are woven more closely *within* than without*.*

Educating Gwendolen

A key purpose of this chapter is to focus attention upon the pathological fragmentation and inflexibility generated by incestuous pedagogy in *Deronda*. It is my contention that Eliot's representation of pedagogy in this novel can be situated within the context of a wider critique of educative methods at mid-century, as illustrated by this passage written by Herbert Spencer (1820-1903), a close friend of Eliot:

> What with perceptions unnaturally dulled by early thwarting, and a coerced attention to books—what with the mental confusion produced by teaching subjects before they can be understood, . . . what with making the pupil a mere passive recipient of other's ideas, and not in the least leading him to be an active inquirer or self-instructor . . . there are very few minds that become as efficient as they might be. (30)

Written in 1859, this parallels key elements of Ferenczi's description of incestuous

pedagogies. Spencer critiques a forcible education into adult knowledge, one which it is

beyond the capacity of the child to process. This in turn precipitates a "mental confusion"

that makes the child the "mere passive recipient of other's ideas". This chapter argues that

where Eliot extends the critique of her contemporaries- and displays similarities with the

complexity of Ferenczi's thought- is by drawing comparisons between the psychic effects of

punitive pedagogy and those of incestuous rape.

I want to illustrate that the pathological consequences of incestuous pedagogies

are depicted in the episode in which Gwendolen seeks assistance from the pianist-*maestro*

Herr Klesmer. Wishing to support herself through a career as a professional singer and

actress, she entreats Klesmer to assist her by means of a specifically pedagogical

intervention: "I could be better taught; I could study" (Eliot, *Deronda* 234). As Penner has

observed, this desire to go on the stage is intended to circumvent exposure to the kind of

pathological relationships that have marred Gwendolen's psychic history: "If she can

become a successful actress, she will never have to live with someone she does not like"

(91).

By this stage in the novel Klesmer has already apprised Gwendolen of the defects

of her previous education: "you have not been well taught" (Eliot, *Deronda* 42). He

observes that she has not been trained to exert adequate agency over her *own* mind and

body: "Singing and acting . . . require a shaping of the organs towards a finer and finer

certainty of effect" (238). The implication is that Gwendolen's internal "organs" are

somehow misshapen, paralleling both the mutilation of Gwendolen's immature psyche and

the damage to her immature genital organs. As a result, she lacks one of the "choice

organisations- natures framed . . . to endure" (236).

It transpires that in Gwendolen's case, an education in achieving such an internal

organisation would entail subjecting herself to a rigid pedagogical regime: "I will tell you

the steps . . . that will be *forced upon you* . . . you must subdue your mind and body to

unbroken discipline. Your mind, I say" (237, emphasis added). The "*unbroken* discipline"

Klesmer prescribes consists of the forcible imposition of an inflexible structure upon

Gwendolen's "mind and body", paralleling her entreaty for guidance as to how she must

"alter *herself*": "*Your* mind, *I* say". In an image that can be compared with Ferenczi's

description of the psyche of a victim of incestuous rape as a "too precisely- regulated

mechanism", Klesmer tells her that the aim of this pedagogical regime is to enable her to

"go like a watch" (238). This machinelike precision corresponds to Gwendolen's mechanical

performance in the role of "Mrs Grandcourt": "it was remarked that she carried herself

with a wonderful air . . . It would by-and-by become a sort of skill in which she was

automatically practiced" (411).

I want to suggest that Eliot underscores correspondences between incestuous rape

and incestuous pedagogy by according them a similar materiality. Eliot in this episode

therefore employs a similar representational strategy to Ferenczi. Gwendolen compares

the sensation of Klesmer's teaching to that of a "lacerating thong", the psychic

fragmentation that he engenders visualised as incisions into her skin (244).

Correspondingly, Gwendolen's recollections of the encounter are fragmentary:

"mortifications- people no longer feigning not to see your blunders- glaring insignificance"

(244). Gwendolen is intent upon violently detaching from these "pain fragments". When

Gwendolen's mother questions her about what has transpired between her and Klesmer,

she replies that "There is really nothing to tell now" (245); "Mamma, don't speak to me . . .

Help me to be quiet" (245-46). I would suggest that this silencing is comparable to her

tactic of physically severing from painful fragments of her psyche: these entreaties to

silence are accompanied by Gwendolen "biting her inner lip" (245).

I want to show that Klesmer's pedagogy also generates psychic fragmentation as a result of its similarity to another pathological consequence of incest trauma, the child's loss of faith in "the testimony of its own senses":

> Herr Klesmer played a composition of his own . . . it gradually turned her inward sob of mortification into an excitement which lifted her for the moment into a desperate indifference about her own doings, or at least a determination to get a superiority over them by laughing at them as if they belonged to somebody else. (43)

Klesmer's composition is played as a didactic-corrective example to overwrite Gwendolen's own vocal idiom, which he represents to her as "faulty". This is a judgment for which she is entirely unprepared: "Her song, determined on beforehand, was a favourite aria . . . she felt quite sure of herself" (42). Paralleling the case of the incestuously raped child, Klesmer's pedagogy warps the testimony of Gwendolen's senses as she is forced to affirm that what she feels to be "bad" is in fact "good", and vice versa. In the case of incestuous rape the child is made to believe that sexual passion, which the child instinctively understands to be bad, is in fact desirable, thus undermining its confidence in the testimony of its senses (*Diary* 16). This confusion is heightened when this behaviour is subsequently identified as requiring punitive control. Gwendolen is punished in order to teach her the undesirability of behaviours that she had been led to believe would coerce attention from potential caregivers. Klesmer's pedagogy can therefore be regarded as corresponding to the pattern established by Gwendolen's experiences of incest trauma.

Gwendolen reacts to Klesmer's pedagogy with a "*desperate indifference* about her own doings, or at least a determination to get a superiority over them by laughing at them *if they belonged to somebody else*" (Eliot, *Deronda* 43, emphasis added). It would appear that Klesmer's pedagogy triggers a defensive fragmentation similar to that experienced by the incestuously raped child described by Ferenczi: "the mechanism of projection . . . is also

represented in the displacement of the events from herself onto 'a girl'" (Ferenczi, "Revision" 242).

In the previous section it was argued that Gwendolen not only attempts to mitigate the shock of incestuous rape through psychic fragmentation, but also by internalising the idiom of the aggressor. When Klesmer plays one of his compositions, he does so by "send[ing] a nerve-thrill though ivory key and wooden hammer . . . *compel[ling]* the strings to make a quivering lingering *speech for him*" (Eliot, *Deronda* 43, emphasis added). As a result of Klesmer's pedagogy, Gwendolen is compelled to function as another instrument that can "make a . . . speech for him". When she is complimented on her singing, she responds by admonishing her interlocutor in a similar manner to how she was admonished by Klesmer: she claims that they only admire her singing because they "are in a puerile state of culture, and have no breadth of horizon" (43). This can be regarded as another instance in which pedagogical methods generate an effect similar to that of the incestuous aggressor. Grandcourt is described as having "wonderful little tongue. Everything must be done *dummy-like* without his ordering" (326, emphasis added). The manner in which Klesmer speaks through the dual instruments of Gwendolen and the piano can be compared with the manner in which the incestuous aggressor ventriloquizes their idiom through their victim.

Ferenczi claimed that another obstacle to meaningful learning encountered by the incestuously traumatised child was a difficulty in maintaining object relationships. For instance, Ferenczi records an incestuously raped analysand unable to finish a book (*Diary* 123). The idiom of the aggressor fills the psyche so completely that nothing further can enter to modify the structure (48). Ferenczi suggested that this psychic experience lends itself to parallels with a physical sense of being "filled up": "with a colossal effort the 'intelligence' swallows the whole hostile power . . . his person consists of a devoured, over-great (fat) aggressor and a much smaller, weaker person, oppressed and dominated"

("Fantasies" 228). Ferenczi observed that this "colossal . . . swallow[ing]" would be re-enacted in later life through pathological overeating (228). It is my contention that Eliot articulates a similar sense of being "filled up" by the idiom of the aggressor by emphasising Gwendolen's reluctance to eat after her marriage to Grandcourt. Whenever Gwendolen is depicted at table she is either mounting a symbolic structural attack upon the aggressor's projections by macerating her food, or attempting to use food as a screen against further physical or psychic incursion (Eliot, *Deronda* 304): "she turned her eyes away from his [Grandcourt's], and lifting a prawn before her, looked at the boiled ingeniousness of its eyes as preferable to the lizard's . . . having devoured her mortification" (546-47).

These pathologies are manifested in Gwendolen's abortive attempts at self-education. It appears difficult for her to find space for the additional object-relations necessary for learning: she is consistently torn away from attempts at independent study by Grandcourt's intrusive and inflexibly unnegotiable demands (509). Similarly, Gwendolen finds the books she wishes to study to be "unreadable" (508), a fulfilment of Klesmer's prophecy that "You would find . . . great difficulties in study" (240). These failures in self-education lead Gwendolen to wish that she could write a book for herself to read, a statement which communicates her difficulties in absorbing additional psychic material (39). It would appear that Gwendolen is able to accommodate Grandcourt because he occupies a similar psychic space as the previous aggressor: "before meeting him, Gwendolen imagines Grandcourt as someone 'she has seen already'" (Herzog 39).

Ferenczi claimed that subsequent violations would correspond to the pattern of trauma established by the archaic incestuous rape. Similarly, Gwendolen's adult experiences of education correspond to patterns established in childhood: "In the schoolroom her quick mind had taken readily that *strong starch* of *unexplained rules* and *disconnected facts*" (Eliot, *Deronda* 34, emphasis added). The "disconnected facts" and "unexplained rules" that are forced into her developing mind can be compared with the

psychic fragmentation caused by incestuous rape. In an image similar to those which depict

Gwendolen's toughened skin, this education has also caused the natural flexibility of

Gwendolen's psyche to become artificially rigid. This section has sought to illustrate that

Eliot in *Deronda* portrays a similar dynamic to that described in Ferenczi, in which

incestuous pedagogies generate psychopathologies of fragmentation and inflexibility

comparable to those produced by incestuous rape.

Educating Daniel

This section seeks to illustrate that an awareness of correspondences between

psychopathologies of incestuous rape and incestuous pedagogy in Gwendolen's narrative

can reveal the incestuous strands in Daniel's history. As far as I am aware, this depiction of

Daniel as an incestuously traumatised subject has not been addressed in existing

scholarship. This section is designed to show that a comparison of the ways in which

Deronda's protagonists have been damaged by incest trauma can advance our

understanding of the representation of trauma in this novel.

As Herzog has noted, Daniel's earliest memory parallels the loss of his mother with

the loss of his foreskin through circumcision (45): "Daniel . . . had a dim sense of being

kissed very much, and wrapped in thin, cloudy, scented drapery, till his fingers caught in

something hard, which hurt him" (Eliot, *Deronda* 150). I agree with Herzog that Daniel's

circumcision is both essential to the novel's plot and closely related to Gwendolen's

narrative (37). Yet whereas Herzog sees Daniel's circumcision and Gwendolen's "hidden

wound" as wounds traceable to patriarchal culture (47-48), this chapter seeks to compare

these wounds with the damage caused by incestuous rape and incestuous pedagogy. It

transpires that Daniel's mother insisted on their separation so that he could be educated to

become an English gentleman (Eliot, *Deronda* 585). I want to show that this archaic trauma-

a trauma with a pedagogical rationale- is depicted as generating psychopathologies similar to those I have argued are experienced by Gwendolen as a result of incestuous rape.

It would appear to be the case that the physical injury to Daniel's body corresponds to his psychic suffering. In an image that once again compares textile with skin, these maternal touches that enfold like drapery are torn away at the same time as another piece of delicate *tissu*(e). Ferenczi claimed that a child's psyche, being "barely consolidated, does not have the capacity to exist . . . without being supported on all sides . . . without this support the *psychic and organic* mechanisms diverge, explode" (*Diary* 210, emphasis added). These correspondences between the tear made in his body and the tearing from his caregiver generate a psychic fragmentation that is paralleled in the immemorial quality of his wound, expressed through its various figurations in the novel as a bitten "finger" (Eliot, *Deronda* 349), a "deformed foot doubtfully hidden by the shoe" (160), and a "maimed . . . limb" (155). K.M. Newton has identified the "deformed foot" and "maimed limb" images as ciphers for Daniel's trauma, but he does not elaborate further upon their materiality or psychic significance (324-25).

I would suggest that by comparing the material expression of Daniel and Gwendolen's trauma, Eliot highlights similarities in their psychic experiencing. Gwendolen's fantasies of shattered limbs and collarbones can be compared with Daniel's fantasies of shattered bones and crushed fingers. The image of the "deformed foot doubtfully hidden by the shoe" indicates that Daniel visualises these wounded fragments of his selfhood protected by cicatrized, leathery skins. Gwendolen's narrative indicates that the purpose of this cicatrisation is to diminish the intensity with which wounds are felt. As I have argued is often the case in this novel, this psychic experiencing can be traced to physical sensation: Daniel's desensitised "skin" in this image corresponds to a belief, widespread in the nineteenth century, that removing the foreskin reduced sensitivity in the penis (Darby 296-97).

There is evidence that Daniel's imagination of his wounding encompasses a sense of the isolated, traumatised fragment of the self being simultaneously "me" and "not-me", a state described by Ferenczi's analysands: "looking at *myself,* or someone who *resembles me* from the outside". Daniel feels "the injury done him as the maimed boy feels the crushed limb" (Eliot, *Deronda* 155). He also describes "a *grief within*, which might be compared in some ways with *Byron's* susceptibility about his deformed foot" (158, emphasis added). Daniel experiences his wound as belonging to his body- "the injury done *him*"- and simultaneously displaced onto the body of another, with the image of the maimed *boy* with a damaged "limb" particularly suggestive in this context. This displacement highlights similarities between the psychic effects of Daniel's pedagogical experiences and the psychic fragmentation suffered by Gwendolen as a result of her attempt to mitigate the trauma of Klesmer's incestuous pedagogy by regarding "her doings *as if they belonged to someone else*".

One possible explanation for the displacement of this wounding is that it represents an attempt to relieve the agony of "pain fragments" associated with the archaic trauma: "Pain . . . is relatively pain-relieving, when its location is displaced to a morally less significant and obviously unreal part of the body" (Ferenczi, *Diary* 23). Yet this displacement and cicatrisation is also a strategy for concealment, with Daniel fearing the exposure of this "doubtfully hidden" wound. His shifting sense of his trauma having alighted on a fear of illegitimacy, Daniel assents to the offer of a public school education in order to excise these tainted parts of his selfhood: "I should like to be a gentleman . . . and go to school, if that is what a gentleman's son must do" (Eliot, *Deronda* 157). This decision can be regarded as commensurate with a desire for psychic cicatrisation, as the belief that public schooling "toughened" boys up in a similar manner to the cicatrisation of skin after exposure was pervasive in this period (Shrimpton 12): "This is the plea put in by some for

the rough treatment experienced by boys at our public schools . . . they are introduced to a miniature world whose hardships prepare them for those of the real world" (Spencer 111).

Daniel is disgusted at Sir Hugo's suggestion that he might become a public singer, as this reference to the profession of his mother raises the spectre of his illegitimacy (Eliot, *Deronda* 153-54). Instead of developing his own (vocal) idiom, Daniel provides scaffolding for his fragmented psyche by imposing upon it an inflexible comprehension of "what a gentleman's son must *do*". It appears that what a "gentleman's son *must* do" is risk subjecting themselves to the rigid and externally imposed regime of public school discipline: Spencer wrote in 1859 that "the discipline which boys meet with at Eton, Winchester, Harrow, &c., is much worse than that of adult life- much more unjust, cruel, brutal . . . accustoming boys to a despotic form of government" (111).

This "despotic form of government" corresponds to the type of incestuous pedagogies that Ferenczi regarded as generating psychopathologies similar to those caused by incest trauma. As is the case with the incestuously raped Gwendolen, Daniel's psychic defences cause him to exchange psychic fragmentation for psychic inflexibility, his reliance on inflexible external regulation reinforcing the effect of his cutaneous "toughening up". When Daniel finally meets his mother, Leonora, she tells him that they separated so that he could be taught how to be an English gentleman (Eliot, *Deronda* 585). Daniel is incensed at hearing this, failing to see how he has enacted similar pedagogical traumas. A further comparison with Gwendolen's history is Daniel's discovery that incest trauma creates an inflexible psychic structure that engenders a series of corresponding traumas.

I want to show that Daniel's auto-traumatisation highlights another aspect of Eliot's culture: the use of familial fragmentation as a pedagogical method. During the nineteenth century, circumcision gained widespread acceptance in the medical establishment as a "cure" for masturbation (Darby 296-99). Yet, as Daniel's archaic trauma implies, the severing of sensitive and intimately connected skins as a means of disciplining

bodily and psychic life was not only reserved for the foreskin. Parental separation was regarded as part of the "toughening-up process"**:** "a 'wholesome neglect' was assumed to foster self-reliance" (Shrimpton 12). Yet Spencer felt that this- in concert with the harsh discipline in schools- only fitted children for "intercourse regulated by brute force" (111), an effect comparable to the damage caused by "barbarous parents" and "the barbarous methods which such parents spontaneously employ" (117).

In addition to forcing pupils to suffer this "wholesome" neglect, nineteenth-century public schools also had a reputation for producing devastating examples of asymmetry, with older pupils able to expose younger children to a form of verbal incest through pornography and threats of sexual contact, or to intimidate them into actual sexual acts. Incestuous rape by adult educators was also not unheard of. This was the case in boarding schools for both sexes (Upchurch 56; Delamont and Duffin 136). This suggests that nineteenth-century schooling paralleled the mechanics of Ferenczian incest trauma by combining separation from the tenderness of caregivers with asymmetrical incest trauma.

It is my contention that the amputations from her mother that Gwendolen endures in the service of "education" leave her vulnerable to retraumatisation. In the midst of her childhood Gwendolen is sent away to a "showy school, where on all occasions of display she had been put foremost" (Eliot, *Deronda* 19). Gwendolen thus learns to conform both physically and psychically to these lessons in eliciting adult approval through eroticised display. Later, the idea of being sent away to school, this time as a schoolmistress, reawakens painful memories: "'You might not have a bedroom to yourself.' Gwendolen's memories of school suggested other particulars which forced her to admit to herself that this alternative would be no relief" (251). The euphemistic vagueness of "other particulars" suggests that Gwendolen has experienced traumas comparable to incestuous rape during these periods of separation. It would seem from this quote that the nineteenth-century practice of separating upper- and middle-class children from their families in order to

submit them to punitive educational regimes was felt by Eliot not only to be devastating, but incestuous.

This chapter has sought to illustrate that Gwendolen suffers the consequences of incestuous pedagogies into adulthood. Similarly, the potential for pedagogical incest resurfaces for Daniel in his relationship with Mordecai Cohen, his instructor in the Jewish religion. In a similar manner to how Daniel's archaic trauma is displaced onto the figure of a "maimed boy", the incestuous character of Mordecai's teaching is demonstrated by his relationship with Jacob. This is a young child to whom Mordecai fulfils a pedagogical and quasi-paternal role, "the teacher's fatherhood" (443): "he had given Jacob his first lessons" (443). Mordecai is depicted forcefully dictating to the child, whilst "he stood trembling with a sense that the house was tumbling in and they were not going to have dinner any more" (446). Jacob instinctively understands this teaching to be performing a type of structural fragmentation: "the *house* was *tumbling in*". Mordecai's description of his teaching of Jacob as "a kind of printing" indicates that this internal fragmentation could be accompanied by the permanent structural imposition of his idiom (444): "the boy will get them [Mordecai's words] *engraved within him*"; "My words may *rule him* someday" (444, emphasis added). This physicalized understanding of the pedagogical role as "printing" or "engraving" can be compared with Ferenczi's disgust at forms of education whose aim is to "to stamp upon . . . plastic minds our own rigid rules as something externally imprinted".

Amanda Anderson has observed how the kind of spiritual imprinting that Mordecai desires to perform upon Daniel is characterised by a "disregard for his informed consent" (50). Similarly, Adela Pinch describes Mordecai's relation to Daniel as "a form of thought-transfer, or file-sharing", in which Mordecai's thinking operates as "a form of 'coercive' action" (146). Referencing Anderson's work, Pinch writes that "the transparent 'mind-meld' between Daniel and Mordecai . . . is not truly held up as an ideal by George Eliot" (147). Interpreting this "mind-meld" as symptomatic of incestuous pedagogies offers a rationale

as to why Eliot depicts such "thought-transfer" negatively, and why it is associated with

"'coercive' action".

Although Pinch claims that Gwendolen *desires* this kind of thought transfer as a

result of an infantile wish to be passively read (147), this chapter has sought to illustrate

that it is rather that Gwendolen finds this kind of thought-transfer *irresistible* as a result of

her traumatic history. It has also argued that Eliot highlights parallels between the psychic

consequences of incestuous rape and those of incestuous pedagogy by attributing to these

experiences a comparable materiality. In similar manner to how Grandcourt's hold upon

Gwendolen is registered through the corresponding pallor of their skin, when Mordecai

adopts the "grasp and speech which assume to dominate" (Eliot, Deronda 469), the

appearance of the emphatically "pink" Daniel becomes similar to that of his teacher:

"Deronda had become as pallid as Mordecai" (466).

I want to show that Daniel's mother Leonora provides him with the most painful

cautionary tale about the dangers of incestuous education. She recalls how her father,

punitive in his moral pedagogy, sought to establish in her a complete identification with his

structures of belief: "he only thought of fettering me into obedience . . . I was to feel

everything I did not feel" (587). Leonora's father engineers a system of didactic commands

and prohibitions similar to the pedagogical framework that threatened to "subdue"

Gwendolen's "mind and body to unbroken discipline": "*Teaching, teaching* for everlasting-

'this you must be', 'that you must not be'" (588, emphasis added). Through this inflexible

pedagogical regime Leonora's father effects an imposition of his idiom similar to that which

Ferenczi associated with incest trauma: "I was to feel everything *I* did not feel".

This pedagogy possesses a physicality that makes it comparable to depictions of

incest trauma in the novel. Leonora experiences his teaching as tantamount to being

"*fetter[ed]* into obedience": "my father's strictness . . . pressed on me like a frame that got

tighter and tighter as I grew" (588). The violent crushing of Leonora's psyche emerges as

the parallel of Daniel's imaginatively displaced wound, corresponding to the "damaged foot" produced by his experiences of incestuous pedagogy: "To have a pattern cut out . . . a woman's heart must be of such a size and no larger, or else it must be pressed small, like Chinese feet" (588). The parallel that Leonora draws between the obstruction of her psychic development and the crushing of bone can also be compared with the pressure that Gwendolen feels to break her arm or collarbone, an internal fragmentation similar to that generated by incestuous rape.

As this chapter has argued is the case for Gwendolen, this "crushing" of Leonora's idiom can be interpreted as paralleling the physical crushing by the adult aggressor: the pedagogical system devised by Leonora's father enables him to "throw all the weight of his will" upon her (589). In a similar manner to how Gwendolen's internal shatter is bound by her corset, these fragments of bone are subsequently contained by an artificially rigid, superimposed fabric "skin". I would suggest that this image offers additional confirmation that Eliot understood fragmentation and inflexibility to work in concert to generate the totality of psychic trauma caused by incest.

The image of the bound foot is also a reminder that this artificial remoulding cripples the sufferer, preventing them from achieving subsequent independence. Leonora is prevented from achieving independence through an incestuous binding to her father's idiom as wife *and* daughter: "such men turn their wives and daughters into slaves" (589). Even when superficially liberated from her father after his death, Leonora continues to carry the taint of his incestuous education. A recurring motif in the novel represents the destruction of an individual's idiom as the suppression of their singing voice. Leonora's unique voice inevitably fails her, and in its place comes the idiom of the aggressor:

> I have after all been the instrument my father wanted. - 'I desire a
> grandson who shall have a true Jewish heart. Every Jew should rear his
> family as if he hoped that a Deliverer might spring from it' . . . [Leonora]

spoke slowly with a new kind of chest-voice, as if she was quoting

unwillingly. (617)

Eliot once again alerts the reader to the psychic presence of the incestuous aggressor by depicting them ventriloquizing their victim. Wilt notes this "speaking through", but appears unsure of its significance: "Is this a daughter mock-imitating her father, an actress recreating an arresting role, or a woman possessed by the male demon who fathered her . . . ?" (324). Dever states that Leonora ventriloquizes both a patriarchal and a Jewish heritage, but remains vague as to the mechanics of this process (156). I want to argue, however, that this scene parallels the dynamics of Gwendolen's incestuous pedagogical encounter with Klesmer. Instead of developing into artists in their own right, both Gwendolen and Leonora are reduced to functioning as a speaking tube for the idiom of the incestuous aggressor: Leonora articulates this when she says "I have been the *instrument* my father wanted".

Another way in which Leonora functions as the "instrument" of the incestuous aggressor is by implementing similar pedagogical methods: her decision to marry her cousin, Daniel's father, was based upon the fact that she could "rule" him (Eliot, *Deronda* 590). This mode of relating, however, further subsumes her in her father's idiom: "My father had no other child than his daughter, and she was like himself" (589). Rather than enabling the incestuously raped individual to achieve independence, operating on the aggressor's behavioural model emerges as an insidious means of capitulating to their inflexible psychic structure: Leonora identifies this paradox when she states that "I meant to have my will in the end, but I could only have it by seeming to obey" (589).

Leonora is painfully aware that as a result of her father's pedagogy, his idiom continues to determine her responses as an inflexible structure forced upon her: "I have been forced to obey my dead father" (588). In what would appear to be a further comparison of incestuous rape and incestuous pedagogy, Leonora makes recourse to the

language of sexual violence to express this: "I don't consent . . . I obey" (588); "things that were thrust on my mind" (594). Daniel's response to Leonora's suffering is to entreat her to "take us all into your heart- the living and the dead", not yet realising what this internalisation of the aggressor signifies to his mother (591).

Lenora, however, refuses to concede, her own painstaking attempts at self-formation allowing her to retain a vestige of resistance even as her internal structural integrity is destroyed. As the image of the bound foot implies, the wounded fragments persist underneath their stiffened coverings, bloodied and festering: "here within me is the same desire, the same will, the same choice, *but* . . . I obey something tyrannic . . . I am forced to *be withered, to feel pain, to be dying slowly*" (588, emphasis added). It is my contention that through her tenacious resistance Leonora forces Daniel to confront the dangers of incestuous pedagogy, including the potential slippage from victim of incestuous pedagogy to its perpetrator.

The final part of this chapter is intended to show that Gwendolen forces Daniel to confront his own history of incest trauma when she asks him to teach her what she can do to relieve the psychic distress caused by her marriage. Daniel responds to Gwendolen's entreaty for him to "guide her" by taking a repressively pedagogical stance (420), compelled to "not . . . let himself be tender, and flinch from implying a hard opinion" (415). As Eliot observes, Daniel has developed a "certain inflexibility of judgment" (295). Daniel operates in a similar manner to the incestuous aggressor here, substituting aggression for tenderness and punishing her for a marriage that was hardly comprehended, and so could hardly be resisted. Daniel's pedagogy also consists of imposing an inflexible behavioural structure upon Gwendolen, as suggested by his imposition of a "hard opinion".

Owing to her history, Gwendolen can do nothing but capitulate: "You must tell me then what to think and what to do" (415). Penner writes that Gwendolen becomes "completely dependent on Daniel's words and teachings for her sense of worth" (91).

Rather than just depending on Daniel for a "sense of worth", however, Daniel's incestuous pedagogy leaves Gwendolen dependent upon him for the most basic cognitive-behavioural scaffolding: "tell me *what to think* and *what to do*". Gwendolen tells Daniel that his teaching has "scourged" her, thus attributing to his pedagogy psychic lacerations similar to those I have argued are associated in the novel with incestuous rape (Eliot, *Deronda* 643).

Daniel's pedagogical "scourging" of Gwendolen parallels a nineteenth-century ambivalence towards the child victim of rape**.** As Jackson has shown, the raped child was frequently subjected to questioning as to his or her "morality", with the implication being that they had either fabricated or encouraged the attack (93). The child could expect to be subjected to "a rigorous cross-examination in court about the origins of her statement, her truthfulness, her malleability or suggestibility in the hands of others, and her sexual reputation" (93). Even for those children exonerated as innocent "witnesses of truth" (93), "the act of sexual abuse was deemed to have corrupted the girl and effected her 'fall' from innocence . . . The sexually abused girl was seen as a polluting presence" (6).

Matus claims that **"**George Eliot is ultimately less interested in Gwendolen's wounded psyche than in her potential guilt and responsibility for her own pain and suffering" (72). Another possibility that emerges, however, is that Eliot is critiquing contemporary attitudes to child victims of incest, who were accorded- explicitly or tacitly- responsibility for their sufferings. As Reimer has noted, several of the characters in the novel regard Gwendolen as a corrupting influence, especially upon their children (70, 76). The repulsion that Eliot engenders for Grandcourt's character makes the reader complicit in these attitudes toward the nineteenth-century victim of incest, as his scaled skin implies that he too has suffered a similar trauma that has caused him to occupy the locus of the incestuous aggressor.

The nineteenth-century solution to the child victim of incest can be summarised as "isolate and educate". Jackson has documented the nineteenth-century practice of sending

child victims of rape or indecent assault to institutions where they could be "reformed" through education: "Girls who lost their innocence could no longer be deemed 'children' and, instead, became social misfits who needed retraining and reforming in a specialist institution" (6). Daniel's attempt to reform Gwendolen through pedagogical means is therefore commensurate with the attitudes of his society. Through Daniel's teaching, Eliot indicates that this type of pedagogical intervention might only serve to perpetuate of the effects of the archaic trauma. Subjecting the child to "perfect discipline" was the stated aim of these institutions, a phrase which in several cases functioned as a euphemism for punitive regimes (139).

I want to show that Daniel also places himself in danger in this pedagogical encounter. Ferenczi suggests that once their idiom is integrated with the child's psyche, the aggressor becomes predominantly part of the child's internal rather than external reality ("Confusion" 162). Because Grandcourt forms part of "meshes woven *within* more closely than without", his death as part of the external reality becomes inevitable, as was the death of Gwendolen's incestuous stepfather before the opening of the novel. Grandcourt lives on instead as Gwendolen's structuring internal reality: "His face will not be seen above the water again . . . Not by anyone else- only by me" (Eliot, *Deronda* 642).

Ferenczi also claimed that the child's desire to reject the idiom of the aggressor was felt to have murderous consequences: "when the fragment of evil is not accepted or is rejected, it returns to the "donor's" person, exacerbates his tensions and sensations of unpleasure, and may even result in the spiritual and bodily annihilation of that person" (*Diary* 59). From the description given in the text, this would appear to be another contributing factor in Grandcourt's death. In the passages leading up to this event, Eliot observes that "the intensest form of hatred is that rooted in fear, which compels to silence and drives vehemence into a constructive vindictiveness, an *imaginary annihilation of the detested object*" (626-67, emphasis added). Grandcourt's death is subsequently framed in

such a manner that the murderous object that strikes him could be interpreted as a piece of shrapnel originating from Gwendolen's psyche: "I don't know how it was . . . *he was struck*- I know nothing- *I only know that I saw my wish outside me*" (648, emphasis added).

As a result of his pedagogical intervention, Daniel risks Gwendolen tearing his psyche to shreds. This is apparent when he returns one of her psychic fragments, a pawned necklace imbued with memories of her deceased father, wrapped in a large piece of his own handkerchief. Gwendolen begins to tear away parts of his psyche to contain painful fragments of her own, in the process tearing a large piece of psychic *tissu*(e) away from Daniel. Daniel barely manages to cling onto the monogrammed section of the handkerchief, holding back the essential parts of his identity (16). Daniel conceptualises these unbidden effects of his pedagogy in terms of a physical enmeshing, similar to the mesh that incest trauma weaves between Gwendolen and Grandcourt: "he saw a coming wrench, which all present strengthening of their bond would make the harder" (718). Unsurprisingly, Daniel comes to fear "the weight of this woman's soul flung upon his own" (642). This quote suggests another facet of the Lamia image, one reinforced by the description of Gwendolen as "Calypso" (91): Gwendolen's trauma makes her capable of ensnaring and devouring the aggressor's selfhood. Whilst Reimer conjectures that "Deronda flee[s] Gwendolen precisely because of her revelation of incest", this reading offers another interpretation of Daniel's anxiety regarding Gwendolen (49).

There is evidence towards the close of the novel that Daniel's encounters with Gwendolen and Leonora have taught him about the mechanics of their shared trauma: "Those who trust us educate us . . . in that ideal consecration of Gwendolen's, some education was being prepared for Deronda" (Eliot, *Deronda* 401). When Gwendolen stretches her arms out to him as if wishing to envelop him entirely, Daniel "seize[s] her outstretched hands and held them together" (749). This gesture can be seen as an encouragement to Gwendolen to bring these fragments of her skin surface- and thus her

psyche- back into contact: Connor writes that **"**the hand (like the face) can be an alternative body, a *second skin*" (141, emphasis added).

Daniel consolidates this gesture by pressing Gwendolen's *own* handkerchief to her face, providing further encouragement to integrate psychic and skin fragments belonging to her, rather than grafting parts of his idiom onto hers: "Deronda *would not let her hands go*- held them still with one of his, and himself pressed *her handkerchief* against her eyes. She submitted like a half-soothed child" (Eliot, *Deronda* 749, emphasis added). Several critics have observed that Gwendolen recovers memories of her stepfather in this scene in which she is reduced to a "half-soothed *child*". Reimer writes that "Gwendolen's task after Deronda is gone is to get to the root of her trauma and exorcise her demons" (48-49); whilst Penner suggests that "watching Grandcourt drown causes Gwendolen to recover her traumatic memories of her stepfather" (85-86). This chapter has argued that Eliot associates Gwendolen's psychic fragmentation with a refusal to touch certain areas of her skin-surface. With Daniel grasping her hands, Gwendolen is forced to touch her own skin, precipitating a re-joining of psychic fragments. This would suggest that it is this contact that results in the recovery of her traumatic past.

As Reimer has observed, Gwendolen's prognosis for recovery seems uncertain (50). Gwendolen initially experiences the joining of her hands as "something like the return of consciousness after fainting" (Eliot, *Deronda* 749), an image similar to the comparison that Ferenczi makes between the severed parts of the psyche and a fainted child. Yet Gwendolen later suffers "hysterical crying" that threatens to parallel the primary fragmentation: "a 'hysterical crying' that unsettlingly duplicates the 'hysterical shrieking' of her wedding night with Grandcourt" (Wilt 333). Ferenczi wrote that bringing psychic fragments back into contact could produce a conscious re-experiencing of trauma. This could be almost unbearable for the analysand, tantamount to the analyst "repeat[ing] with his own hands the act of murder" (*Diary* 52). A similar dynamic could be said to underlie

the "intolerable" anguish that Daniel experiences on witnessing the suffering produced by exhuming these painful fragments of Gwendolen's psyche (Eliot, *Deronda* 749). If we accept the logic of this model, then Gwendolen's sufferings implicate Daniel as her incestuous aggressor: "'I am cruel too, I am cruel', he repeated" (749). Daniel in this moment is alive to the manner in which he is operating in a similar manner to the incestuous aggressor, an awareness entirely lacking in his earlier pedagogical interventions.

This awareness allows Daniel to take steps to avoid destruction like Grandcourt and Gwendolen's stepfather. Drawing upon descriptions of Gwendolen's ego as a "pit in the flesh" only to be removed with "blood and pain", Carpenter and Penner have argued that such imagery serves to parallel Gwendolen's trauma with Daniel's circumcision (Eliot, *Deronda* 237). Carpenter claims that Gwendolen experiences a parallel of this cutting in the symbolic castration of her phallic egoism (7), whilst Penner argues that what is excised is Gwendolen's independence (91). I would suggest that with their (psychic) skins partially fused by incestuous pedagogies, this severing is necessary to separate them from each other before there is any further "strengthening of their *bond*". When Daniel detaches from Gwendolen he feels an archaic, "crushing pain" similar to that of his crushed "fingers" (Eliot, *Deronda* 715). Yet because he has developed an understanding of the mechanics of pedagogical incest, this is an amputation he is able to survive.

Connor writes that "Marking is at the heart of Judaic religious thought. A marked man is one who is a target (a mark means a target). But a marked man is also a protected, reserved man" (82). Drawing upon Newton's reading of Daniel's circumcision, Penner relates this dual nature of "marking" to discourses of sexual purity, writing that "the ambiguous sign of his [Daniel's] circumcision serves as both self-policing mechanism for him until he learns that it does not signify 'impure' or 'tainted' birth, but is instead a sign of the 'purity' of his Jewish blood" (89). It is my contention that Daniel's circumcision also operates as an "ambiguous sign" within the context of incestuous pedagogy. With

Gwendolen and Leonora challenging him to confront the various ways in which he been "marked", Daniel can use this knowledge of himself as a "marked man" to avoid again becoming an instrument of pedagogies that generate psychopathologies of fragmentation and inflexibility similar to those caused by incestuous rape.

This chapter has sought to illustrate that comparing the work of Eliot and Ferenczi can reveal how *Deronda* represents pathologies of psychic fragmentation and inflexibility as endemic in nineteenth-century society. The following chapter explores how this understanding of psychopathology was shaped by the influence of computing technology. The purpose of this chapter is to trace correspondences between a model of computational efficiency based on fragmentation and inflexibility and depictions of the cognitive-behavioural effects of the nineteenth-century factory system.

The Difference Engine and Incestuous Pedagogies: Babbage, Eliot and the Factory System
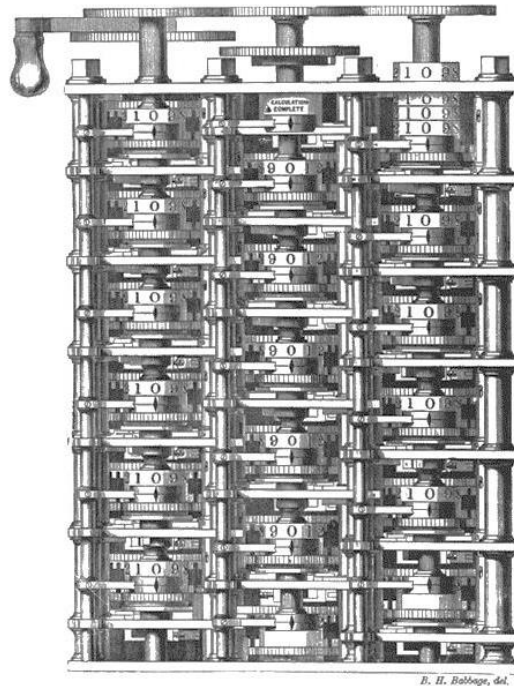
Fig. 1. Trial Piece of the Difference Engine, 1832. Charles Babbage. *Passages from the Life of a Philosopher.* (London, 1864; *Internet Archive*; Web; 26 August 2015).

Beginning in the early 1820s, the British polymath and inventor Charles Babbage designed a series of calculating Engines capable of arithmetical computation. Babbage designed and constructed the first of these, the Difference Engine, from the early 1820s until the early 1830s. Babbage did not complete the construction of a full-scale Difference Engine, but an operational trial piece was completed in 1832 (see Fig. 1). Babbage's other major contribution to knowledge in this period was a treatise on the factory system, *On the Economy of Machinery and Manufactures* (1832). This chapter aims to show that Babbage in *Economy* associates optimal efficiency with a system in which the cognitive-behavioural capacities of the factory worker share correspondences with the architecture of the Difference Engine. This chapter claims that this results in the worker in *Economy* suffering

cognitive-behavioural pathologies similar to those that Ferenczi associated with incest trauma: fragmentation, decontextualisation, and cognitive-behavioural inflexibility.

Several historians have identified the Difference Engine as a substitute for a routinized form of subdivided mental labour in which human computers execute simple, repetitive calculations (Berg 189; Otis 31; Wise 174-75). Historians Lorraine Daston, Jessica Kuskey, Harro Maas and Louise Purbrick identify parallels between this "routinisation and then mechanisation of computing" and "the routine labour executed in factories" (Maas, *Jevons* 101; see also Daston 197; Kuskey 256; Purbrick 21). As I explain below, historians Maxine Berg and Maas also perceive affinities with factory labour in the timing cycle and precise operation of the Engine.[5]

This chapter seeks to contribute to the historicization of intersections between computing technology and the organisation of human labour by offering an interpretation of how the Difference Engine shaped Babbage's perception of the cognitive-behavioural effects of factory work. Although, as discussed in this chapter, historians Simon Schaffer and Joseph Shieber have identified a cognitive dimension to Babbage's thinking concerning labour organisation, the specific comparisons I draw between computing, Ferenczian theory and the cognitive-behavioural attributes of the worker in *Economy* represent new contributions to scholarship in this regard.

As discussed in the introduction to this thesis, I understand the terms "psyche" and "cognitive" to be allotropes, simply different languages for speaking about mental processing. This chapter seeks to transition from a twentieth-century psychoanalytic model

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[5] Maas also writes that "Babbage's own description of the working of his calculating engine in *Machinery and Manufactures* reads like a Taylorised scheme of labour organisation" (*Jevons* 101). It is possible that training schemes associated with Taylorism might prove comparable to those which I argue characterise *Economy.* Although this is an area that would merit further study, my focus upon attachment theory means that I am unable to pursue this here.

to a nineteenth-century pre-psychoanalytic framework, whilst highlighting similarities in how these models depict a specific register of pathological experience. Although the word "cognitive" is used in this thesis in order to demarcate between this latter approach and that of Ferenczi, this chapter is also intended to highlight and explore correspondences between these two models.

Despite some consternation in the press caused by Babbage referring to the *Edinburgh* and *Quarterly* reviews as "the advocate of despotic principles . . . fast receding from the advancing intelligence of the age" (*Economy* 269), *Economy* proved to be both influential and commercially successful (Maginn 171; Bizup 53). This chapter aims to show that as a result of *Economy*, a computational understanding of the cognitive-behavioural effects of the factory system influenced its portrayal in mid-nineteenth-century culture. In this chapter I focus upon contemporary accounts of a pedagogical system employed in factories at mid-century known as the "half-time system". I argue that as a result of the computational foundations of *Economy*, the explanations in these sources as to why pedagogies employed in factories are detrimental to cognitive-behavioural development are similar to Ferenczi's critique of incestuous pedagogies. Whereas the narrative in *Economy* is technophilic, stressing the increase in worker efficiency generated by computationally-derived modes of labour organisation, I suggest that these sources are implicitly technophobic in their attitude towards the cognitive-behavioural traits that Babbage assigned to the worker as a result of computing technology.

This chapter concludes by offering a reading of *Silas Marner* (1861) that claims that Eliot in this novel critiques the factory system and its pedagogies, exploring their relationship to computing technology. I want to show that Eliot in *Marner* examines the computational origins of a model of cognitive-behavioural pathology that she deploys in a number of her texts, including, as argued previously, *Daniel Deronda*. This approach is

designed to allow *Marner* to be situated for the first time in the context of a specifically computational mode of representing the factory system at mid-century.

The Difference Engine and *Economy*

The "factory system" emerged in the nineteenth century as a theory of labour organisation: "The very purpose and meaning of a factory is the division and combination of labour" (Cooke-Taylor 31). Babbage's text was an important contribution to this body of theory, refining Adam Smith's theory of division of labour to meet the demands of rapid industrialisation (Rosenberg 49-50; Zimmermann 10-11). Babbage indicates that computing influenced his depiction of the labour process in *Economy*, describing this text as "one of the consequences that have resulted from the Calculating-Engine" (iii). The association between *Economy* and the Difference Engine was also highlighted by his contemporaries: "it seems . . . to have owed its birth to the fecundating influence of the 'calculating engine'" (Maginn 171).

This section sets out to show that the Difference Engine provided Babbage with both explanatory model and theoretical justification for cultivating cognitive-behavioural pathologies in the worker. To my knowledge, this is the first time that Ferenczi's writings have been used to consider the cognitive-behavioural pathologies that characterise the worker in *Economy*. I hope to illustrate that by using this theoretical framework it is possible to identify mechanisms of pathology in *Economy* not yet addressed in existing scholarship, such as the manner in which fragmentation and inflexibility function in tandem to generate cognitive-behavioural pathologies judged necessary for worker efficiency.

The Difference Engine is named after the mathematical principle upon which it is based. "Differencing" is the principle that numerical tables can be calculated by finding a

numerical constant that allows a table of values to be formed by an inflexible addition routine. The following table contains a sequence of square numbers:

	A Column of Square Numbers	B First Differences	C Second Differences
	1		
	··········	3	
	4	··········	2 b
	··········	5	
a	9	··········	2 d
	··········	7	
c	16	··········	2
	··········	9	
	25	··········	2
	··········	11	
	36		

Fig. 2. Table of Differences. Luigi Menabrea. "Sketch of the Analytical Engine." *Charles Babbage and his Calculating Engines: Selected Writings by Charles Babbage and Others*. Ed. Phillip and Emily Morrison (New York: Dover, 1961; Print; 228).

If you have the initial terms of a numerical sequence you can use these to calculate additional values. Subtracting each square number from the following term in the sequence (4-1= 3, 9-4=5, 16-9=7, et cetera) generates a second column of values. These are the first differences. These are then subtracted from one another in a corresponding manner. This process continues until the difference between each of the numbers is equal. In this case, this occurs after the second round of subtractions, in the column of second differences. This number is the "constant".

Once the constant is found, other values in the table can be calculated by addition alone by reversing the process, with higher orders of differences added to lower orders of differences. For example, to calculate the next value in the table above: 2+11= 13. 36+13=49 (7 x 7). The result of each calculation is one tabular value. Because the mathematical laws governing a function can change, it is also necessary at intervals to

compute "pivotal" values using the fundamental mathematical formulae (Wilkes,

"Expectations" 142). The Difference Engine computes between these pivotal values,

subtabulating using the method described above (143). Babbage's collaborator Dionysius

Lardner (1793-1859) states in in his 1834 description of the Engine that it "has . . . literally

thrown this mathematical principle into wheel-work" (184).

The Difference Engine comprises a series of vertical columns composed of metal

gearwheels (see fig. 1). Each column represents an order of differences and holds a

number, with the leftmost column containing the tabular value. Each individual numerical

digit is associated with three gearwheels. One of these gearwheels displays a digit between

0 and 9, and is called a figure wheel (Bromley, "Evolution" 117). The other two allow the

figure wheel to transfer digits to another figure wheel during addition. The lowest figure

wheel in a column represents the units place value, the one above the tens, and so forth

(Lardner 202). The trial portion of the Difference Engine contains two order of differences

columns and the tabular value, each six figure wheels high. Lardner describes how cranking

the Difference Engine's drive handle generates "two systems of waves of mechanical action

continually flowing from the bottom to the top; and two streams of similar action

constantly passing from the right to the left" (195). The first of these "waves of mechanical

action" passes horizontally across the Engine, adding numbers in higher order of

differences columns to those on lower order of differences columns (189-90). If a figure

wheel stands at 3, for example, and the one adding to it stands at 4, during this wave it will

be pushed on 4 digit places to stand at 7. The second, vertical wave performs any carries

required (192-93).[6]

It is possible to perceive that the routine of the Difference Engine has a hierarchical

structure, with the addition and carry "wave" composed from sequences of inflexible and

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[6] Babbage invented a method of effecting addition in two half-cycles in order to increase

efficiency. This is why Lardner describes "*two* systems of waves".

elementary machine behaviours. The following description is of the elementary actions

which comprise the addition wave. The diagram below depicts the three gearwheels

associated with each digit, broken and laid flat:
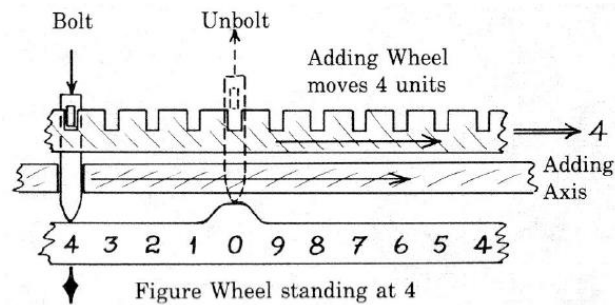
Fig. 3. Gearwheels associated with a single digit in the Difference Engine. Allan G. Bromley.

"The Evolution of Babbage's Calculating Engines" (*Annals of the History of Computing* 9.2

(1987): 113-136. *IEEE Xplore*; Web; 5 Jan 2014; 117). © IEEE 1987

The adding axis- the central wheel- carries a bolt. At the beginning of the adding cycle, this

effectively "bolts" the adding axis and the toothed adding wheel together. The adding axis

then rotates through 360 degrees, carrying the adding wheel with it. At some point in the

cycle the bolt encounters a wedge on the figure wheel, forcing the bolt to release the

adding wheel at the 0 position (Bromley, "Evolution" 117; Lardner 192-93). In the diagram

above, by the time it is released the bolt has carried the adding wheel forward four digit

positions. The adding wheel subsequently remains stationary, but the adding axis

completes its cycle. The adding wheel has teeth cut in its face that mesh with those cut into

the figure wheel in the next lower order of differences. Moving the adding wheel through

four digit positions, for instance, pushes the lower order figure wheel forward four digit

positions (Bromley, "Evolution" 117; Lardner 192-93). Addition therefore consists of a

sequence of inflexible units of machine behaviour: "bolt adding axis to adding wheel",

"rotate adding axis" "release bolt".

Babbage invented a means of specifying sequences of machine behaviours in the Difference Engine using "a series of cams onto which control surfaces could be screwed in any desired pattern" (Bromley, "Evolution" 117). The relationships specified by this mechanism can be understood to consist of the *next* relation: "bolt adding axis to adding wheel" *next "*rotate adding axis", and so on. This results in an inflexible and deterministic routine with a "simple sequential flow" (115). This pattern repeats at the higher hierarchical level: the inflexible carry wave invariably follows the inflexible addition wave. The architecture of the Difference Engine can therefore be interpreted as consisting of an inflexible arrangement of inflexible units that is modular and hierarchical.[7]

Examining the sequence of inflexible actions that comprise addition can reveal the extent to which Babbage made inflexibility a property of the Difference Engine. The lower-order figure wheel may be pushed forward any number of digit positions between one and nine, yet the sequence of elementary actions used to encompass this range of contingencies ("bolt adding axis to adding wheel", "rotate adding axis", "release bolt") remains inflexible. In addition to possessing an inflexible operating cycle composed from discrete units, the Difference Engine itself can be regarded as a discrete and inflexible fragment of a larger process, having been designed as an efficient producer of numerical data for use in more complex calculations (Lardner 176). The Engine is unable to perform these calculations itself, being capable of only one limited and inflexible routine: it can only compute what is stated in a form calculable using the method described above.

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[7] As discussed in the introductory chapter, the term "architecture" is used to refer to the structure of a computer's instruction set.
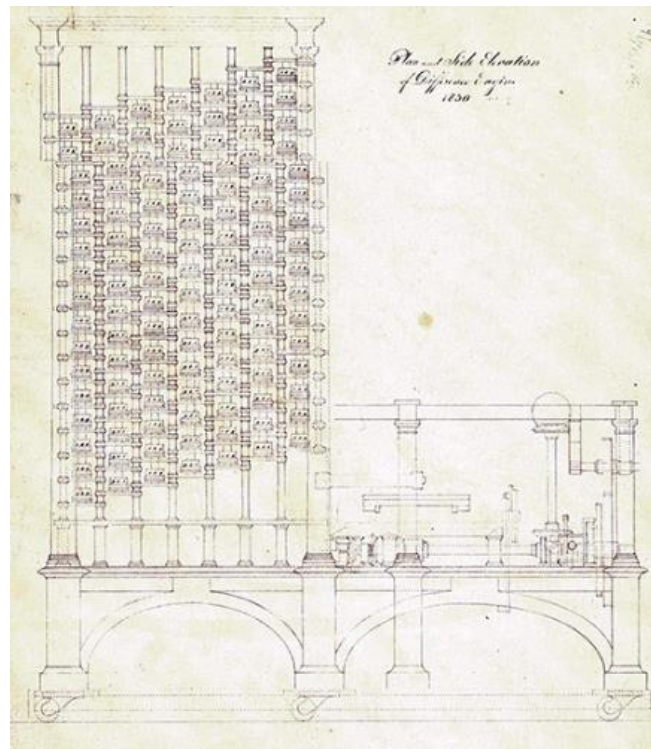
Fig. 4. Difference Engine, 1830. Charles Babbage. (Science Museum, London).

Another significant feature of this Engine is the separation that is maintained between the mechanisms that guide the routine and those that execute the computations. In the trial portion the directive mechanism consists of interlocking gearwheels situated above and below the calculating portion, whilst in a design drawing dated 1830, the separation of calculating portion on the left and control mechanism on the right is clearly visible (see fig. 1 and fig. 4). This can be viewed as corresponding to the external origin of the Difference Engine's routine with human programmers.

The remainder of this section seeks to explore how, as a result of these features of the Difference Engine, Babbage came to associate worker efficiency with pathologies similar to those that Ferenczi attributed to incest trauma. Babbage in *Economy* identifies division of labour as "the most important principle on which the economy of a manufacture depends" (131). Division of labour consists of decomposing a production process into a series of discrete tasks, "each . . . the sole occupation of one individual" (135). Babbage in

Economy extends the Smithian division of labour, offering a rationale for increased fragmentation of the production process now known as "Babbage's principle" (Braverman 81): "*The master manufacturer, by dividing the work to be executed into different processes, each requiring different degrees of skill and force, can purchase exactly that quantity of both which is necessary*" (Babbage, *Economy* 137-38, emphasis in original). Although entrepreneurs had experimented with larger textile mills from the late-eighteenth century, the factory system continued to evolve throughout the 1830s (Hudson 78-79; Gray 15). The Babbage principle represented an aggressive division of labour as a rational approach for manufacturers wishing to maximise productivity and minimise costs (Zimmermann 10-11).[8] Although Babbage's principle still imaginatively locates a number of skilled labourers in factories, it facilitates the use of cheap unskilled or semi-skilled labour for the majority of production: "Such labour can always be purchased at an easy rate" (Babbage, *Economy* 157).

I want to show that focusing upon specific features of the Difference Engine can explain how the efficiency of unskilled or semi-skilled workers in *Economy* is secured through cognitive-behavioural pathologies. Babbage writes that the "operation" performed by each worker should be as "limited and simple" as possible (*Economy* 173), leading historian Bernard Cronin to equate the Babbage principle with "job fragmentation" (65-66). This execution of a fragment of the labour process can be regarded as corresponding to the capacities of the Difference Engine as "the embodying of *one particular and very limited set of operations*" (Lovelace 249, emphasis in original). The inflexibility of each component movement of the Difference Engine and its inflexible progression from one instruction to the next allows its entire routine to be regarded as a discrete fragment within a more complex process (as "*one . . . set* of operations"). Similarly, the worker in *Economy* executes

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[8] That is, manufacturers with adequate capital to subdivide the labour process to this extent.

a deterministic sequence of actions whose inflexibility enables the entire sequence to be regarded as a discrete fragment.

For Babbage, the Difference Engine could perform its calculations with a rapidity that justified its existence as a fragment of the calculating process:

> a machine to execute the mere *isolated operations* of arithmetic, would be comparatively of little value . . . unless it executed not only accurately, but *with great rapidity*, whatever it was required to do . . . the method of differences supplied a general principle by which all Tables might be computed *through limited intervals, by one uniform process*.
>
> (*Passages* 42-43, emphasis added)

It is possible to identify a parallel with how, in *Economy,* the "constant repetition" of a fragment of the labour process is understood to produce "excellence and rapidity" in the labour force (134). This can be compared with the way in which the inflexible or "*uniform process*" of the Difference Engine allows it to operate as a discrete fragment that can be executed with "great rapidity".

This quote suggests that Babbage regarded efficient calculation in the Engine as contingent upon not only fragmentation, but also decontextualisation: its productivity derives from its performance of "*isolated operations*". Similarly, Babbage in *Economy* indicates that the "scattered arts" generated by division of labour are not only "scattered" spatially, but cognitively: "there are a hundred and two distinct branches of this art, to each of which a boy may be put apprentice . . . [he] is unable, after his apprenticeship has expired, without subsequent instruction, to work at any other branch" (162). This is similar to how, in the narrative of incest trauma that Ferenczi describes, shattered fragments exist in a decontextualised state. Referring to Babbage's description of the production of numerical tables in the French *bureau de cadastre*, Shieber argues that the opacity of other processes in the system confines the worker's attention to the execution of one function

(272-73). He does not, however, consider how this principle operates in the wider factory system that Babbage depicts in *Economy,* or its relationship to the Difference Engine.

Purbrick also mentions this "lack of knowledge" of other processes, but places emphasis on the physical rather than the cognitive capacities of the worker: "The discipline of repetition of the same function and a lack of knowledge of other functions produced a body that was faster and more accurate" (21). I would suggest that the Difference Engine not only underpins the fragmentation and decontextualisation of cognitive-behavioural capacities in *Economy*, but it also determines the relevance of these pathologies for the factory system that Babbage describes*.*

This interpretation of *Economy* using principles derived from the Difference Engine suggests that the cognitive-behavioural pathologies that secure worker efficiency in this text are predicated upon inflexibility at the level of the individual operation, but at the same time fragmentation and decontextualisation at the macroscopic systemic level. Applying these computational principles not only allows this apparent paradox to be identified as a feature of the factory system that Babbage portrays in *Economy,* but also indicates how inflexibility and fragmentation operate in concert in this text to produce cognitive-behavioural pathologies deemed necessary for worker efficiency.

I would argue that these pathologies function to generate a cognitive division of labour between worker and manufacturer. As historian Joseph Bizup states, the manufacturer in *Economy* is no longer involved in physical production, which is given the status of *making*. Instead, he takes on a new role organising and overseeing systems of production (60). Accordingly, Babbage observes that "if the *maker* of an article wish to become a *manufacturer . . .* he must carefully arrange the whole system of his factory" (*Economy* 99, emphasis in original):

> it requires far other *habits to combine* into one machine these *scattered*
>
> *arts*. A previous education as a workman in the peculiar trade, is

undoubtedly a valuable preliminary; but in order to make such

combinations with any reasonable expectation of success, *an extensive*

knowledge of machinery . . . are [*sic*] essentially requisite.

(136-37, emphasis added)

Referring to the distribution of cognitive capacities within an organisational grouping,

Shieber observes that "the skills required for the completion of the cognitive tasks that are

the responsibilities of the individuals making up the network are likely very different than

the skills that would be required to design, track, and assess socially distributed cognitive

networks" (273). Shieber is concerned, however, with how Babbage depicts the distribution

of cognitive tasks in the eighteenth-century *bureau de cadastre* rather than in the

nineteenth-century factory (275). Shieber also does not align Babbage's thinking in this

regard with the Engines, aside from observing that the labour of unskilled human

computers was susceptible to mechanisation (270).[9]

Schaffer, meanwhile, argues that the "algebra of machine analysis" that Babbage

"designed to describe the engine's work" led him to envisage a manufacturing elite with

the skills to codify and thus manage the discrete "components" of the factory system,

including the labour of the worker ("Intelligence" 207-208). As such, the Difference Engine

"*embodied* the intelligence of theory": "Only the superior *combination* and *correlation* of

each component guaranteed efficient, economical, planned and therefore intelligent

performance" (210, emphasis in original). Schaffer equates the capacity of the carry

mechanism in the Analytical Engine to remain vigilant for the occurrence of carries with the

superintendent role in factories: "the qualities attributed to this intelligence were just

those required from this form of superintendence- anticipation and meticulous scrutiny"

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[9] Shieber quotes a section from *Economy* in which Babbage refers to the *The Times*
newspaper office as a "factory", but he does not offer detailed analysis of the cognitive
division of labour that characterises this system (276).

(224). Although I share Schaffer's concern with how Babbage represents the division of cognitive labour in factories, my focus upon comparisons between the architecture of the Difference Engine and cognitive-behavioural pathologies suffered by the maker-worker in *Economy* seeks to offer a new approach to this subject.

The Difference Engine indicated to Babbage that computational efficiency was best served by performing a decontextualised fragment in an inflexible manner, thus allowing it to function as a discrete component within a wider system of computation. Similarly, the efficiency of the worker in *Economy* is contingent upon the fragmentation and decontextualisation generated by their inflexible functioning. This mode of operation enables their unit of the labour process to function as a discrete unit suitable for combination by manufacturers. I suggest that these architectural features of the Difference Engine underpin the division of cognitive labour that Schaffer identifies, with the capacities of the Difference Engine in *Economy* corresponding to those of the maker-worker rather than the manufacturer. It is possible to conjecture that Babbage was thinking of the Difference Engine when he described the labour of maker-workers as that "which may almost be termed *mechanical,* requiring the *least knowledge*" (*Economy* 157, emphasis added).

There is evidence that operating in the manner of a Difference Engine militates against the maker-worker in *Economy* developing the combinatorial "habits" of the manufacturer. As a result of possessing an understanding of systems that is comprehensive rather than fragmentary ("an *extensive* knowledge of machinery"), the manufacturer can develop cognitive-behavioural skills, or "habits", that enable them to organise discrete units as functional systems: "The watch-finisher, whose business is to put together the scattered parts, is the only one . . . who can work in any department than his own" (162-63). Unlike the majority of maker-workers, who function as decontextualised fragments within the system in which they operate, the watch finisher does not regard the processes

that created these "scattered *parts*" as "scattered *arts*". This knowledge forms the foundation of habits that enable him to modify his own operations.

I would argue that the discrete separation between executive and directive mechanisms used to improve efficiency in the Difference Engine confirmed to Babbage that it was not necessary for operatives to understand the coordination of their task at a systemic level. This offers a rationale for the belief that Shieber attributes to Babbage that "reflect[ing] upon the properties of the network would be an extraneous task for members of the network" (272). This external imposition of an inflexible routine can be compared with how the fragmented psyche of the incestuously traumatised child is left reliant upon the idiom of the incestuous aggressor for structure. This structure, having been externally dictated rather than developed through a process in which the individual has exerted agency, is experienced as inflexible.

This adds to the complexity of the cognitive-behavioural paradoxes that characterise the factory system in *Economy.* The labour of the maker-worker consists of performing a decontextualised fragment of the labour process**.** However, this fragmentation and decontextualisation is simultaneously generated by the inflexibility of their individual operation. The inflexibility of this fragment subsequently enables it to be organised as part of a larger structure, which is in turn experienced by the maker-worker as inflexible. Once again, a combination of inflexibility and fragmentation constitutes the totality of cognitive-behavioural pathology in *Economy.* It is my contention that this paradox results from the status of the Difference Engine as an inflexible and decontextualised fragment of a wider process of computation.

As Schaffer observes, debates about where specific intellectual capabilities were located in the factory system were freighted with political meaning ("Intelligence", 209). Doubtless with the division between maker and manufacturer in mind, Babbage argues that maker-workers are incapable of judging when it is appropriate to form "combinations"

to force a change in the organisation of a factory (*Economy* 244). For Babbage, a combination is where workers "interfere with their employers in the mode of carrying on their business" (252): such "improper" *combinations* violate the discrete division of labour between manufacturer and maker he foregrounds (252). This can be interpreted as an instance of cognitive-behavioural pathologies arising from the computational origins of the factory system being utilised to rationalise the control of manufacturers over production.

The disciplinary apparatus that Babbage derived from computing would appear to challenge dominant perceptions of how a disciplinary apparatus is structured, as fragmentation within a disciplinary structure might more readily be conceptualised as a source of anarchy and chaos. However, this section has argued that the Difference Engine led to fragmentation being figured as an integral part of a disciplinary schema. It is one of the aims of this thesis to show that the paradoxes contained within this computational model are fundamental to its expression. A similar situation is represented in Ferenczi's writings, where pathologies resulting from incest trauma lead the traumatised individual to believe that unless they submit to their aggressor's control, they will suffer uncontrollable psychic fragmentation (*Diary* 175). Pathologies of fragmentation and decontextualisation thus lay the groundwork for aggressive structures of external regulation.

If the Difference Engine is the theoretical justification for Babbage's model of labour organisation, then machinery represents the means of its practical implementation. As historian Nathan Rosenberg writes, *Economy* was the first text to offer precise explanations of how labour could be organised to maximise efficiency in mechanised factories (49). Babbage observes that "One of the most singular advantages we derive from machinery is the check which it affords against the inattention, the idleness, or the knavery, of human agents" (*Economy* 39). According to historian Andrew Zimmermann, Babbage's rationale of efficiency is contravened by "undisciplined" actions: machinery "sets limits to the variety of human actions, which Babbage believes disrupt production" (9). The

regularity of machines is figured as paring off all extraneous movements in the operative, confining them to an inflexible sequence of predetermined actions. Babbage also highlights several instances of mechanisation enabling a greater division of labour, further exacerbating the fragmentation and decontextualisation experienced by the worker (*Economy* 13, 48).

The discipline of machinery, in conjunction with the external regulation of the manufacturer, effectively pre-programs the worker in *Economy* to execute an inflexible sequence of actions in the manner in which the Difference Engine is preprogramed to carry out an inflexible sequence of mechanical motions: the factory becomes characterised by "an emphasis on the replication of many parts on automatic machines which could be pre-set . . . close supervision of work set out in advance and in great detail" (Cronin 65). The functioning of machinery in *Economy* can therefore be compared with the role of the incestuous aggressor in Ferenczi, a figure with the capacity to "stamp upon their [children's] plastic minds . . . rigid rules as something externally imprinted" ("Child-Analysis" 134).

Maas argues that Babbage's aim was to enable workers to "reach the highest level of precision attainable" (*Jevons* 185). As Maas observes, functioning with this degree of precision is to approach the mechanical, to be regulated in the manner in which a "precise order of wheels and gears fits precisely to the exact timing of different manual activities" in the Engine (186). According to Berg, Babbage in *Economy* was "bringing to bear the mathematical precision and predictability of his machine on the factories" (182). Whereas Berg and Maas see this "mechanical" precision in terms of temporal accuracy, I would suggest that it could be also be read in terms of external regulation. As discussed in the previous chapter, Ferenczi identifies a "mechanical" quality in the incestuously traumatised child that results from the execution of inflexible cognitive-behavioural schemata derived from the incestuous aggressor.

Correspondingly, Babbage appears to have perceived a mechanical quality in the worker whose cognitive-behavioural capacities have been delimited by the factory system. There is little extraneous commentary in *Economy*, but the subtleties of Babbage's language are revealing. The use of the word "knavery" in the above quote allows interplay between the connotations of knavery as a carnivalesque or disruptive freedom, the figure of the servile knave, and "knave" as a machine part, a segment of a spool or spindle (*OED*). Machines in *Economy* turn knaves (individuals possessing a disruptive freedom) into knaves (servants), by forcing them to become knaves (machine parts).

The tightly circumscribed routine produced by the inflexible and routinized operation of machines also reinforces the sense of the individual operation as a discrete unit: Babbage describes the factory system as consisting of "a multitude of separate machines, each complete in itself" (192). Tamara Ketabgian argues that although it initially appears that machinery in *Economy* is augmenting the powers of the worker, it ultimately renders "all machine-workers . . . in effect, disabled" (33-34). Because Babbage locates part of the skill necessary to perform a given task in the machine, the worker in *Economy* is left handicapped without the prosthetic appendage that enables him to function within the factory (31). Yet the limitations machinery imposes upon workers in *Economy* would appear to exceed even this partial apportioning of skill, with machines forming part of an apparatus of labour management designed to generate specific cognitive-behavioural pathologies in the worker. These were pathologies intended to increase both the efficiency of the worker and their reliance upon management. This section has sought to show, however, that the form that these pathologies take in *Economy* is not so much the product of industrial machines as of a computing machine.

Industrial Education and Cognitive-Behavioural Pathologies

The following two sections focus upon a range of mid-nineteenth-century accounts of half-time education, beginning with descriptions of the "industrial education" that constituted one half of the "half-time" system. The purpose of these sections is to illustrate that, as a result of the influence of *Economy,* the cognitive-behavioural pathologies attributed to the half-time system by its contemporaries are similar to those that Babbage sought to attribute to the worker as a result of the Difference Engine. Although these mid-century sources do not possess the conceptual framework that would allow them to identify the pedagogies of the half-time system as "incestuous", I want to show that they depict their pathological consequences in a similar manner to Ferenczian theory. Historian Clark Nardinelli has identified concern amongst nineteenth-century reformers that factories "destroyed the future prospects of children" (89). This section seeks to elaborate upon Nardinelli's claim by providing analysis of specific cognitive-behavioural pathologies attributed to factory workers, contextualising this body of representation by highlighting parallels with the computational model depicted in *Economy.*

I wish to begin this discussion with the caveat that the following represents a critique of a body of representation, rather than an attempt to ascertain the real effects of the educational apparatus in mid-century factories. The sources discussed here are contemporary responses to the condition of child workers in the textile industries of Lancashire and Yorkshire during the 1850s and 1860s. A half-timer at mid-century would typically have formed part of the workforce of a medium-to-large, steam-powered mill (Walton 203; Timmins, 183). By mid-century, textile production had become highly stratified in its organisation, with subdivided processes engendering a range of tasks

capable of being performed by children (Honeyman 1-2; Samuel 29).[10]An additional reason for focusing upon this particular regional and socioeconomic demographic is that the half-time system was firmly established in these counties by 1850.

The experience of the child textile worker was by no means ubiquitous. At mid-century, of the 30 percent of English and Welsh children aged ten to fourteen recorded as having a job, only 15 per cent of males and 24 per cent of females were employed in large factories (Kirby 544; Tuttle 142). Nevertheless, child textile workers were still a significant demographic, especially in the counties studied here (Walton 202; S. Rose 161-62). Assistant Commissioner J.S. Winder reported in 1859 that in Rochdale alone, in excess of 3,500 children worked in textile factories (177), and in 1850 13, 500 half-timers were recorded in sample districts in Lancashire and Yorkshire (Horner 15).

The Factory Acts had since the 1830s stipulated that the working hours of children employed in textile manufacture should not exceed a statutory limit, and that child textile workers of both sexes should be provided with elementary education (Silver 142). Nassau Senior in *Suggestions on Popular Education* (1861) summarised the law as it stood in 1860:

> No child under eight years can be employed, and no other child under thirteen years can be employed for more than six hours and a half in a day, or ten hours on alternate days. A child working every day must attend school for three hours, a child working alternate days must attend school for five hours. (175)

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[10] The internal organisation of textile factories was, of course, subject to regional and individual variations (Walton 199-200, 203; Timmins 182). However, a stratified division of labour is agreed upon by historians as a common feature of mid-century textile factories (Galbi 364). It is beyond the scope of this thesis to provide a comparative survey of textile industries outside these regions, or of non-textile industries within them.

This was known as the "half-time system" (Akroyd 3). Although the primary function of

half-time education was to defend the child against overwork, during the 1860s the system

was studied as the model for a national system of popular education, one which would

protect the interests of employers whilst palliating demand for working-class education (4).

Babbage in *Economy* advises that it is necessary for workers to learn the physical

and cognitive attributes required for factory work in a factory setting (133). This view was

paralleled at mid-century: Leonard Horner, an inspector of education in factories, wrote in

1850 that the half-time system provided "the double advantage of school and of that most

valuable industrial education" (15). This "industrial education" consisted of performing

tasks that were understood to result from the application of Babbage's principle in textile

factories: "This tendency to employ merely children . . . shows how the scholastic dogma

of the division of labour into degrees of skill has been exploited" (Gaskell 365). Typical

employments included a "doffer", removing full bobbins from spinning machines, a "little

piecer" re-joining broken threads, or a "scavenger" cleaning under machinery (Great

Britain, Children's Employment Commission 164; Society for Promoting Christian

Knowledge 138-9).[11]

Inculcating certain cognitive-behavioural attributes, or "habits of industry", was

identified as a key purpose of industrial education (Dawes v). I would suggest that this

understanding of "habit" as cognitive-behavioural traits is similar to that found in *Economy*:

"the spirit of order and discipline which pervades our factories, is not the mere restraint

which is imposed on the labourer whilst he is within the walls of the factory itself . . . it is

the formation of a habit" (Gladstone 769). Several mid-century critics, however, intimated

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[11] There were, however, many others. A survey is provided in Tuttle (104). Although
conditions in factories varied, it is without doubt that many half-timers suffered appalling
privations (Cruikshank 52; Society for Promoting Christian Knowledge 138, 143). This is not
meant to imply, however, that conditions in textile factories were worse than in other
forms of child labour.

that these "habits of industry" were synonymous with cognitive-behavioural pathologies. In addition to concerns regarding the half-timer's physical wellbeing, it is also possible to identify anxieties regarding the cognitive detriment caused by industrial education. The Children's Employment Commission at mid-century described the "pressure of work upon the child's mind as well as body", claiming that "industrial education" resulted in the "injury of their children's health by early labour, and . . . the certain injury of their minds" (qtd. Senior 213, 33).

In the previous section it was argued that in the system that Babbage derived from the computational capacities of the Difference Engine, the inflexibility of the movements performed by the worker enables their task to be regarded as a discrete fragment. In a statement that can be compared with Babbage's principle, Babbage claims that not only can the required quantity of skill be purchased, it can also be taught: "confined to one operation, a very small portion of his time will be consumed unprofitably at the commencement [of labour]" (*Economy* 132).

It is my contention that these mid-century sources represent the "habits" resulting from this fragmentation of industrial education as a tolerance for fragmented and decontextualised tasks. In 1850 an anonymous contributor to the *London Journal of Arts, Sciences and Manufactures* claimed that

> when they [children] have acquired *habits of industry*, combined with quickness of perception (however *limited in degree*), and a kind of *mechanical* dexterity . . . they have imbibed all the good they are likely to receive within the mill. ("Factory Labour" 262, emphasis added)

The inflexibility of its routine results in the half-timer being regarded as a discrete component of the factory system. This parallels the status of the Difference Engine as a discrete and inflexible fragment in the process of knowledge production: "already to feel that he is but a portion of a mighty machine" (Gaskell 143-44); "The child instinctively feels

that it is used as a mere bit of machinery" (Children's Employment Commission, qtd. Senior 213). Imagining the half-timer as a "portion" or "mere bit" depicts them as a fragment of the global mechanism of the factory. In an image that can be compared with the portrayal of the worker in *Economy,* this worker-as-fragment is understood to be non-functional if decontextualised from the stratified organisation of the factory: "if it [a child] is to work in the mill at all, it must become an integral *part* of the machinery of that mill . . . subject to the general economy" (Gaskell 173).

Performing fragmented and decontextualised tasks is portrayed as preventing workers from acquiring the knowledge that Babbage claimed was necessary in order to develop the cognitive capacities of the manufacturer: "It is not, indeed, improbable that the exclusive attention which is required to one particular employment, may, in some degree, limit and confine the general capacity for acquiring diversified knowledge" (Gaskell 166); "monotony of occupation . . . is very detrimental to the development of the mental powers of the child" ("Factory Labour" 263). These sources suggest that a failure to acquire "diversified knowledge" results in an inability to develop the "mental powers" required for a comprehension of various units within the factory system: the "exclusive attention" upon "one particular employment" confines such a "general capacity". These quotes suggest that half-time education was felt to render the factory system inflexible yet fragmented from the worker's perspective: mid-century sources speak of workers desiring "to have their minds set in order about their own operations" (Maurice 151).

A further comparison with *Economy* is that cognitive-behavioural habits were figured as central to the "discipline of work" that industrial education sought to cultivate (R. Baker *1866* 101). Assistant Commissioner Henry Lord claimed in 1862 that the benefit to the manufacturer of the half-time system was the "supply of trained hands growing into full-timers under his control" (Great Britain, Children's Employment Commission, 164). Although there are numerous accounts of violence being used to discipline child textile

workers, many mid-century observers instead chose to highlight the disciplinary effect of

labour organisation (Humphries 246; "Woman and Womankind" 218). In the previous

section, it was claimed that the origin of Babbage's principle can be traced to computing

technology. By mid-century, this principle was identified as a disciplinary strategy in

sources differing in their attitudes towards the factory system:

> with the growth of the factory system, [emerged] that organisation and
>
> division of labour requiring a subordination of ranks in every mill according
>
> to capacity and skill. Hence grew habits of punctuality, order . . . and exact
>
> obedience to discipline. . . . it has included more gradations of rank, and a
>
> still more complicated system of submission to authority.
>
> (Kay-Shuttleworth, qtd. "Psychological Quarterly Retrospect" iii)

Franklin Baker, an apologist for the factory system, declared approvingly in 1850 that "the

order and regularity enforced upon the operatives are so nearly akin to moral habits" (15).

In contrast, William Dodd, writing in 1849, deplored how Babbage's principle of

"subordination of ranks in every mill" had stripped workers of their agency: "she [the

worker] has no voice in making conditions, but must submit to such as are offered" (108).

Despite the conflicting perspectives of these sources, the parallel between Babbage's

principle and a "complicated system of submission to authority" remains consistent.

Another point of comparison with *Economy* is that machinery in these sources is

interpreted as a form of labour discipline. Reports highlighted the horrific penalties that

machines exacted for lapses in "efficiency": "the child who shall be behind in doing its

allotted work . . . [their] fingers will be bruised and skinned" (Fielden 138); "if [fingers are]

placed with hesitation or carelessness, they are sacrificed" (Redgrave *1866* 9). Machines

are depicted as habituating the worker's cognitive-behavioural capacities to the routinized

performance of a deterministic sequence of inflexible actions. It is possible to conceptualise

this in terms of the worker functioning in a similar manner to the Difference Engine. The

behaviour of the half-timer in these accounts can also be compared to the automatism of the incestuously traumatised child in Ferenczi's writings, with the child performing work that is "for the most part mechanical" (Winder 195).

Half-Time Schooling and Cognitive-Behavioural Pathologies

This section aims to provide further evidence that the computational representation of the cognitive-behavioural effects of the factory system in *Economy* played a role in shaping mid-century thinking concerning pedagogical systems associated with factories. In this section I focus upon contemporary depictions of the other facet of the half-time system, the school education received by the factory child. I hope that the analysis in this section can advance our understanding of discourses relating to half-time schooling, an important forerunner of the 1870 Elementary Education Act. Again, this section is intended as a critique of a certain body of representation rather than as an attempt to judge the actual cognitive-behavioural effects of this system.

Although evasion of the educational clauses of the Factory Acts was common, the majority of half-timers received a school education that was effectively compulsory (Bremner 309). The largest provider of half-time education in the Lancashire and Yorkshire districts inspected by Alexander Redgrave were schools established by the Anglican National Society for Promoting the Education of the Poor in the Principles of the Established Church, known as "National schools" (Redgrave *1861* 18). Along with those operated by Dissenting organisations, these were known as "public schools". "Private schools" designated schools run by private individuals, often in their homes, whilst "factory schools" were maintained by manufacturers for the education of their workers (Purvis 91). In a representative sample in 1861, 11, 611 half-timers attended National or similar Church schools, 6, 559 Dissenting, 5, 046 factory schools, and 3, 617 private schools (Redgrave

1861 18). Reflecting the employment demographics of an area, some schools were entirely

populated by half-timers, and in others they comprised as little as ten percent of the school

population (Redgrave *1861* 18; Lamb 12).

The general consensus at mid-century was that poor standards were the norm

across all classes of schools for half-timers: Winder claimed in 1861 that many were "a

complete fraud upon the Factory Acts" (231). Interestingly, private schools were frequently

judged to be no worse than public schools, the condition of which Horner describes as

"lamentable" (Horner 12; see also Redgrave *1861* 19-20). Nevertheless, thirty-two private

schools in Redgrave's district were judged to be unsatisfactory without hope of

improvement, but "not so obviously inefficient as to justify . . . annulling the Certificate of

the Teacher" (Redgrave *1861* 19-20). Factory schools reportedly fared no better in

inspections, with complaints of pupils "scarcely knowing their alphabet after some months"

(R. Baker *1866* 107).

The aim was that half-timers would leave at thirteen able to read, write and

perform arithmetic, with perhaps some basic knowledge of geography and history (R. Baker

1866 222; Lamb 129). Winder claims, however, that half-timers often departed the system

"unable to read a simple narrative with understanding . . . incompetent to do more than a

simple addition or subtraction sum" (230-231). The Rev. F. Richardson, a superintendent of

factory schools, observed in 1861 that many half-timers were "incapable of receiving more

during the five years they remain at school than the mere A B C of knowledge" (qtd. R.

Baker *1861* 32). A range of factors was blamed for low attainment amongst half-timers,

including exhaustion, inadequate funding, and the limited duration of schooling ("National

Schoolmaster", qtd. Chadwick 11; Horner 14; "Headmaster of Parochial School" qtd.

Chadwick 10). A major subject of criticism, however, was the use of inefficient teaching

methods: the "methods of teaching some of the common subjects" are described as

"frequently most ineffectual and stupid" (Winder 219).

I want to show that these "ineffectual" teaching methods are portrayed as generating cognitive-behavioural pathologies similar to those I have argued Babbage attributed to the worker in *Economy* as a result of computing technology. This is exemplified by Winder's appraisal of a teaching method he had "frequently seen adopted":

> When the child comes to a word he does not know, he simply spells it out letter by letter, and then, without making any attempt to find it out for himself, looks up at the teacher, who forthwith to save trouble pronounces the word. (227)

The pupil taught using this method executes a discrete task (reading a word) as a deterministic sequence of inflexible actions ("he . . . spells it out *letter by letter*"). Paralleling the operation of the Difference Engine, the child is able to complete this task because there is no ambiguity as to how he proceeds from one inflexible action to the next. This process corresponds to how, in *Economy*, the inflexibility of a sequence of actions generates a task that can be regarded as a discrete unit. The child, however, does not understand the significance of this process any more than the Difference Engine comprehends the significance of the data produced by its discrete and inflexible routine of calculation: a Lancashire schoolmaster admitted in 1861 that "letters and monosyllables" described the level of comprehension amongst his pupils (R. Baker *1861* 35). The discrete task of "spelling a word" thus remains a decontextualised fragment, similar to the tasks performed by the half-timer in the factory.

The concern was that even when half-timers read narrative rather than fragments of text, they did so without understanding the relation of what they were reading to other words, concepts or even syllables: "reading mechanically without any apparent notion that the words have a meaning" (Winder 222). The inflexible combinations generated by these methods are simultaneously represented as decontextualised fragments, similar to the inflexible and fragmented processes I have argued were understood to characterise factory

labour in this period as a result of *Economy*. Because this body of representation draws upon a corresponding model of cognitive-behavioural pathology to that found in *Economy*, it anticipates the construction of psychopathology in Ferenczi. That this model is used here to formulate a critique of pedagogical methods further intensifies the Ferenczian flavour of these sources.

Cognitive-behavioural pathologies are depicted in these sources as besetting the dominant pedagogical methodologies of the period. W.F. Richards, a National school headmaster, wrote in 1856 that the catechetical method constituted a key element of the teaching in elementary schools: "instructing his pupils by questioning the meaning into them, and then examining them by questioning it out of them" (40). Richards observed that to do this well required significant skill. He emphasised that questions should be organised as a connected series to prevent the material taught from becoming too fragmented (41-42). Whilst educationalist William Ross cautioned against the practice of regurgitating formulaic questions and answers directly from textbooks (83), Richards emphasised that pupils should not be forced to provide answers in a prescribed form of words (41). The units of knowledge produced by these methods are depicted in these sources as both fragmented and inflexible. I would therefore suggest that these sources regard a combination of fragmentation and inflexibility as constituting the totality of trauma, making them comparable with both Ferenczian theory and *Economy.*

The manner in which the catechetical method is depicted by Ross and Richards portrays it as similar to rote learning, in which pupils are required to answer in a "prescribed form of words". Rote learning was a method that exerted a continued grip upon schools in this period, often for pragmatic reasons: Ross advised in 1858 that causing "the pupils to repeat after him [the teacher]" would be necessary in order to teach large classes of half-timers (111). Writing at the end of the 1850s, the educator H.G. Robinson claimed "many lessons are nothing more than a recital of names, dates, technical terms,

&c." (qtd. Senior 337). In 1859 Herbert Spencer observed that teaching rules and facts in this manner left them "lying isolated in the mind . . . a confused heap of materials" (61).

These pedagogies are portrayed as generating effects that parallel the status of the Difference Engine as both a self-contained, inflexible routine and a fragment in a wider economy of knowledge production. By habituating the child to the routinized performance of inflexible, fragmented and decontextualised units, these pedagogies can be thought of as causing pupils to function in a similar manner to the Difference Engine. It is my contention that a cognitive-behavioural model paralleling the architecture of the Difference Engine entered nineteenth-century culture via *Economy,* informing the representation of the conditions of factory labour and the pedagogical systems associated with it. This claim would appear to be supported by the fact that Ross compares the rote-type methods discussed above with the conditions of labour in factories: "confined rigidly and mechanically to his text-book, he ceases to be, in the higher sense of the term, a teacher; he is rather a task-master" (83); "attainments thus made are altogether too much a matter of mechanism and routine" (99).

The failure to possess a comprehensive knowledge of various units is depicted by Babbage as preventing the maker-worker from developing habits that in *Economy* characterise the manufacturer. Spencer wrote that even if pupils were taught a range of facts and rules, their existence as isolated fragments would mean that the pupil would ultimately be left with a paucity of knowledge: "the greater part of what has been acquired, being unorganised, soon drops out of recollection" (30). For Spencer, the acquisition of knowledge alone is not enough: "the art of applying knowledge" must also be taught (30). There seems to have been growing consensus amongst mid-century educationalists that in order for complex subjects to be communicated effectively, they should be broken down into their "simplest elements" (Wayland, qtd. Sullivan 96; see also Drew 5). Equally important, however, was ensuring that pupils could form connections between these

elements. Ross advises teachers to "*connect the newly acquired with the previously acquired*" (33, emphasis in original), whilst educationalist Thomas Morrison stated in 1863 that if left without a sense of the connections between units of knowledge, "there is a danger of disgusting the child altogether" (98).

It was emphasised that, wherever possible, pupils should be assisted in discovering associations between units of knowledge for themselves. An article in the *National Society's Monthly Paper* stated in 1858 that "in place of being told the pronunciation of words . . . the scholar should be made to discover it for themselves, by applying their mind to the sound of the letters placed in connection" ("Lessons on Geography" 148). Educationalist George White admitted in 1862, however, that little progress had been made in implementing these improved methods in schools for the working classes: "he [the child] seems to say . . . 'Give me a little help in the art of disentangling these elements, and of redisposing them, so that I may form words for myself'" (17). According to White, this help to disentangle and redispose various "elements" was rarely forthcoming: "It is somewhat humiliating . . . to find so little improvement in school methods" (3).

The "mechanical" teaching methods described above involve an external authority dictating to the child exactly how various units should be organised. I would suggest that this corresponds to the separation between executive and directive portion in the Engine that this chapter has argued informs the distinction between maker and manufacturer in *Economy.* Winder observes that rather than teaching the half-timer how to construct a word from its component units, teachers instead pronounced complete words to "save trouble". White complained that as a result of provision of complete words and formulaic answers, "when the same literal elements are found together, the little learner will insist on one collocation of them" (17). Through such methods the half-timer is effectively programmed to execute one predetermined sequence. This makes the behaviour of the half-timer in these sources comparable to that of the Difference Engine.

These sources suggest that the teaching of fragmented and decontextualised units of knowledge left the pupil reliant on external organisation of these fragments. This can be compared with Ferenczi's claim that the shattered psyche of the incest victim is left dependent on the structure provided by the idiom of the incestuous aggressor. Robinson claimed that as a result of methods comparable to rote learning, pupils, "if thrown upon their own mental resources and required to apply their knowledge, to make new combinations, or to draw inferences, immediately are at a loss" (qtd. Senior 335).

A further point of comparison with *Economy* is that the ability to exert organisational agency within factories continued to be associated with a "good school education". Engineer William Fairbairn observed in 1841 that "[i]t appears to require mental training in early life to enable a man to arrange a sequence of operations in the best manner for clear and efficient practical efforts" ("Should Working People Be Educated?" 75). It was implied, however, that preventing the development of these capacities was the very purpose of half-time education. Maurice claimed in 1855 that rather than a concern for the development of the child, the implicit consideration was how children "might be made into the handiest tools for their [the manufacturer's] purposes" (10). Although historian Simon Frith claims that parallels between nineteenth-century factories and schools arise from a "shared rational solution to a similar organisation problem" (78), I would argue that the cognitive preparation of the pupil for factory work was interpreted as a conscious agenda in mid-century texts. Educationalist Robert Sullivan claimed in 1863 that educators should "*impress upon the minds of their pupils the great rule of regularity and order . . .* subordination to superiors" (100-101, emphasis in original), whilst working-class poet Elijah Moss wryly observed that "Our masters are determined to care well for their hands/if only they will come to school, and there obey commands" (qtd. Robson 106).

As in factories, "subordination to superiors" was enforced through scolding and corporal punishment (Humphries 359-60). However, some mid-century educationalists saw

this submission as encoded more subtly in teaching methodologies. Historian Leopoldo Mesquita observes that rote learning "worked as a 'pedagogical solution' to the dilemma faced by the upper classes when carrying out the education of the masses and simultaneously considering their intellectual development as pernicious" (669-70). This section has sought to explain how cognitive habits capable of underpinning disciplinary structures were understood to derive from pedagogical methods.

Spencer claimed that teaching fragmented and inflexible units of knowledge engendered susceptibility to external organisation: "Such and such are the meanings of these words, says the teacher . . . So and so is the rule in this case . . . By the pupil these dicta are received as unquestionable" (49). Spencer goes on to imbue this with political significance, arguing that such methods "increase the already undue respect for authority" (56). Meanwhile, Winder implies that these subtle disciplinary methods heightened the similarities between schools and factories. In an image that can be compared with contemporary depictions of the half-timer as machine part, he describes encountering "600 children present at one time, all under the most perfect command, moving with the rapidity and precision of a machine" (Winder 224-25).

It has been argued in these sections that a body of representation existed at mid-century that attributed specific cognitive-behavioural pathologies to the child as a result of the half-time system. I wish to stress that this is a representational strategy in these texts, and thus a potentially distorting lens. For instance, modern historians have shown that half-timers received myriad influences from their peers and families to counterbalance the discipline and teaching in schools (Goldstrom 106). There are also several historiographies that illustrate how elementary schooling enabled male textile workers to take advantage of subsequent educational opportunities such as mutual improvement societies and Mechanics' Institutes, supporting a rich and often subversive intellectual and political life in these communities (J. Rose 62-67; Simon 245; Walton 188-89). What these sections have

sought to demonstrate, however, is that many mid-century observers believed there to be a correlation between the cognitive-behavioural traits inculcated by schooling and increased subservience to the demands of factory work: "educated workers are the most controllable, the most efficient" (R. Baker *1866* 230). This chapter has argued that these mid-century depictions of the cognitive-behavioural effects of factory pedagogies can be compared with the computational understanding of the factory system in *Economy.*

Silas Marner and Factory Pedagogies

This final section offers a reading of *Silas Marner* that compares this novel with the body of mid-century representation discussed above. Whereas critics have previously viewed industrial England in the novel as confined to "the outskirts of the landscape" (Horowitz 175), this section argues that Eliot in *Marner* explores the relationship between the factory system and cognitive-behavioural pathologies. Although critic Susan Stewart observes that Silas begins the novel in a proto-industrial setting, she claims that "[a]s Silas' body moves forward in time . . . his practice as a weaver moves backward into earlier and earlier phases of weaving artisanry" (523). Rather than the factory, Stewart links Silas' habitual weaving with mythic archetypes such as the Fates (522). This section seeks to illustrate that through the experiences of her eponymous protagonist, Eliot portrays modes of labour and cognitive-behavioural habits similar to those depicted in *Economy* and the mid-century sources discussed above. I hope to illustrate that by depicting these habits as exacerbated by the pedagogical systems that Silas is exposed to, Eliot draws attention to similarities between computing and the half-time system.

As detailed above, by mid-century textile manufacture was firmly associated with both child labour and half-time education. Eliot's decision to make her eponymous protagonist a weaver from "North'ard" would have evoked these associations for her

contemporaries (*Marner* 6). Silas' weaving in his northern town occurs within a system known as "putting-out", a form of labour organisation Babbage identifies as a prototype of the factory system he describes in *Economy* (181). Dealers, or "factors", supplied materials on credit to weavers from a warehouse, or "factory", and weavers wove cloth in their own homes (Zimmermann 7). Finished cloth was returned to the factor, who would arrange for its sale (M. Rose 3-4). Silas weaves in his own home (Eliot, *Marner* 13), but is paid a wage by a "wholesale dealer" (16).

Putting-out, however, was not yet the highly subdivided factory system of *Economy*. Weavers exerted agency over the work carried out within their own homes, ordering its component tasks independently (Cronin 2, 106). Because of this relative autonomy hand-loom weavers were regarded as superior to common labourers, even if their living conditions were often equally wretched (Rule 112). I want to show, however, that Eliot regarded even the lesser degree of stratification and less intensive use of machinery within the proto-factory system as sufficient to generate cognitive-behavioural pathologies in the worker.

Marner suggests that the forms of machinofacture described in *Economy* exacerbated an existing tendency towards cognitive-behavioural pathology in the proto-factory system. In combination with division of labour, weaving by machine allows Silas to spend the majority of his time "moving with . . . even repetition" (Eliot, *Marner* 20). Eliot emphasises that this form of labour organisation generates certain cognitive-behavioural habits: "His loom, as he [Silas] wrought in it without ceasing, had in its turn wrought on him" (40). Paralleling Eliot's representational strategy in *Deronda*, Silas' habits are made visible by inscribing them onto his body. He is depicted "bent . . . into a constant mechanical relation" to his loom (19): "he produced the same sort of impression as a handle or a crooked tube, which has no meaning standing apart" (19). His habits

determined by labour organisation and loom, Silas functions as a fragmented unit, a "component" similar to a handle or tube.

In an image similar to those that depict the half-timer as machine part, Eliot depicts Silas' fragmented unit of behaviour as vulnerable to decontextualisation: his unit of labour and, by extension, his cognitive-behavioural capacities, have "no meaning standing apart". This image of Silas as machine part also parallels mid-century accounts of the factory system in its suggestion that fragmentation and decontextualisation result in the cognitive-behavioural capacities of workers becoming machinelike: "like all objects to which a man devotes himself, they had fashioned him into correspondence with themselves" (40).

I would argue that Silas' cognitive-behavioural capacities share correspondences with one machine in particular: the Difference Engine. It is functioning in a similar manner to this computer that for Silas exacerbates the pathologies of the proto-factory system. This can be compared with Babbage's intervention in shaping an emergent factory system. Written in consultation with Babbage, a series of articles detailing the mathematical and mechanical principles of the Engines were published during the 1830s and 1840s by Lardner and the mathematicians Ada Lovelace (1815-1852) and Luigi Menabrea (1809-1896). It is my contention that the influence of these accounts can be traced in *Marner*. Silas habitually arranges coins in piles in order to compute his earnings, creating an arrangement similar to the columns of stacked discs in the Difference Engine (18). He then uses these metal discs to form a numerical sequence:

> Do we not wile away moments of inanity or fatigued waiting by repeating some trivial movement or sound, until the repetition has bred a want, which is *incipient habit*? . . . Marner wanted the heaps of ten [coins] *to grow into a square, and then into a larger square*. . . (18, emphasis added)

This repetition of a fragmentary and decontextualised unit of behaviour is described as generating a "habit", paralleling Babbage's terminology in *Economy.* In a similar manner to

the Difference Engine, Silas progresses from smaller to larger "squares" using an inflexible and deterministic computational routine: Menabrea highlights the calculation of square numbers as a routine particularly suited to this computer (228). By consistently adding ten coins Silas engineers a constant difference that generates the sequence. This produces a "tabular" value: the money literally arranged on Silas' table (Eliot, *Marner* 160). I would suggest that the similarity of Silas' computational routine to those depicted in contemporary accounts of the Difference Engine indicates that Eliot was aware of the principles underlying this computer. The inflexibility of this routine gives it the semblance of a discrete fragment or decontextualised "function", thus making it comparable to the depiction of labour in *Economy* : Silas executes "mere functions of weaving and hoarding, without any contemplation of an end towards which the functions tended" (19).

Silas' execution of this computational program exacerbates similar pathologies in his weaving routine, generating isolated "functions" of "weaving *and* hoarding". Silas' weaving is fashioned into correspondence with his computational routine, with the repetition of an inflexible sequence of actions forming successive "squares": he sees "the little squares in the cloth complete themselves under his effort" (15). Silas' weaving therefore parallels Babbage's computational understanding of the manner in which the inflexibility of a sequential routine generates the semblance of a "limited and *simple*" (as opposed to *complex*) task. Each repetition of this inflexible weaving routine generates a single square. This can be compared with the way in which each discrete repetition of Silas' computational program generates a square. As is the case with the Engine, the inflexibility of Silas' weaving routine- its "even repetition"- works to obscure its complexities, allowing it to be regarded as a discrete fragment. As it did for Babbage, computing appears to have suggested to Eliot a mode of working that intensifies the effect of pathologies of fragmentation and inflexibility inherent in the proto-factory system.

These habits impair Silas' ability to form connections between various discrete units, making them comparable to the cognitive-behavioural pathologies in *Economy*:

> he [Silas] had had a brown earthenware pot . . . One day as he was returning from the well, he stumbled against the step of the stile, and his brown pot, falling with force . . . was broken . . . The brown pot could never be of use to him any more, but he stuck the bits together and propped the ruin in its old place for a memorial. (19-20)

Throughout the novel Silas' behaviours are portrayed as a collection of fragmented and decontextualised units. His computations are described as "another element of life, like the weaving" (16). Eliot describes these "elements" as "subsisting quite aloof" from one another (16). Juxtaposing these discrete behavioural units only emphasises their decontextualisation: "the *money* had come to *mark off* his *weaving* into *periods*" (18, emphasis added). Silas lacks the ability to take various "elements . . . and blend them with his new impressions, till he recovered a consciousness of unity" (138).

Although the fragments of Silas' pot are placed together in a constellation that superficially gives the semblance of a whole object, on closer inspection it emerges that because the fragments are not adequately connected, the whole is rendered non-functional. I would suggest that Silas' pot can be regarded as another material embodiment of his cognitive-behavioural capacities, symbolising his inability to construct a functional "unity" between various "elements". This leaves him vulnerable to the collapse of any system that undertakes the role of the manufacturer in organising his fragmentary behaviours: the "immediate purpose, which fenced him in from the wide, cheerless unknown" (74).

The point at which this fragmentation occurs would appear to be significant. A stile functions as a type of "lock" whose "key" can be interpreted as the cognitive and behavioural capabilities of an individual. This image suggests that Silas' cognitive-

behavioural habits have locked him out from the possibility of negotiating change without suffering fragmentation; a fragmentation symbolised by the shattering of his pot. The image of the stile forms part of a semantic field surrounding keys and locks in the novel. These images are similar those used at mid-century to describe the cognitive-behavioural pathologies of the factory worker. The Children's Employment Commission saw the plight of metalworkers left unable to forge both locks and keys as exemplifying the defects of industrial education: "They serve their time . . . with a locksmith, and they cannot make a key; the keymaker cannot make a lock, &c" (qtd. Senior 214).

A lock and key form two discrete, but intimately associated units. For these units to achieve functionality there must be an understanding of the way in which they are linked. As fragments with "no meaning standing apart", they can be compared with the image of Silas as machine part. What is signified by locks and keys in this image, however, is a set of cognitive-behavioural capacities. It emphasises that in the factory system, the habits necessary to construct a lock, and those necessary to construct a key, are isolated in individual workers. Unless these are brought into relation by the manufacturer, nothing functional can result. Paralleling the division between maker and manufacturer in *Economy*, the worker who does not possess the habits of both lock and key is understood to relinquish their personal agency to one who understands the relation of these units, in a similar manner to how a person who only owns one unit of a lock and key loses agency over physical space.

When Silas tries to explain one of the "elements" of his former life to his neighbour she is unable to understand him, as "experience gave her no key" (Eliot, *Marner* 138). Silas' system of weaving and computing undergoes total fragmentation when he is deprived of one of its components through the theft of his gold. This occurs when Silas uses his key as a part of a makeshift roasting-jack, one composed of "a string passed through a large door-key" (37). This key is similar to Silas in that it is isolated from a functional constellation of

interrelated units and forced to operate as a fragmented and decontextualised machine

part. Failing to maintain these interrelated units in contact, Silas leaves his front door

unlocked, placing him at the mercy of those who would aggressively reconfigure and

exploit his working environment.

Eliot compares the loss of Silas' gold to the forcing of a lock, a species of damage

that prevents this unit from again operating as part of a functional combination: "his heart

had been as a locked casket . . . but now the casket was empty, and the lock was broken"

(79). Although he does not provide specific textual evidence, critic Walter Francis Wright

claims that Eliot felt that a reduction in the division of labour was necessary, and that

workers should be capable of "shifting to a related type of labour" (1113-14). I would

suggest that the pathologies described in this chapter offer a rationale for Eliot's belief that

preventing excessive fragmentation of the labour process enables workers to adapt to

industrial change.

The final part of this chapter aims to show that Eliot represents the cognitive-

behavioural pathologies generated by Silas' pedagogical experiences as similar to those

generated by his proto-factory labour. Silas is a member of a religious fellowship, referred

to as "the church assembling in Lantern Yard" (Eliot, *Marner* 8). "[E]arly incorporated" into

this sect, it is here that Silas receives his elementary education (8). This section argues that

the pedagogy Silas receives at Lantern Yard corresponds to descriptions of mid-century

teaching methods:

> the pulpit where the minister delivered unquestioned doctrine, and
>
> swayed to and fro, and handled the book in a long-accustomed manner;
>
> the very pauses between the couplets of the hymn, as it was given out, and
>
> the recurrent swell of voices . . . these things had been the channel of
>
> divine influences to Marner . . . (14)

The way in which this "unquestioned doctrine" is delivered can be compared with the repetition of predetermined responses criticised by Ross and Richards, with multiple voices answering the minister in "recurrent" chorus. This pedagogy also corresponds to Winder's description of the "stupid" methods used in mid-century schools, where the teacher pronounces the word to "save trouble": "A weaver who finds hard words in his hymn-book knows nothing of abstractions" (14). The pronunciation of the words is provided for Silas by the congregation, and he therefore absorbs this "teaching" without actually understanding what he is reading: he is left "know[ing] nothing". Because Silas reads these "hard words" without understanding, they remain fragmentary and decontextualised.

These methods are depicted as habituating Silas to the organisation of cognitive-behavioural units by external authority:

> To people accustomed to reason about the forms in which their religious
> feeling has incorporated itself, it is difficult to enter into that simple,
> untaught state of mind in which the form and the feeling has never been
> severed by an act of reflection. (13)

Silas has not been taught the "reason[ing]" skills that would enable him to connect various units of knowledge. Paralleling Ferenczi's portrayal of the effects of cognitive-behavioural pathologies, this leaves Silas vulnerable to the imposition of inflexible structures ("forms") of behaviour. In an image that can be compared with White's description of pupils mechanically executing one "collocation" of letters, these "forms" generate a type of preprogramed action similar to that found in the Engine. These structures persist in the inflexible form in which they were taught, as Silas has no skills that would enable him to reconfigure their components. These cognitive-behavioural limitations cause Silas' cognitive-behavioural capacities to parallel the preprogramed routine of the Difference Engine, and by extension, the capacities required of the worker in *Economy.* The

description of Silas as "untaught" suggests that Eliot considered such pedagogies to hardly constitute an education at all.

As a result of these pedagogies the fragmentary knowledge imparted to Silas at Lantern Yard exists as an inflexible structure, epitomised by the monolithic "principles of the Church" (12). Their inflexibility can be compared with White's assertion that teaching methods led half-timers to insist upon one fixed "collocation" of units. Yet after Silas' faith in one of these principles is shattered, the drawing of lots as a means of judgment, he realises that this element of Lantern Yard practice cannot be questioned without experiencing the fragmentation of the whole: "if she did not believe the testimony against him, her whole faith must be upset as his was" (12). Because Silas lacks the habits necessary for flexible cognition and behaviour, any forcible alteration to an inflexible unit results in the total atomisation of the system. This suggests that Eliot in *Marner* depicts a model similar to that which characterises *Economy,* in which imparting knowledge as an inflexible structure generates pathologies of fragmentation and decontextualisation.

Eliot, like her contemporaries, implies that the purpose of these pedagogies was not cognitive-behavioural development but social control. It initially appears that the ordinary members of Lantern Yard possess a degree of agency: it is described as a place "where the poorest layman . . . has, at the very least, the weight of a silent voter in the government of his community" (8). I want to suggest that the "silent" vote of the "poorest" in *Marner* is meaningless because they lack habits that would enable them to disentangle themselves from externally imposed structures of control. It emerges that the Lantern Yard authorities do not tolerate deviation from prescribed "principles", preventing individual members from acting upon dictates of "reason" that are not "sanctioned by the feeling of the community" (10). Eliot depicts these pedagogies as literally preparing the ground for the structures of the factory system: when Silas returns some decades later to what has become a "great manufacturing town" (171), Lantern Yard has been replaced by a

"large factory" (173). Eliot, like her contemporaries, represents the factory system as an edifice built upon cognitive-behavioural pathologies.

This chapter has sought to explore correspondences between computing technology and the factory system portrayed in *Economy.* It has claimed that drawing parallels between computers and the factory system led Babbage to depict workers with cognitive-behavioural habits comparable to the psychopathologies that Ferenczi associated with incest trauma. This chapter has also focused upon contemporary sources relating to the operation of the half-time system in Lancashire and Yorkshire in the 1850s and 1860s, with the aim of exploring how cognitive-behavioural habits similar to those depicted in *Economy* are portrayed in mid-century depictions of factory pedagogies. This chapter has argued that Eliot engages with this body of mid-century representation in *Marner,* highlighting correspondences between factory pedagogies, cognitive-behavioural pathologies, and nineteenth-century computing technology.

The purpose of these first two chapters has been to highlight and explore a model that depicts cognitive-behavioural pathology in terms of fragmentation and inflexibility. This chapter has argued that this model was shaped in the nineteenth century by the computational architecture of the Difference Engine. The next chapter seeks to illustrate how a tradition of representing normative cognition as a flexible arrangement of inflexible units was given a specific computational expression as a result of a second computer designed by Babbage. Another key purpose of this chapter is to draw attention to a corresponding expression of this tradition in mid-twentieth-century attachment theory.

This chapter intends to show that, as a result of their basis in computational models, both the mid-nineteenth-century and mid-twentieth-century expressions of this tradition figure normative flexible behaviour as composed from states possessing correspondences with those found in incest trauma. I argue that these correspondences between pathological and normative states arose in the nineteenth century from

similarities between the Difference Engine and a second, more flexible computer designed by Babbage. This chapter seeks to demonstrate that this resulted in the narrative of normative cognitive-behavioural development that Babbage derived from the developmental trajectory of his mechanical computers retaining similarities with incestuous pathologies and pedagogies associated with nineteenth-century factories. I also hope to show that by considering the cultural implications of the computational expression of this tradition in the nineteenth century, it is possible to uncover similar pathological connotations in modern attachment theory. This movement between the second and third chapter therefore represents a transitional moment in my thesis, one in which correspondences between normative and pathological states are highlighted.

Teaching Children and Computers: Constructing Flexible Behaviour from Babbage to Bowlby

This chapter seeks to draw attention to similarities between computational models of mental processing in mid-twentieth-century cognitive science and attachment theory, and computational models of mental processing in the mid-nineteenth century. This chapter aims to show that these models are corresponding computational expressions of a tradition of depicting flexible cognition as a flexible arrangement of inflexible units. Another purpose of this comparison is to show that this computational model depicts flexible cognition and behaviour as constructed from states of inflexibility and fragmentation similar to those found in Ferenczian incest trauma. This is a transitional chapter that seeks to identify parallels between the pathologies of incest trauma and the factory system discussed in the first half of this thesis, and the normative structures of cognition and behaviour I now address in the second.

This chapter is characterised by a reverse chronological movement, with twentieth-century computing and cognitive science used as an interpretative framework for nineteenth-century models of computing, cognition and behaviour. This approach is controversial: historian Doron Swade cautions that "backward projection[s] from the modern computer age" are "fraught with the known historiographic hazards of anachronical interpretation" ("Construction" 70). Although I understand these concerns, I hope that this chapter will demonstrate that a comparison of mid-twentieth and mid-nineteenth-century computing can offer a rigorous means of comparing not only computational models, but also the cognitive-behavioural models that derive from them. This chapter aims to show that these correspondences can reveal previously overlooked aspects of both nineteenth- and twentieth-century thought.

This chapter begins with a discussion of concepts from mid-twentieth-century computing. It then proceeds to explore similarities between these computational concepts and the cognitive-behavioural model in *Plans and the Structure of Behaviour* (1960), a text written by the American cognitive scientists George Miller (1920-2012), Eugene Galanter (1924-) and Karl Pribram (1919-2015). A foundational text of cognitive science, *Plans* was instrumental in disseminating computational models of mental processing (Gardner 32; Migone and Liotti 1075). I argue that the model of cognitive-behavioural flexibility in this text parallels the computational model of flexibility as a flexible arrangement of inflexible units within modular hierarchies. This reading interprets *Plans* as a specifically computational expression of the tradition described in this thesis, in which flexible cognition and behaviour are constructed from states similar to those found in Ferenczian incest trauma. This interpretation of *Plans* is also intended to illustrate that pedagogies depicted in this text as normative share similarities with the incestuous pedagogies described in previous chapters.

The next part of the chapter seeks to trace correspondences between the model of computational complexity and flexibility found in mid-twentieth century computing and that found in Babbage's second computer, the Analytical Engine. This computer was intended as a general-purpose machine for arithmetical computation. The major design work for the Analytical Engine took place during the 1830s and 1840s, although Babbage continued to produce designs for this Engine until his death in 1871 (Bromley, "1838" 196). A trial portion of the Analytical Engine was assembled circa 1870, but a full-scale version was never constructed. This section aims to show that flexibility in the Analytical Engine consists of the flexible arrangement of inflexible units within modular hierarchies. This makes the architecture of flexibility in this computer similar to that found in mid-twentieth century computing.

I argue that the reason why computational flexibility is structured in this manner is that the architecture of the Analytical Engine evolved from that of the Difference Engine as an *inflexible* arrangement of inflexible units within modular hierarchies. It is my contention that establishing inflexible routines in the Difference Engine provided Babbage with the structural basis for subsequent computational flexibility. As far as I am aware, this is the first time that this understanding of the relationship between the Engines has been explicitly formulated. This interpretation of the architectural development of the Engines seeks to contribute to scholarship regarding their design evolution. Existing scholarship has primarily focused upon Babbage's insight that the Difference Engine could be made to function as a differential analyser by altering the arrangement of its columns, thus anticipating the increased capabilities of the Analytical Engine (Bromley, "Evolution" 120; Collier and MacLachlan 75-76).

The next part of the chapter is intended to show that the model of human cognition and behaviour that Babbage offers in *Passages from the Life of a Philosopher* (1864) is underwritten by specific principles of the Engines. It also seeks to claim that as a result of their basis in similar computational models, *Passages* and *Plans* represent corresponding computational expressions of the tradition depicted in this thesis. Despite the scholarly interest in *Passages* demonstrated by historians including James Essinger, Antony Hyman and Laura Snyder, large segments of this text have never been subjected to critical analysis, including the "sketch" I consider in this chapter. I want to show that that interpreting these understudied segments of *Passages* in conjunction with close attention to the technical detail of the Engines can offer new interpretations of how the structure of human cognition and behaviour is depicted in this text.

As discussed in the introduction to this thesis, several historians remain sceptical as to whether Babbage attached cognitive significance to his machines. Most Babbage historians acknowledge that he regarded his Engines as a substitute for certain cognitive processes,

particularly routinized calculation (Green, "Mechanical Model" 42; Kuskey 256). As Swade observes, "by exerting a physical force, you could for the first time achieve results that up to that point in history could only have been arrived at by mental effort" (*Difference Engine* 83). Claiming that the Engines are capable of replacing certain human mental processes, however, is not the same as asserting that Babbage understood the operation of his machines to correspond to human mental processing. Although a number of historians have argued for the latter, a perceived shortage of evidence from Babbage's own writings has given critics limited scope to assess how Babbage conceptualised the cognitive significance of the Engines.

William Ashworth, along with Snyder and Swade, cites Babbage's biographer Henry Wilmot Buxton, who observed that "the marvellous pulp and fibre of a brain had been substituted by brass and iron. He [Babbage] had taught wheelwork *to* think, or at least to do the office of thought" (qtd. Snyder 88; see also Ashworth 649; Swade *Difference Engine* 85). These historians interpret this as a claim for equivalence between human and machine processing, but Buxton's wording is far more equivocal than this, speaking in terms of "substitut[ion]" and the Engine performing the "*office* of thought". Similarly, historians Simon Schaffer and M. Norton Wise refer to phrases such as "the engine knows" and references to the "foresight" of the carry mechanisms as evidence that Babbage perceived similarities between the Engines and human mental processing (Schaffer, "Intelligence" 207; Wise 175). However, without additional substantiation, such phrasing has been dismissed as convenient descriptive shorthand (Cook 346; Green, "Mechanical Model" 42).

This chapter discusses the work of several historians who have offered suggestions as to various similarities that Babbage might have perceived between human and machine intelligence. In an elaboration of Schaffer's argument that Babbage saw machine intelligence as subject to formal rules, Harro Maas and Herbert Sussman conjecture that Babbage may have figured equivalence between human and machine processing in these

terms. As discussed below, historians have also considered parallels between the Engines and the symbol manipulation carried out by the mind in algebraic reasoning. Although the theories advanced by these historians are both intelligent and plausible, I would suggest that the absence of any sustained attempt to map technical features of the Engines onto material drawn from Babbage's own writings has made it difficult to assess their validity. This shortage of technical detail has also, on occasion, resulted in imprecise statements as to how relationships are foregrounded between the Engines and human mental processing. This chapter seeks to address these issues by explaining how specific features of the Engines correspond to the model of human cognition and behaviour in *Passages*.

I want to show that *Passages* not only contributes a computational model of human cognition and behaviour, but also a computational model of human development corresponding to the developmental trajectory of the Engines. I claim that because of architectural similarities between the Difference and Analytical Engines, normative flexible cognition and behaviour is depicted as encompassing states found in incest trauma. This interpretation of *Passages* forms the basis for my argument that the developmental model depicted in this text is comparable to that found in *Plans*. A further similarity with *Plans* is that the computational model of cognitive-behavioural development in *Passages* is also a pedagogical model. I wish to illustrate that architectural correspondences between the Engines generated parallels between the normative pedagogies of *Passages* and the incestuous pedagogies of *Economy.* As detailed in the introduction to this thesis, historian Tamara Ketabgian identifies a dual register of the psychically vital and psychically deadening machine in nineteenth-century culture. This chapter suggests that nineteenth-century computing resulted in these registers sharing fundamental similarities, considering for the first time these implications of Babbage's thinking.

This chapter concludes with a discussion of similarities between the model of human cognition and behaviour found in *Passages* and *Plans*, and that found in modern

attachment theory. A primary reason for my selection of *Plans* as an object of study is its influence upon the work of the British psychologist John Bowlby (1907-1990), who cited this text as an influence upon some of his most important theoretical work. I want to show that as a result of *Plans,* concepts deriving from mid-century computing can be traced in Bowlby's seminal text *Attachment* (1969) and subsequent theoretical volumes including *The Making and Breaking of Affectional Bonds* (1979) and *A Secure Base* (1988).[12] I offer this as an intervention into current scholarship concerning the history of psychoanalytical thought, as a detailed study of how the attachment model shares correspondences with models from mid-century computing.

Having argued that as a result of their basis in similar computational models the cognitive-behavioural model in *Passages* corresponds to that found in *Plans,* I claim that the model of flexible behaviour in attachment theory represents another comparable computational expression of the tradition described in this thesis. This chapter also argues that an additional reason for similarities in the expression of this tradition in *Passages, Plans* and attachment theory is the intersection of this computational model with pedagogical discourses. I hope to show that tracing these intersections can reveal correspondences between the normative pedagogies foregrounded by attachment theory and the incestuous pedagogies described in previous chapters. As well as seeking to contribute to existing historiographies of mental science and pedagogical theory, I wish to foreground these correspondences as a means of supporting the claim of attachment theory to be a historically sensitive framework with which to interpret nineteenth-century literature and culture.

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[12] Bowlby also published a revised edition of *Attachment* in 1982. All the material from *Attachment* referenced in this chapter, however, can be found in the 1969 edition.

Mid-Twentieth-Century Computing

This account of mid-century computing synthesises the work of several individuals whose influence upon *Plans* is cited by Miller, Galanter and Pribram: the British computer scientist Alan Turing (1912-1954), and the American computer scientists Marvin Minsky (1927-), Allen Newell (1927-1992), John Clifford Shaw (1922-1991), and Herbert A. Simon (1916-2001). Further to these sources, John Haugeland's *Artificial Intelligence: The Very Idea* (1985) provided me with an invaluable point of entry into the computer science of this period. By the mid-twentieth century the computer had been formalised as an *information processing system* (IPS). An IPS has properties that make it describable as an *automatic formal system.* This section aims to explain these statements and to discuss their implication for the type of flexibility achievable within computers.

An IPS is designed to interpret and operate upon "symbol tokens" (Newell and Simon 23). Symbol tokens are the discrete entities manipulated by the IPS, for instance, numerical or binary digits. There are two broad categories of symbol tokens: symbol tokens that are interpreted within the IPS as instructions, and symbol tokens that are interpreted as data. Each symbol token is identified by the formal rules acting upon it within a specific IPS. Newell and Simon state that if two symbol tokens are acted upon by the same rules, then they are of the same "symbol type" (31). There is no ambiguity in this designation: any properties of a symbol token that do not have a bearing upon the formal rules of the IPS are treated as irrelevant (29).[13] This ability to precisely identify symbol tokens is what makes computers digital (Haugeland 53).

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[13] These meanings may be relevant, however, to how the eventual output of the system is interpreted. Yet because an IPS is self-contained, any interpretation beyond that specified by the rules of the system is beyond its remit (Haugeland 50).

As Haugeland writes, an *automatic* formal system is one capable of operating upon symbol tokens without external intervention (76). An IPS has the ability to execute a finite set of elementary operations, each perfectly definite and simple enough to be automated using known mechanism (Newell and Simon 151, 29; Minsky 27). These inflexible operations are referred to as "elementary information processes" or "primitive process[es]"(Newell and Simon 20; Newell, Shaw and Simon 151). The ability to automate primitive processes allows an IPS to be automatic. Each primitive process must be specified by an inflexible "primitive instruction": "Symbols that designate elementary information processes, so that these eip's [*sic*] can be executed by means of these symbols" (Newell and Simon 25). An IPS must also possess a mechanism capable of bridging between primitive instructions and primitive processes. Newell and Simon call this mechanism an "interpreter" (37), whilst Turing terms it a "control mechanism" ("Computing Machinery" 437). This mechanism interprets the current instruction and then locates the next in the sequence: "it is the duty of the control to see that these instructions are obeyed correctly and in the right order" (Turing, "Computing Machinery" 437). A tripartite organisation thus emerges of primitive instructions, control mechanism, and primitive processes.

Newell and Simon write that "The entire behaviour of an IPS is compounded out of sequences of these elementary processes" (29). The simplest way to generate complexity is to have one primitive process follow directly after another. Because each corresponds to a primitive instruction, a chain of primitive processes requires a corresponding chain of primitive instructions. A chain of primitive instructions is formed by specifying their relationship to one another using the "the single relation next (with sometimes the inverse relation, prior)" (28). Newell and Simon refer to such chains as "list structures" (28). Joining sequences of primitive instructions using specified relationships generates an algorithm*,* a "recipe" with the potential to infallibly attain a specified outcome in a finite number of

steps (Haugeland 65). Its construction means that an algorithm possesses a "composite" or hierarchical structure (Newell and Simon 22).

Newell and Simon observe that "it might be thought that the possible variation in [the order of] elementary processes . . . would still be essentially unlimited. This proves not to be the case" (29). Legal combinations are circumscribed by "a set of rules . . . that describe sequences of eip's [*sic*] as a function of the informational context" (31). Because of this, computer science at mid-century focused upon "well-defined" fields such as chess and mathematics "in which the rules are defined with absolute clarity" (Minksy 9, 21). As Minsky observes, because the components of an algorithm are defined by their relationship to formal rules, they are a species of symbol token (25). The ability to designate relationships between symbol tokens according to formal rules is another feature of an automatic formal system (Haugeland 48). Combinations conforming to the rules of an IPS are referred to as "symbol structures" (Newell and Simon 21). Turing termed symbol structures designating instructions "instruction tables" ("Computing Machinery" 438), but the name given to them by Newell and Simon will be more familiar: programs (21).

The problem with list structures is that they cannot encompass contingencies. It is, however, possible to stipulate a rule that allows the machine to "branch" between two or more instructions when a specified contigency arises: for instance, if the symbol token arrived at is *x*, then execute instruction *A,* if the symbol token arrived at is *y*, then execute instruction *B* (Turing, "Heretical Theory" 437-38). This rule must be precisely stated: "The machine interprets whatever it is told in a quite definitive manner" (Turing, "Lecture" 392). Newell and Simon term this a "tree structure" (26), but I will use the more familiar "conditional branching".

Although he does not use either term, Turing identifies iterative loops as an use for conditional branching. He observes that a typical conditional branch of this type specifies that if a certain condition is attained, then the control should locate the next instruction,

but if it is not, then the current instruction should be repeated ("Lecture" 388-89). This allows a process to be repeated a number of times unknown to the human programmer at the time of composing the program. Branched programs share similarities with list structures that make them both describable as algorithms. They are hierarchically-structured routines for infallibly attaining a specified outcome within a finite number of steps, constrained by a "definite set of rules for combining processes into whole programs" (Newell, Shaw and Simon 151). The key difference, however, is that a branched algorithm achieves a degree of flexibility through the flexible arrangement of inflexible units.

Relationships specified between primitive instructions act as a form of "algorithmic glue" binding the component units of an algorithm together (Haugeland 70). This allows an entire algorithm- including any conditional branches it contains- to be treated as a discrete instruction within a more complex routine (Newell and Simon 28). It also enables an algorithm to be designated by a single symbol token at a higher hierarchical level: "hierarchical structures of lists may be built up, in which some lists contain symbols that name other lists" (28). Turing calls these "subsidiary tables" ("Lecture" 389), whilst Newell and Simon term them "subprograms" (37). A subprogram can function as a standardised component when constructing programs: Turing observes that routines are largely composed of instructions "taken off the shelf" ("Lecture" 390).

Specifying rule-determined relationships between sequences of subprograms joins them using the "algorithmic glue" used to join together primitive instructions: "As new symbol structures are stored . . . they are designated by symbols . . . These new names can, in turn, be embedded as symbols in other symbol structures" (Newell and Simon 792). From this it is possible to visualise the complexity that can be constructed. Sequences of subprograms can be treated as a single, discrete subprogram in a more complex instruction, and so forth (Newell and Simon 729; Haugeland 80). These units, once constructed, can also be specified as part of a conditional branch (Haugeland 74). The

architecture of computational flexibility therefore consists of the flexible arrangement of inflexible units at multiple levels within a hierarchical structure.

The emphasis at mid-century upon using computers to solve problems in fields such as mathematics, logic and chess made it imperative to find a means of allowing an IPS to make nondeterministic choices (Garnham 134). Problem solving in these sources is typically figured as a search through a space of potential solutions, with an important category of search identified as the search for the right sequence of primitive processes or subprograms to attain a desired outcome (Newell and Simon 82; Minsky 9): "the problem is clearly equivalent to that of finding a program" (Turing, "Intelligent Machinery" 430).

However, multiple sequences can be identified as legal responses to a specified contingency: the rules of an IPS can state "what sequences may legitimately be constructed, not what particular sequence should be constructed" (Newell, Shaw and Simon 159). The choice between routines is nondeterministic, but an algorithm must be deterministic. One way to resolve this difficulty is to trial all sequences consecutively, but as Minsky points out, this approach is usually uneconomical (9). There must be a means for the IPS to (a) generate routines as solutions and (b) select between solutions without needing to trial every possibility.

A property of programs that facilitates the generation of solutions is that as a species of symbol structure, programs can be generated and modified by other symbol structures, or programs: "If the IPS wishes . . . [to] construct or modify a program, then it must deal with the program as a symbol structure" (Newell and Simon 36). Newell and Simon observe that this ability to treat a symbol structure as data to be operated upon and as a program to be executed allows a program to compose or manipulate another program: "algorithms should exist for the component processes for selecting, evaluating and analysing operators" (192). Newell, Shaw and Simon term programs used to operate upon other programs "master routines" (153).

The difficulty of nondeterministic choice was solved by incorporating "rules of thumb" or general principles into master routines. Newell and Simon term these principles "methods" (91). Methods consist of precisely stated rules: "machines can be made to do any rule of thumb process by remembering suitable instructions" (Turing, "Lecture" 385). In a similar manner to branched or list structures, these deterministic methods can only operate upon symbol tokens within the rules governing a particular IPS (Newell and Simon 91-92). Another point of comparison with branched and list structure algorithms is that the flexibility afforded by these programs consists of the flexible ordering of inflexible subprograms or primitive processes. The crucial difference is that these programs cannot guarantee that a specified result *could* be achieved in a finite number of steps: "there must always remain some core of search, or 'trial and error'" (Minsky 9). Potentially fallible programs of this type are described as "heuristic" (Newell and Simon 116).

But are heuristic programs algorithms? The intuitive answer is no, as an algorithm is an *infallible* routine. However, if we define "specified result" as determining an optimal choice according to well-defined rules and within a specified time frame, then an IPS *is* able to do this infallibly: "the same inner system could be regarded from one point of view as performing an algorithmic calculation . . . and from another point of view as making somewhat clever (though fallible) heuristic decisions" (Haugeland 114). Like the majority of programs in an IPS, heuristic programs are generally provided by human programmers: "One must therefore not expect a machine to do a great deal of building up of instruction tables on its own" (Turing, "Lecture" 394). It was hypothesised, however, that by operating upon programs using preprogramed master routines, an IPS could modify its behaviour whilst remaining within the parameters of deterministic rules (393). Again, this consists of manipulating inflexible units (symbol tokens) at multiple levels within a hierarchical structure: this is *the* principle of flexiblity in computers.

Computational Models and *Plans and the Structure of Behaviour*

The purpose of this section is to show that the model of cognition and behaviour described by Miller, Galanter and Pribram corresponds to the structure of automatic formal systems. In *Plans,* the tripartite structure of instructions, control mechanism and executable behaviours found in an IPS is mapped straightforwardly onto human cognition and behaviour. Miller, Galanter and Pribram claim that each cognitive or behavioural action must have corresponding "instructions . . . that could guide the action described" (16). They term these instructions "Plans", capitalising to distinguish from ordinary usage (16). These Plans are explicitly compared with computer programs: "we are reasonably confident that 'program' could be substituted everywhere for 'Plan'" (16). The parallel of the control mechanism is envisaged as a feedback loop that interprets an instruction, confirms it has been executed, and then passes control to the next instruction (26-28): "This concept appears most frequently in the discussion of computing machines, where control of the machine's operations passes from one instruction to another" (28). This mechanism mediates between instructions and executable processes: "we shall say that a creature is executing a particular Plan when in fact that Plan is controlling the sequence of operations he is carrying out" (17).

Paralleling the structure of computational complexity in an IPS, cognitive-behavioural complexity is achieved by constructing hierarchies of "elementary unit[s]" (21). Miller, Galanter and Pribram describe the construction of a hierarchically-structured behaviour that they term *X.* This behaviour is represented at the lowest hierarchical level as the sequence of elementary behaviours *a, b, c, d*, and *e* (13)*.* These can be compared with the primitive processes in an IPS: "A Plan is . . . essentially the same as a program for a computer, especially if the program has the sort of hierarchical character described" (16). As historian Hunter Crowther-Heyck states, "To Miller, the most important feature of

Newell and Simon's program was that it combined the idea of feedback with the principle

of *hierarchical organisation*" (55, emphasis in original). In describing the structure of Plans I

follow the terminological conventions set out by Miller, Galanter and Pribram, in which the

component units of a Plan are termed subplans (96).

Miller, Galanter and Pribram also apply a computational logic to the construction of

hierarchically-structured Plans. Sequences of subplans are generated by specifying rules

for their combination, so that "complicated phenomena are then describable as lawful

compounds" (21). Crowther-Heyck writes that "he [Miller] saw the chunks of information

produced by recoding as symbolic representations formed, organised and related to one

another using a set of rules akin to a grammar- or a program" (53).

Considering the architecture of mid-century computing described above can reveal

the extent to which this logic is applied in *Plans.* An immediate similarity with computing is

that the simplest way to generate complexity is depicted as "*chaining* one activity to the

next" (Miller, Galanter and Pribram 84, emphasis in original). The inflexibility of a rule-

determined sequence is consolidated through repetition, inflexibility being defined as a

state in which "component parts . . . cannot be rearranged or reordered" (74). This is

figured in terms of skill acquisition: "skills are Plans . . . that have become relatively

inflexible" (82). In the above example, the subplans *a, b, c, d* and *e* are chained together as

two stable sequences, (*ab*) and (*cde*). Through repetition, these sequences are consolidated

as the inflexible units *A* and *B*. Although *a,b,c,d,e* continues to function as a description of

the Plan guiding behaviour *X,* (*A* =(*ab*)) **+** (*B* =(*cde*)) reveals much more about its structure

(13).

In a similar manner to how a sequence of primitive processes can operate as a

discrete, inflexible subprogram, an entire Plan can be treated as a discrete, inflexible

subplan in a more complex Plan: "The entire pattern . . . can then be represented in other

Plans as if it were a unitary, independent act" (89). Miller, Galanter and Pribram draw

parallels between this hierarchical structure and the work of Newell, Shaw and Simon: "Newell, Shaw and Simon have explicitly and systematically used the hierarchical structure of lists" (16). In a comparable manner to how complex programs are generated, they claim that "The same procedure of welding these new units together to form still larger skilled units may repeat at the higher level" (89). Cognitive-behavioural complexity in *Plans* emerges as "a hierarchy of behavioural units, each unit guided by its own Plan" (85).

Miller, Galanter and Pribram use this concept of welding together subplans to circumvent a fundamental difficulty that arises when using digital computers as a metaphor for human cognition and behaviour. When skill components are discrete and atomic, such as those involved in learning to type, there is no difficulty in drawing parallels between computing and human mental processing: Plans to type letters are welded into Plans for syllables, and Plans for syllables are welded into Plans for words, and so on (86). They admit, however, that "Probably most of the skills we have to acquire are much more fluid in their execution" (86).

Miller, Galanter and Pribram claim, however, that mastering an "analogue" skill allows it to be represented digitally: "Once the subplan is mastered . . . this program, which looks so continuous and apparently analogue at the lower levels in the hierarchy, is itself a relatively stable unit that can be represented by a single symbol at the higher levels" (90-91). The need for such ingenious solutions, however, suggests flaws in this comparison of computing and human cognitive-behavioural processing. These difficulties lead Miller, Galanter and Pribram to replicate the biases of mid-twentieth-century computing by concentrating upon cognitive-behavioural processing in well-defined fields such as chess, language and mathematics (155, 180-81,184-87).

Miller, Galanter and Pribram observe that "we must have Plans to operate upon Plans, as well as Plans that operate upon information to guide motor behaviour" (98). It would appear that these "metaplans" correspond to master routines (178): "They

[metaplans] not only permit the electronic computer to seem creative . . . they permit men to be creative" (178-79). A further comparison with computing is that Plan manipulation is figured as symbol manipulation: "In man we have a unique capacity for creating and manipulating symbols . . . it becomes possible for him to use language to rearrange the symbols and to form new Plans" (38). Several historians have observed that this concept of cognition as symbol manipulation was an important way in which the "computational metaphor" was expressed in the decades after 1960 (Gigerenzer and Goldstein 136; Kolers and Smythe 290-91).

Miller, Galanter and Pribram observe that it is unusual for an organism to construct an entirely new Plan (151). A more typical use of metaplans is to modify existing Plans (178, 155): "the major source of new Plans is old Plans. We change them around a little bit . . . but they are basically the same old Plans" (177). This can be compared with Turing's observation that standard components form the basis of most programs. It is far more economical- in terms of both time and (mental) storage- to use "rules of transformation, rather than rules of formation" (151): "Often it is a metaplan that is stored- a metaplan from which a large number of Plans can be generated" (178).

The previous section discussed a tendency in mid-century computing to conceptualise the search for a solution to a problem as the search for a program. Correspondingly, Miller, Galanter and Pribram claim that "the study of thinking can be reduced rather generally to the heuristic Plans people use for generating proposed solutions" (167). A means of generating and selecting Plans-as-solutions is therefore necessary: "In the more complex kind of problem-solving . . . we must have some way to generate alternative Plans and then to operate on them" (169). Miller, Galanter and Pribram write that we could attempt to generate every possible solution, and then proceed through them sequentially: "This is an algorithm, a systematic Plan for solving the problem"

(164). Like Minsky, however, they observe that this approach generally "take[s] too long, or cost[s] too much" (160).

Paralleling the use of heuristics in mid-century computing, the alternative is to use heuristic methods to generate and select between Plans-as-solutions (183). Heuristic metaplanning involves "a set of rules for generating moves" that are relevant to a certain goal (185). According to Miller, Galanter and Pribram, computing demonstrated that "heuristic rules of thumb can indeed be proposed as elements of a serious theory of thinking" (183). Their concept of a heuristic Plan corresponds to that of a heuristic program: "A heuristic Plan may be cheap and quick, but it will sometimes fail to produce the intended result" (160); "If the heuristic method is ambiguous, the program simply will not work" (183).

This allows Miller, Galanter and Pribram to absorb heuristic Plans into a cognitive-behavioural model that is algorithmic and deterministic in nature: "heuristic rules can be incorporated into completely deterministic programs" (186). Another comparison with mid-century computing is that this approach is facilitated by their choice of "well-defined" problem spaces (56, 155, 162-65, 180-81, 184-87). Miller, Galanter and Pribram use similar logic and examples to those found in mid-century computing in order to have their algorithmic cake and eat it heuristically, too. They are ultimately unable, however, to determine how this approach corresponds to the generality of human problem solving: "it is a challenging task to convert them [human heuristics] into explicit rules that can be programmed for a machine" (188).

The flexible modifications performed by metaplans, including heuristic metaplans, consist of altering the configuration of inflexible units within a Plan. Miller, Galanter and Pribram consider Plans to be inflexible when "the component parts of the Plan cannot be rearranged or reordered" (74). In contrast, a flexible Plan is one in which "the parts can be performed in any order" (74). Extrapolating from the computational correspondences

already identified in *Plans,* I would argue that this model of plan flexibility- one predicated upon the rearrangement of inflexible component "parts" within modular hierarchies- derives from computational models that enact flexibility in a similar manner.

I would therefore suggest that *Plans* represents an instance of a tradition of conceptualising flexible cognition and behaviour in terms of a flexible arrangement of inflexible units within modular hierarchies. I want to illustrate that the specific expression that computing gives this tradition in *Plans* foregrounds processes of *partial* fragmentation and *partial* inflexibility. A Plan must possess areas of inflexibility, as these are integral to its structure. At the very least, there must be inflexible subplans corresponding to the primitive instructions in an IPS. At the same time, the ability to modify Plans by decomposing and rearranging their constituent parts is essential.

This even extends to the fragmentation and reconfiguration of sequences that have become inflexible in their execution:

> Take a skilled typist who for years has triggered off a muscular pattern for writing *t,* then *h*, and finally *e* for whenever he wants to write "the". Offer him money to type a page with the word "the" always transcribed as "hte" . . . Probably he will not be able to do it . . . But one word of caution . . . habits are not completely resistant to change. Let him practice enough and he will build up the action unit needed to win your money. (89)

This principle of partial inflexibility and partial fragmentation obtains here, as some inflexible units ("letter habits") must remain intact to provide structure during these modifications. This example also suggests another feature of this partial inflexibility: sequences that are inflexible in their execution can be decomposed and reconfigured, but before the new sequence can be executed efficiently, it must have attained the status of an "inflexible" unit. Partial inflexibility here means inflexibility that is *total* yet *temporary.*

The total inflexibility necessary for flexible cognition and behaviour on this model can be compared with the pathological inflexibility which for Ferenczi characterised incest trauma. It is my contention that the influence of computing upon *Plans* resulted in a model of cognitive-behavioural flexibility predicated upon states of inflexibility and fragmentation similar to those found in Ferenczian incest trauma. In order to achieve flexibility Plans must be disaggregated to a greater or lesser extent, a process which corresponds to the traumatic separations of incest:

> A rule that most people seem to learn, probably when they are very young, is: When in the execution of a Plan it is discovered that an intended sub-plan is not relevant or is not feasible, the smallest possible substitutions of alternative tactical subplans are to be attempted first . . . if the person becomes planless rather suddenly, marked mood swings are apt to occur…
> (114)

Miller, Galanter and Pribram explain the distress caused by Plan fragmentation in terms of the affront it represents to an individual's self-image (116). Yet I would argue that there are similarities between the distress caused by the fragmentation of Plans and Ferenczi's description of the traumatic fragmentation caused by incest. It would therefore appear to be the case that the computational expression of this intellectual tradition in *Plans* foregrounds similarities between normative forms of cognition and behaviour and those associated with incest trauma.

I want to show that additional similarities between incest trauma and normative cognition and behaviour are revealed by tracing the relationship between pedagogical discourses and computational models in *Plans.* Miller, Galanter and Pribram state that "communicability is an extremely important property that a program- or a Plan- can have" (82). The reason communicability is so important is that "communicable Plans play the central role in our educational processes" (82). According to Miller, Galanter and Pribram,

we generally acquire Plans via "imitation or verbal instruction" (177): "we are continually executing Plans tediously mastered at school" (178). We also acquire the rules that determine our metaplanning by such pedagogical means: "Children acquire their store of heuristic methods by listening to verbal suggestions" (184). As substantiation for their pedagogical model Miller, Galanter and Pribram cite Minsky's description of the generation of non-preprogramed behaviours using deterministic programs: "verbal information provides the organism with 'a set of instructions for constructing . . . out of parts available there, a machine to perform a response of the desired kind'" (184).

Although these pedagogies are figured as normative, they share similarities with incestuous pedagogies in which inflexible cognitive-behavioural routines are imposed upon a child: historians Paul Kolers and William Smythe have claimed that computing led to learning being figured as "a matter of repeating or stamping in wholly identical routines" (306). The pedagogue not only provides the child with largely inflexible Plans, but also with the deterministic metaplans they will use to make relatively minor modifications to them. This suggests that just as flexible cognition and behaviour in *Plans* share correspondences with incest trauma, pedagogies figured in this text as normative can be compared with the incestuous pedagogies discussed in previous chapters.

Nineteenth-Century Computing: The Analytical Engine
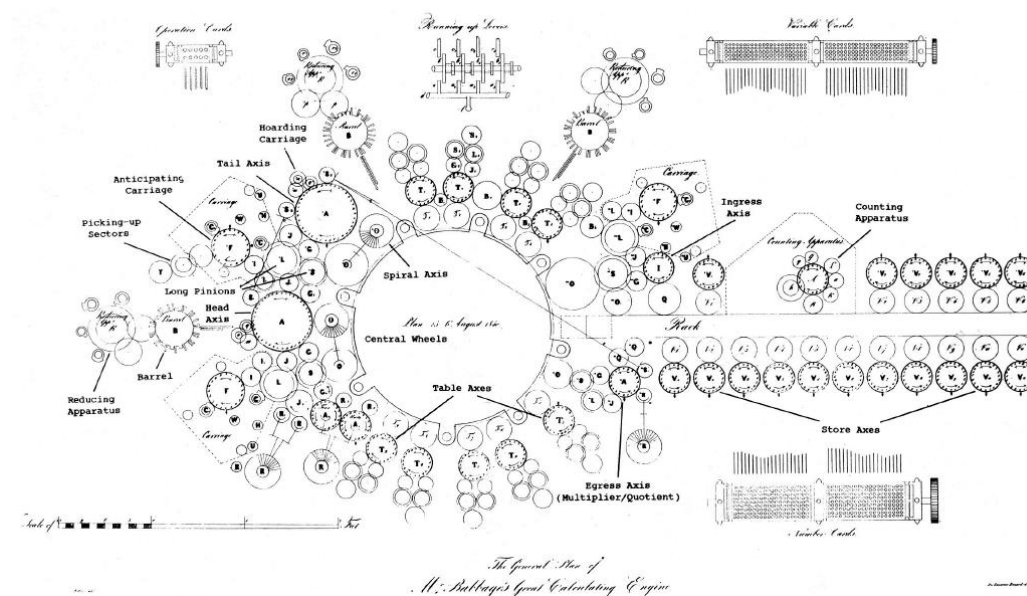
Fig. 5. *General Plan 25* of the Analytical Engine, with annotations by Allan Bromley.

Bromley, Allan G. "Charles Babbage's Analytical Engine, 1838" (*Annals of the History of Computing.* 4.3 (1982): 196-217. *IEEE* Xplore; Web; 26 April 2013). © IEEE 1982

This section focuses on parallels between the Analytical Engine and mid-twentieth century computing with the aim of using this comparison to reveal previously overlooked aspects of this machine. The description below is based upon the stable form of the design that emerged *circa* 1837-8: "later designs can be seen largely as refinements rather than new approaches" (Bromley, "Evolution" 134). Reflecting the concerns of this chapter, I focus upon programming and control in the Engine, rather than upon how arithmetical functions are executed in its central processing unit. My analysis of computational flexibility and complexity in this computer draws upon various modern and historical sources, including the description of the Analytical Engine Babbage produced in 1837, "On the Mathematical Powers of the Calculating Engine". As mentioned in the previous chapter, the mathematician and engineer Luigi Menabrea produced a description of this Engine in 1840. His article was subsequently translated by Ada Lovelace, who, in consultation with Babbage, produced extensive notes to accompany Menabrea's article when it was

published in the British journal *Scientific Memoirs* in 1843 (Toole 242). This account of the

architectural evolution of the Engines also draws upon the modern scholarship of Allan

Bromley, Subrata Dasgupta, Haugeland and Maurice Wilkes.

The Analytical Engine consists of two principle structures: the "mill" and the "store"

(Babbage, "Mathematical Powers" 17). The circular structure to the left of *General Plan 25*

(1840) is the mill where arithmetical operations (+ - x ÷) are executed upon signed

numerals (see fig. 5).[14] The linear structure to the right is the store where input data, partial

products and results are held (Babbage, "Mathematical Powers" 21). Swade identifies this

separation of mill (central processing unit) and store (memory) as similar to the

organisation of modern computers ("Construction" 70). On a more fundamental level,

however, the Analytical Engine is a computer in that it is an automatic formal system

capable of automatically manipulating symbol tokens according to stored procedural

instructions: Haugeland describes signed numerals as the "tokens" manipulated by the

Engine (127), whilst Dasgupta cites Lovelace's assertion that the Engine possessed "an

ability to 'combine together general symbols'" (21).

In developing the Analytical Engine Babbage was not transitioning from simple

"calculator" to sophisticated "computer", as several historians have suggested, but rather

from computer to more sophisticated computer (Swade, "Construction" 70; Wilkes,

"Expectations" 141). As illustrated in the previous chapter, the Difference Engine also

possesses this capacity to automatically operate upon symbol tokens (numerical data)

according to stored procedural instructions to generate output data from input data. This

capacity differentiates the Engines from all other nineteenth-century automata (Lovelace

252; Swade, *Difference Engine* 83).

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[14] Babbage proposed additional operations, including approximate multiplication and

division ("Mathematical Powers" 21). Focusing on the four principle operations, however,

streamlines this description.

Routines specifying the required sequence of arithmetical operations are provided to the Analytical Engine as a string of punched cards (Menabrea 223). As Essinger has observed, the use of punched cards was a technology derived from the Jacquard loom (47). The individual cards that comprise a card-string are known as "Operation cards", with each corresponding to an arithmetic operation (Babbage, *Passages* 118). The Engine can compute whatever is specified to it as a sequence of arithmetic operations for operating upon numerical data (Wilkes, "Calculating Machines" 56-57): as several historians have observed, the Analytical Engine is programmable (Bromley, "Interface" 5; Haugeland 126). Although Wilkes and Swade claim that Babbage had no general concept of programming (Wilkes, "Pioneer" 423; Swade, "Construction" 70), it is agreed that Babbage nevertheless implemented programming and microprogramming in his Engines (Bromley, "Interface" 5, 10; Haugeland 126). Although Babbage may not have explicitly defined these concepts, it would seem that he understood their fundamental principles. I therefore use the terms "program" and "programmer" here as convenient shorthand.

In order for the Engine to act upon the user-level program specified by the Operation cards, however, they must first be interpreted by a mechanism similar to control in a modern computer (Wilkes, "Pioneer" 421-22). Babbage in "Mathematical Powers" refers to control mechanisms as "the directive part" (49). He describes the card-string being draped over a hexagonal structure, or "prism", "situated in front of a number of levers" (23). The prism advances, pushing an Operation card against the levers. If there is a hole on the card at a particular position, then the opposite lever passes through undisturbed. If there is not, however, "then when the prism advances the lever opposite . . . will be pushed and any order given for which that lever was appointed" (23).

As well as being joined by strings, Operation cards are also joined using specified relationships. Babbage considered the use of additional holes on the Operation card itself and separate cards for the purpose of specifying the order in which Operation cards should

be read (Babbage, "Mathematical Powers" 21; Wilkes, "Pioneer" 424). This use of specified

relationships allows individual Operation cards to be linked as routines for arithmetical

computation, thus paralleling the architecture of modern programs. Another comparison

with modern programs is the manner in which these relationships between discrete

instructions are circumscribed by deterministic rules: the Engine "uses algebraic *signs*

according to their proper laws" (Lovelace 285, emphasis in original).

The patterning of depressed levers generated by an Operation card communicates

the interpreted instruction to a secondary control mechanism known as a "barrel", a

cylindrical structure upon which metal studs are screwed in vertical rows (see fig. 6). This

mechanism is identified by Bromley as a generalised version of that used to program the

Difference Engine ("Evolution" 117). Each row of studs forms a discrete instruction,

referred to as a "vertical" (Babbage, "Mathematical Powers" 19).
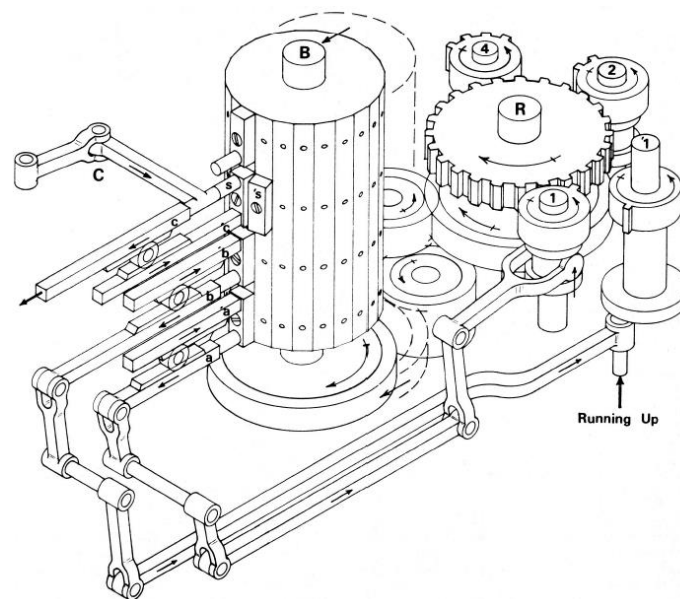
Fig. 6. Barrel and Reducing Apparatus. Bromley, Allan G. "Charles Babbage's Analytical

Engine, 1838" (*Annals of the History of Computing*; 4.3 (1982): 196-217. *IEEE Xplore*; Web;

26 April 2013). Note the rows of metal studs, or "verticals". Rotation of the barrel is

controlled by the "Reducing apparatus", marked *R*. © IEEE 1982

Bromley compares these verticals to modern subprograms ("Evolution" 124). Verticals are interpreted using a mechanism not dissimilar to that used to read Operation cards (Babbage, "Mathematical Powers" 19-20). The barrel advances horizontally, pressing a vertical against an array of levers (see fig. 6). Each stud either has a rod protruding from it, or it is blank (Bromley, "1838" 206). If there is a rod on a particular stud, the corresponding lever is depressed: "when the barrels advance horizontally these studs act on levers" (Babbage, "Mathematical Powers" 19).

An instruction designated by an Operation card only initiates a particular sequence of verticals. The verticals themselves subsequently control the progress of each operation: as Babbage observes, "The barrels . . . direct themselves to be turned to another vertical" (22). A stud in each vertical, acting through mechanical linkages and partially toothed gearwheels called "sectors", instructs a mechanism positioned below the barrel known as the "Reducing Apparatus" to rotate through a specified number of verticals: "It consists of six or eight sectors which can be made to act on the barrel and give it a rotary movement so as to make it pass over 1, 2, 3 or any required number of verticals" (22). The final vertical in the sequence requests the next instruction to be interpreted by the higher-level control mechanism (22). Sequences of subroutines are thus created using specified relationships: "Every vertical orders the transfer to the next" (Bromley, "1838" 206). This allows a sequence of verticals to be interpreted as a single instruction at the higher hierarchical level: "Babbage was clearly aware of the hierarchical nature of his machine" (Bromley, "Evolution" 129). A comparison with modern computing is that architectural complexity in this Engine is generated using specified relationships, a technique which allows the construction of units that can function as discrete and inflexible components within more complex routines.

If Operation cards and verticals share similarities with modern subprograms, then each stud can be regarded as similar to a primitive instruction. Each stud corresponds to an

elementary, inflexible unit of executable machine behaviour, paralleling the correspondences between primitive instruction and primitive process in a modern computer: "studs act on levers which cause various movements in the mill" (Babbage, "Mathematical Powers" 19). All computation in the Analytical Engine is ultimately expressed as a sequence of elementary behaviours: as Wilkes writes, Babbage understood that "What the designer of any general purpose computer must do is define a small closed set of fundamental operations . . . from which a program for solving any computational problem can be constructed" ("Expectations" 144).

In previous sections it was claimed that flexibility in mid-twentieth-century computing consists of the flexible arrangement of inflexible instructions. The purpose of the remainder of this section is to compare this model of computational flexibility to that found in the Analytical Engine. The Engine has various mechanisms that enable it to modify the arrangement of discrete instructions within a card-string. The simplest relationship that can be specified between cards in the Engine consists of turning to the *next* specified card in the card-string (or a *prior* specified card) (Babbage, "Mathematical Powers" 20-21). This generates a routine comparable to the list structures of modern computing. I would argue that such routines are similar in their architecture to the inflexible and sequential routine of the Difference Engine.

Menabrea observes, however, that the Analytical Engine also has the capacity to select between Operation cards in response to a specified contingency: "These new cards may follow the first, but only come into play contingently" (240). This *flexible* ordering of *inflexible* instructions corresponds to a conditional branch (Bromley, "Evolution" 124). Conditional branches between cards can be implemented using a mechanism known as a "registering-apparatus" (Menabrea 240). The number of repetitions of an Operation card required, n, is placed on the registering apparatus. The registering apparatus then subtracts 1 from n each time the card is read. When n reaches zero, an instruction is given for the

prism to be rotated in order to locate the next specified instruction in the card-string (240-41). Babbage suggested that additional flexibility could be achieved by using a value calculated by the Engine for n ("Mathematical Powers" 21). Another comparison with mid-twentieth-century computing is that conditional branches in the Engine are deterministic: Babbage describes cards to "direct the number and nature of those repetitions which are to be made" (21). This suggests that the architecture of computational flexibility in the Analytical Engine consists of the flexible arrangement of inflexible units within the parameters of specified rules.

Similar modifications can be made at the level of the verticals. The simplest movement of a barrel is from vertical to next specified vertical. This is comparable to a list structure, one embedded within the higher-level routine specified by the cards. Yet Babbage also included functionality for conditional branching between verticals. For instance, during the division operation the divisor is repeatedly subtracted from the dividend. If the divisor is subtracted once too often, then the value of the dividend will pass through 0. Babbage describes this in the "Mathematical Powers" article as "Running up" (40). The "running up lever" causes a thick metal wire to raise a sector to gear with the reducing apparatus (Babbage, "Mathematical Powers" 40; Bromley, "1838" 206-207) (see fig. 6). This causes the reducing apparatus to turn to a different vertical to the one that would have been read had Running up not occurred: it is "an order to move such verticals, that at the succeeding turns they should direct the erroneous subtraction" (Babbage, "Mathematical Powers" 41). In other words, the order in which verticals are read can be altered in response to a specified contingency. I would suggest that, once again, flexibility in this Engine consists of the flexible arrangement of discrete units that are treated as inflexible. The integrity of this model is preserved by making alterations to the sequence of verticals implicit within the higher-level instruction: the interpretation of an Operation card is not changed by any modifications to the order of verticals that might subsequently occur.

Modifications can also be made to the order of verticals using a mechanism called a "conditional arm" (Bromley, "1838" 207). When a specified contingency occurs, a conditional arm interposes between a stud and a lever (see fig. 6, where the conditional arm is marked **C**). Interposing the conditional arm effectively changes the symbol type of a stud, altering the structure of the vertical for a particular advance of the barrels (207). When pushing against the levers, however, a modified vertical is treated no differently from the inflexible constellation of a preprogramed vertical. Although during the transition between verticals changes to the structure of an instruction can occur, the moment it is read it is treated as inflexible. Behavioural flexibility at this hierarchical level consists of a movement from fixed state to fixed state, with the potential for partial decomposition and reconfiguration in the interim. On these grounds, I want to argue that computational flexibility in the Analytical Engine encompasses a movement between states of *partial* fragmentation and *partial* (*total* yet *temporary*) inflexibility similar to that found in mid-century computing.

Both Babbage and Lovelace saw the potential for routines to be manipulated to an extent far surpassing a conditional branch. Although the Analytical Engine is numerical in character, Babbage realised that it would be theoretically possible for a modified Engine to manipulate algebraic symbols (Belanger and Stein 89; Swade, *Difference Engine* 169): "the engine might act upon other things besides *number,* were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations" (Lovelace 248, emphasis in original). As historian Betty Toole has noted, Lovelace recognised that an Engine capable of manipulating arithmetical and algebraic symbols could write its own programs (246). It is my contention that this symbol manipulation would have consisted of the flexible arrangement of inflexible units according to deterministic rules: as Lovelace writes, the "relations" between symbols must be specified.

The high degree of inflexibility that underpins the Analytical Engine's flexible routines means that they share correspondences with the inflexible routine of the Difference Engine. In addition, both Engines also feature hierarchically structured, modular routines constructed from discrete units that are treated as inflexible. The crucial difference is that in the Analytical Engine, the configuration of these inflexible units can be modified to allow a degree of behavioural flexibility. These parallels suggest that establishing the architecture of behavioural inflexibility in the Difference Engine was vital in enabling Babbage to develop the architecture of computational complexity and flexibility in the Analytical.

Computational Models in *Passages from the Life of a Philosopher*

The purpose of this section is to show that *Passages* and *Plans* can be regarded as comparable computational expressions of the tradition discussed in this thesis. This section also seeks to illustrate that *Passages* offers a model of human cognitive-behavioural development predicated upon architectural similarities between the Difference and Analytical Engines. As far as I am aware, this is the first time that a computational model of human cognitive-behavioural development has been identified in the nineteenth century.

I will return to this discussion of developmental models in *Passages* in Chapter Four with the aim of continuing and broadening my analysis of developmental narratives in this text. This chapter, however, focuses on a section in *Passages* referred to as a "sketch" (52), in which Babbage embodies his Engines in a human child, an "inquisitive boy" (51). When we first encounter this child-Engine, it is possible to perceive that he is manipulating marbles, a discrete symbol token, using a set of procedural rules. He begins by placing five marbles in a line. He then places another two marbles under the second group, and in all

subsequent groups. He then places another three under the third group, and in all

subsequent groups, and so forth:

Fig. 7. Sequence of Marbles. Babbage, Charles. *Passages from the Life of a Philosopher*

(London, 1864; *Internet Archive*; Web; 26 August 2015; 51)

The child has discovered an inflexible routine for generating a series of triangular

structures: "commencing always one group later, and making the addition one marble

more each time" (51). Interpreting the child's behaviour in computational terms, an

interpretation that Babbage's representational strategy invites, this routine can be

regarded as similar to an algorithm composed of primitive instructions. On the basis of the

correspondences between Plans and programs described by Miller, Galanter and Pribram,

this routine can be interpreted as an inflexible Plan with the capacity to guide a

hierarchically-structured sequence of actions. With its computations at the lowest

hierarchical level consisting of inflexible sequences of primitive actions and instructions,

the Difference Engine can be regarded as the model for the computational sophistication

that the child displays during this Plan.

Babbage writes that the child "might also want to know how many marbles the

thirtieth or any other distant group might contain" (51). Babbage, inserting himself into the

sketch, provides the child with a deterministic Plan for generating triangular numbers, not

through the mechanical action of arranging marbles, but by manipulating numerical digits.

Babbage explains that "a Table of these numbers, representing the group of marbles, might

be constructed to any extent by mere addition" (53). Because "an inquisitive boy would

naturally count the numbers in each group", the child has already found the values he needs to begin differencing (51):

Number of the Group.	Table. Number of Marbles in each Group.	1st Difference. Difference between the number of Marbles in each Group and that in the next.	2nd Difference.
1	1	1	1
2	3	2	1
3	6	3	1
4	10	4	1
5	15	5	1
6	21	6	
7	28	7	

Fig. 8. Table of Differences for Triangular Numbers. Babbage, Charles. *Passages from the Life of a Philosopher* (London, 1864; *Internet Archive*; Web; 26 August 2015; 52).

To identify this Plan I will refer to it as the Plan for tabulation. As an inflexible Plan constructed from a chain of inflexible subplans, this Plan is similar to the marble-manipulating routine. By depicting the child executing this Plan, Babbage further emphasises correspondences between the cognitive-behavioural capacities of the child at this stage in its development and the inflexible program of the Difference Engine.

As several historians have noted, Babbage was fascinated with symbolic representation and manipulation, as demonstrated by the "Mechanical Notation" he devised for depicting the component parts of mechanism (Otis, 39; Hyman, 58). Ashworth has argued that Babbage sought to "condens[e] language and ideas into symbols", thus making mental processing comparable to algebraic analysis (629): "perception and discrimination were mechanical and were based on the operations of modern analysis" (649). To explain how this "mechanical" view of mental processing relates to the Engines, Ashworth quotes a section of *Passages* in which Babbage compares the operation of carriage mechanisms to "memory" and "foresight" (649). It is unclear, however, how this quote relates to algebraic analysis, especially as Ashworth does not provide any further explanation of this material.

Certain claims made by Lovelace have also led historians to focus on symbol manipulation as a means of drawing parallels between the Engines and human mental processing. Dasgupta writes that the Engine offered "a link . . . between the machinations of a material artefact and the kinds of symbol manipulations the mind carries out in mathematical reasoning", quoting Lovelace's assertion that "the punched-card mechanism imbues the Analytical Engine with an ability to 'combine together general symbols' of 'unlimited variety'" (21). In a similar vein, Maas claims that Lovelace "implied that the reasoning processes of minds and machines were organised by the very same science of operations that first came into existence with Babbage's Analytical Engine", citing Lovelace's claim that "when mathematical processes pass through the human brain instead of through the medium of inanimate mechanism, it were equally a necessity of things that the reasonings connected with *operations* should hold the same place as a clear and well-defined branch of the subject of analysis" (*Jevons* 111). Historian Dorothy Stein identifies this "science of operations" as the separation of operation cards from those designating numerical data, thus enabling the independent manipulation of arithmetic symbols (53). Stein does not go further, however, than observing that Lovelace attributed this "cognitive significance" (53).

I would suggest that the evidence offered by these historians does not offer conclusive proof that either Babbage or Lovelace saw the totality of mental processing as comparable to the type of symbol manipulation theoretically possible in computers. In these accounts, the comparison is only applicable to the operations that occur when "*mathematical processes* pass through the human brain". As Lovelace implies, however, algebraic analysis is amenable to computational representation as it involves the manipulation of discrete symbol tokens within the parameters of specified rules. I want to show that this manipulation of discrete symbol tokens is how Babbage applies this computational model to the generality of human mental processing.

The child begins by physically manipulating marbles as discrete symbol tokens whose combinations are determined by rule, and then proceeds to manipulate numerical digits in a comparable manner. This manipulation of numerical digits can be compared with the manipulation of discrete symbol tokens in the Difference Engine. It is my contention that Babbage in the sketch gestures towards the potential for this computational model to generalise across a range of cognitive-behavioural capabilities. Another feature of the manipulation of symbol tokens in the sketch that suggests a comparison with computational models is the manner in which these manipulations are guided by rules that are hierarchical and modular in character, paralleling the modular and hierarchical architecture of the Engines.

Another indication of similarities between the computational model in *Passages* and *Plans* are the corresponding biases that emerge in their accounts. These include a bias towards forms of cognition and behaviour amenable to representation in terms of symbol manipulation within well-defined fields such as formal games and arithmetic. Using a similar representational strategy to Miller, Galanter and Pribram, these examples allow Babbage to apply an analogue-to-digital converter to the child's cognitions and behaviours. By concentrating on the formal manipulation of marbles and numerical digits, Babbage shifts emphasis away from analogue processes such as the motion of the child's hands.

Babbage directs the child to square numbers as another sequence calculable using this inflexible Plan, asking that he "make for his own instruction, the series of their first and second differences (54-55). Babbage indicates that another point of comparison between this child and the Difference Engine is the ability to apply an inflexible Plan to different data sets. Babbage requests that the child apply this Plan to the square numbers independently. The child is assisted by the fact that the components of this Plan are chained using the relation *next*. Paralleling the execution of programs in the Difference Engine, executing this Plan is just a matter of cranking through an inflexible sequence of predetermined subplans.

The child-Engine is now not only operating as a formal system during arithmetical computations, but also as an *automatic* formal system. He can now perform an inflexible algorithm without external intervention, making his functioning similar to that of the Difference Engine.

The remainder of this section aims to illustrate that Babbage uses the architectural evolution of the Engines as the basis for a narrative of human cognitive-behavioural development. With the child-Engine functioning as an automatic formal system for arithmetical computation, Babbage helps him to devise a Plan to compute the number of cannonballs stacked in various pyramids (55). In a move that can be compared with the computational heuristics of *Plans*, Babbage frames the process of discovering a solution to this problem not only as a search, but as a search for a Plan: "Looking on the simplest form- the triangular pyramid- he will observe that it exactly represents his own heaps of marbles placed each successively above one another until the top of the pyramid contains only a single ball" (55). Babbage's reasoning can be represented diagrammatically:
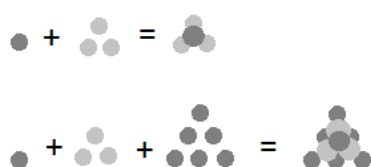
Fig. 9. Construction of triangular pyramids. Diagram by the author.

Another comparison with *Plans* is that problems in the sketch are figured as reducible to formal symbol manipulation similar to that found in computers. Babbage begins by manipulating the discrete symbol tokens of the data, breaking down the structure into its component forms and revealing triangular structures familiar to the child. This indicates that the pyramidal numbers might be calculated by a Plan corresponding to the Plan for

tabulation: Babbage refers to the pyramidal numbers as "The new series thus formed by the addition of his own [the child's] triangular numbers" (*Passages* 55).

Babbage represents the problem to the child in a manner that it can process within its computational capacities, a responsibility shared by the Engines' programmers (Babbage, "Mathematical Powers" 45). At this point in the sketch, Babbage continues to state problems in a form computable using the Plan for tabulation. He instructs the child to apply this Plan to the pyramidal numbers:

Number.	Table.	1st Difference.	2nd Difference.	3rd Difference.
1	1	3	3	1
2	4	6	4	1
3	10	10	5	1
4	20	15	6	
5	35	21		
6	56			

Fig. 10. Table of Differences for Pyramidal Numbers. Babbage, Charles. *Passages from the Life of a Philosopher* (London, 1864; *Internet Archive*; Web; 26 August 2015; 55).

Although the child is now able to execute inflexible Plans automatically and apply them to a range of contexts, he is not yet capable of manipulating their component subplans. Applying this Plan to the pyramidal numbers necessitates an additional column, but this does not represent cognitive-behavioural flexibility any more than it represents computational flexibility. The child at this stage in its development continues to offer a closer parallel with the Difference Engine than the Analytical.

By this point, however, Babbage has already referred to a second Plan that is presented as a sequence of deterministic steps. In this sense, this Plan is comparable to the Plan for tabulation. This inflexible Plan allows any value in the table of triangular numbers to be calculated without the need to calculate the entire series of previous values. For example, for the fifth group:

Take the number of the group   5

Add 1 to this number, it becomes   6

Multiply these numbers together   .   .   .   2)30

                                                     _____

Divide the product by 2   15

(Babbage, *Passages* 56)

This Plan can be compared with Wilkes' observation that algorithms for arithmetical computation must be specified to a computing machine as a sequence of arithmetical functions. Yet whereas the Plan for tabulation is constructed solely from a series of additions, this Plan also comprises multiplication and division. The introduction of these subroutines suggests that this is the routine that will enable the child to develop capacities corresponding to those of the Analytical Engine. For clarity, I will call this the Plan for direct calculation, as opposed to the Plan for tabulation.

Babbage asks the child to suggest a Plan to find the nth term of the pyramidal sequence: "a little consideration will lead him to a fair guess" (56). Babbage and the child search for a Plan to solve this problem by being "unsystematic-in a clever way" (Miller, Galanter and Pribram 160): by making a fair *guess*. Because the child in the sketch is both child and Engine, this not only offers an indication that Babbage had considered the use of heuristics in computing, but that he had also considered their applicability to human cognition and behaviour. This would appear to be another respect in which *Passages* is similar to *Plans.*

Babbage and the child begin with their existing heuristic metaplan, transferring the Plan for direct calculation to the new data. It is my contention that Babbage at this point in the sketch incorporates shared features of the Difference Engine and Analytical Engine into his developmental narrative. This technique of applying a deterministic routine to various

data sets is found in both Engines, even if its implementation is very different in each. The deterministic character of these examples also underscores the deterministic nature of algorithms in both Engines.

This transfer of a Plan to another set of data is given an additional degree of sophistication in *Passages,* as it is figured as a heuristic method of generating a Plan. Wilkes observes that the Analytical Engine was a tool of logical, mechanical and theoretical exploration, and this elaboration of its principles seems commensurate with this ("Pioneer" 428). As a Plan used to operate upon the discrete units comprising another Plan, Babbage's suggestions to the child can be compared with Lovelace's insight that a modified Engine could theoretically operate upon symbol tokens in order to generate its own routines. I have argued in this section that Babbage in *Passages* applies this concept to the modification and construction of cognitive-behavioural sequences in humans. The emergence of this comparison is currently dated to the mid-twentieth century (Gigerenzer and Goldstein 137; Kolers and Smythe 291-93).

By depicting techniques to extend the relevance of inflexible Plans, it is my contention that Babbage highlights correspondences between cognitive-behavioural flexibility and inflexibility. The cognitive-behavioural capacities associated with the Difference Engine in *Passages* are very different to those in *Economy,* with emphasis placed upon the independent and adaptive implementation of even inflexible Plans. With this initial heuristic metaplan, a more sophisticated understanding of cognitive-behavioural inflexibility begins to emerge.[15] Babbage and the child find, however, that simply

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[15] Babbage in the late 1840s designed an improved version of the Difference Engine, the "Difference Engine No.2" (Swade, "Construction" 70). This suggests that even after designing the Analytical Engine, Babbage still considered computational inflexibility- and by extension, behavioural inflexibility- to be valuable.

transferring the Plan will not provide the correct answer. An additional heuristic is needed to fit the Plan to the data.

Babbage suggests to the child that they might make the following alteration to the structure of the Plan:

Now let us make a *bold conjecture* respecting the Table of cannon balls, and try this rule: -

Take the number whose tabular number is

[*sic*] required, say   5

Add 1 to that number   6

Add 1 more to that number   7

————————

Multiply all three numbers together   .   .   2) 210

Divide by 2   105

(Babbage, *Passages* 56, emphasis added)

This example underscores the principle that cognitive-behavioural complexity is constructed using a hierarchical architecture of inflexible subplans similar to that found in computing, with large segments of the Plan for direct calculation treated as inflexible subplans within this modified Plan. The construction of cognitive-behavioural complexity in *Passages* once again corresponds to that found in *Plans.*

I want to suggest that the primary significance of this example for the child's cognitive-behavioural development, however, is its demonstration that inflexible subplans form the basis of not only cognitive-behavioural complexity but also of cognitive-behavioural flexibility. The inflexible subroutine "add 1 more to that number" is part of the original routine for direct calculation, and the modification the child makes to the routine consists of its repetition. This "bold conjecture" alters the configuration of subplans within a Plan for the first time. Marbles turn into cannonballs as Babbage assists the child in

making this structural change, with this image serving to highlight the partial fragmentation taking place within this routine. Unlike the Plan for tabulation or the original Plan for direct calculation, this modified Plan can now be termed flexible.

It has been claimed that the Analytical Engine possesses a similar capacity to repeat or reconfigure inflexible subroutines at a number of hierarchical levels. I would argue that Babbage imagined human cognitive-behavioural flexibility to be structured in a similar manner, making *Passages* and *Plans* corresponding computational expressions of the intellectual tradition described in this thesis.[16] The choice of modular, hierarchically-organised Plans as a basis for these flexible modifications also highlights correspondences with the inflexible routines performed by the child when it was functioning in a similar manner to a Difference Engine. I would suggest that this model of human cognitive-behavioural development derives from similarities between the modular hierarchies of inflexible units that characterise the architecture of the Difference Engine and the flexible arrangement of inflexible units within modular hierarchies found in the Analytical. This analysis of *Passages* aims to illustrate that Babbage not only used his computing machines to formulate a model of cognition and behaviour, but also as the basis for a model of cognitive-behavioural development.

Another comparison with the Analytical Engine is that flexible modifications to Plans are delimited by deterministic instructions. Although the child performs these modifications as part of an ostensibly nondeterministic "fair *guess*", Babbage intensively structures this heuristic process by signalling to the child the particular modifications that

---

[16] Schaffer has described how the Mechanical Notation allowed Babbage to envisage the combination of machine parts within the Engines ("Intelligence" 210). This model of the combination of discrete units is, however, very different from the one foregrounded in this thesis, which seeks to explain how the architecture of Babbage's computers resulted in a model of human cognitive-behavioural flexibility as a flexible arrangement of inflexible units at multiple levels within modular hierarchies.

should be made to a specific Plan. The sketch elaborates upon principles derived from the

Analytical Engine by indicating how the nondeterministic choices crucial to cognitive-

behavioural flexibility could theoretically be regulated by deterministic Plans. This mode of

representing nondeterministic choice as governed by deterministic rules can be regarded

as another point of comparison between *Passages* and *Plans.* Historian Laura Otis claims

that Babbage believed that the rule-bound nature of the Engines disqualified them from

replicating "the more versatile human brain" (32; see also Bullock 31). In contrast, it is my

contention that *Passages* illustrates that Babbage understood how heuristic reasoning

could be represented using deterministic rules theoretically capable of being programmed

in a computer.

Schaffer observes that the Difference Engine can calculate rule-bound series in

which there are apparently arbitrary "leaps" between values: "To the observer, each

discontinuity would seem like a 'miracle' . . . Yet in fact the manager of the system would

have given it foresight" ("Intelligence" 226). According to Maas, Babbage saw this as

demonstrating how free will and consciousness could be subject to mechanistic rules

("Mechanical Rationality" 592-93). Although Maas cites a specific feature of the Difference

Engine, the subsequent comparisons he formulates with consciousness and "freedom of

the will" are far less specific (593). Maas also cites the Analytical Engine's ability to

anticipate if a carry will take place, claiming that this for Lovelace "qualified Menabrea's

assertion that the Analytical Engine would only be able to execute mechanically prescribed

rules" (595). He does not specify, however, whether this statement is intended to

foreground a more sophisticated concept of rule-bound behaviour, or whether it is

intended to show that the Engine could transcend rule-bound functioning altogether.

Historian Herbert Sussman claims that Lovelace saw both minds and machines as

operating "according to a set of laws or algorithms" (46), citing her description of the

Engine's capacity "translat[e] the operations which may be indicated to it" (qtd. Sussman

46). I would argue, however, that this does not offer conclusive proof that either Lovelace or Babbage understood the Engine to replicate human mental processing. This section has sought to demonstrate that Babbage saw correspondences between rule-bound behaviour in computers and human cognitive-behavioural processing by highlighting the specific expression of this concept in his writings.

A final point illustrated by the sketch is that this principle of constructing flexible behaviour as a flexible arrangement of inflexible units has the potential to repeat at multiple levels within a hierarchically organised Plan. The child finds that the modified Plan still does not arrive at the correct solution: "The real number in the fifth pyramid is 35. But the number 105 at which we have arrived is three times as great" (Babbage, *Passages* 56). Because this metaplan is heuristic, it is therefore fallible. Babbage instructs the child that an additional subplan derived from the original Plan for direct calculation-division- should be added to the modified Plan: "If, therefore . . . we had divided by 2 and also by 3, we should have arrived at a true result" (56).

Although it is designated by a discrete instruction, Babbage indicates that this division step is composed of repeated subtractions. Babbage learns from the Plan for tabulation that the number in the fifth pyramid is 35. He compares the two numbers and ascertains that 35 can be subtracted from 105 three times (56). The subsequent inflexibility of this sequence of primitive instructions (subtractions) allows it to be designated as a discrete instruction (division), and for this composite subplan to form part of a flexible Plan. It would appear that cognitive-behavioural flexibility and complexity is again portrayed as a hierarchical arrangement of inflexible instructions similar to those found in the Analytical Engine, with Babbage transposing the concept of welding together units using "algorithmic glue" to human mental processing. The application of these computational principles to cognition and behaviour represents a further point of correspondence between *Passages* and *Plans.*

It is not only subplans, however, that are treated as inflexible. Although it has been modified, the entire Plan for direct calculation is treated as inflexible as it is executed. This movement between states of *total* yet *temporary* inflexibility, through states of *partial* fragmentation and reconfiguration, is fundamental to behavioural flexibility in the Analytical Engine. I would argue that the specific expression in *Passages* of a tradition of conceptualising cognitive-behavioural flexibility as a flexible arrangement of inflexible units parallels the structures of computational flexibility in the Analytical Engine.

Although the child now has the ability to construct and modify Plans, the decision to begin with an existing routine indicates that the easiest method of generating new Plans is by modifying the arrangement of component units within existing Plans. Paralleling the use of metaplans in *Plans,* rules of transformation are more frequently employed than rules of formation. The child therefore follows a similar developmental pathway to the Engines: inflexible routines corresponding to those associated with the Difference Engine persist to provide the structural foundation of the child's subsequent cognitive-behavioural flexibility. The next section explores how correspondences between the Engines engendered a model of normative pedagogy that shares similarities with the incestuous pedagogies of the nineteenth-century factory.

Passages and Incestuous Pedagogies

Babbage in the sketch portrays himself providing intensive pedagogical support to the child-Engine by furnishing both Plans and metaplans. Babbage also describes himself as "teaching" the Analytical Engine to perform different tasks, indicating that he perceived similarities between the roles of pedagogue and programmer (114). This section proposes that Babbage's comprehension of how pedagogy supports the development of flexible cognition and behaviour evolved alongside his understanding of what mechanisms and

techniques could be used to achieve behavioural flexibility in the Analytical Engine. A similar trajectory is visible in *Plans,* where human learning is compared with machine learning: "If we want to develop a self-programming automaton, maybe we should let it learn the way we do" (Miller, Galanter and Pribram 184).

It is my contention that Babbage's attitude to machine and human behaviour underwent a transformation between 1834 and 1864. The previous chapter argued that, as a result of the influence of the Difference Engine, Babbage in *Economy* portrays children as requiring disciplinary strategies in order to regularise their actions. Chaos is opposed to order, the latter being viewed as synonymous with behavioural inflexibility. This chapter has suggested that, a result of developments in his thinking regarding computing machines, by 1864 Babbage no longer saw chaos opposing itself to inflexibility in a simple binary. Instead, correspondences between behavioural flexibility and inflexibility are depicted as the foundation of adaptive behaviour in both humans and machines.

The child in *Passages* begins the process of attaining flexible cognition and behaviour by establishing a degree of cognitive-behavioural inflexibility that, if left undeveloped, would prove similar to that which Ferenczi associated with incest trauma. When the child does achieve flexibility, it is through utilising states of *partial* fragmentation and *total* inflexibility comparable to the *total* fragmentation and *total* inflexibility that characterises incest trauma on this model. I therefore wish to argue that, as a result of the architectural evolution of the Engines, normative pedagogies in *Passages* share similarities with the incestuous pedagogies of *Economy*. The computational metaphor in *Passages* generates a pedagogical model predicated upon "stamping in" largely inflexible routines, making the depiction of pedagogy in this text similar to that found in *Plans.*

In addition, the child in *Passages* is taught how to effect flexible behaviour as a movement from fixed state to fixed state, with partial decomposition and reconfiguration possible in the interim. If we represent *total* inflexibility and *total* fragmentation as

pathological extremes, then computing produces a model in which similarities exist

between states found in normative and pathological cognition and behaviour. This chapter

has argued that these correspondences also characterise *Plans* as a result of similar

computational models*.* This is a challenging model, as it invites us to consider similarities

between pathological states caused by incest trauma and normative flexible behaviour, and

between normative pedagogies and the sufferings of children in nineteenth-century

factories.

Attachment Theory and Computing: Nineteenth-Century Parallels

Although psychologists Peter Fonagy and Mary Target have described Bowlbian attachment

theory as predicated upon a "metaphor of the mind as an information-processing

mechanism", no detailed reading of Bowlby's work in relation to *Plans* or specific features

of mid-century computing yet exists (421). This final section seeks to address this gap in the

literature. Having situated *Plans* and *Passages* as corresponding computational expressions

of the tradition described in this thesis*,* I hope to show that a computational model similar

to that foregrounded by Babbage structures attachment theory as a result of the influence

of *Plans*. As far as I am aware, this is the first time that parallels have been suggested

between attachment theory and a computational model of mental processing in the

nineteenth century.

Bowlby defines attachment behaviour as that which results "in a person attaining

or retaining proximity to some other differentiated or preferred individual" (*Making and

Breaking* 154). Bowlby claimed that attachment behaviour evolved as a means of securing

proximity to those able to nurture and protect (*Attachment* 227; Chisholm 3). From the late

1960s Bowlby depicted attachment behaviour as hierarchically organised as a result of the

influence of *Plans*:

> The great merit of the contribution of Miller, Galanter and Pribram is that
> they have shown how some of the most complex and flexible sequences of
> behaviour could in principle be organised by means of a hierarchy of
> systems… (*Attachment* 77)

In an image that can be compared with the architecture of an IPS, Bowlby uses a military metaphor to illustrate that a hierarchically-structured behaviour is guided by a corresponding hierarchy of instructions: "in a hierarchical system . . . each plan and sub-plan is to be regarded as a set of instructions for action" (*Attachment* 78). He imagines a commander outlining a plan to achieve an objective. Each subordinate down the hierarchy is then "expected to make more detailed plans" (78). This elaboration of the plan proceeds until instructions are finally communicated to those executing the operation (78).

At this lowest level, attachment behaviour corresponds to the primitive instructions and operations found in computing:

> each of the sub-plans in turn being made up of a number of sub-sub-plans,
> and so on right down to miniscule plans (or, more probably, systems of
> simpler type) that control the most elementary units of behaviour. (78)

As Fonagy and Target have observed, the information-processing model conceptualises mind in terms of "distinct and divisible systems" (423).

According to Bowlby, the hierarchically-structured instructions guiding behaviour must be mediated by "a regulating apparatus" (*Attachment* 42). It is possible to perceive that this "regulating apparatus" is similar to the control mechanism in an IPS. The attachment system thus corresponds to the tripartite structure of instructions, executed behaviour and interpreted instruction found in both mid-nineteenth- and mid-twentieth-century computing.

Bowlby in *Attachment* writes that "the simplest method of organising behaviour . . . is by means of a chain" (75). Paralleling the limitations of list structures, Bowlby observes

that these "simple chains" cannot encompass contingencies: "the whole organisation fails in its purpose if one link in the chain miscarries" (76). The solution is to use conditional branching, making the model of cognitive-behavioural flexibility in attachment theory similar to the model of computational flexibility in mid-twentieth-century computing:

> There are, however, ways by which a chain-linked organisation of behavioural systems can be made more flexible . . . at any point in a chain it can have one or more alternative links so that, whenever activation of the first of a set of alternative behavioural systems fails to achieve results . . . one of the other systems of the set becomes active. (76)

According to Bowlby, "any particular link in a chain can be a behavioural system of any degree of complexity" (76). In other words "chains", which may or may not include conditional branches, are eventually incorporated as discrete components within a hierarchically-structured Plan. Complex attachment behaviour is therefore a "structure made up of a hierarchy of subordinate structures" (77). Inge Bretherton has observed that the work of Miller, Galanter and Pribram led Bowlby to foreground "behavioural systems organised as plan hierarchies", but does not mention the influence of computing upon this model (766). This section aims to reveal the extent to which computing informs the Bowlbian attachment system through detailed study of mid-century computing.

A further comparison with computing is that Bowlby foregrounds a model of cognitive-behavioural flexibility as a flexible arrangement of "subordinate structures":

> The whole [behavioural] sequence is conceived as a master plan . . . the master plan itself being made up of a number of sub-Plans . . . and each of the sub-plans in turn being made up of sub-sub-sub-plans, and so on . . . the complete master plan must be executed, but the sub-plans and other subordinate systems that go to make it up, can, within limits, be varied. (*Attachment* 78)

Cognitive-behavioural flexibility is equated here with a capacity to reconfigure inflexible subplans at various hierarchical levels within a modular Plan. I would therefore argue that Bowlbian attachment theory after 1969 can be interpreted as a computational expression of the tradition described in this thesis: Bowlby observed that *Plans* had demonstrated how "flexible sequences of behaviour could in principle be organised by means of a *hierarchy of systems*". The model described by attachment theory therefore corresponds to the cognitive-behavioural model depicted in *Passages.*

It is my contention that attachment theory also shares with *Passages* and *Plans* the specific computational expression of this tradition as a movement between states of partial inflexibility and partial fragmentation. Paralleling the computational model in *Passages* and *Plans*, significant areas of inflexibility remain to structure modifications made to attachment Plans: "Usually they [changes] are completed but only slowly" (*Attachment* 82). In addition, the inflexibility of attachment Plans can be temporary. Bowlby claims that although "patterns, once formed, are apt to persist, this is by no means necessarily so . . . if the parent treats the child differently the pattern will change" (*Secure Base* 127).

A further comparison with *Passages* and *Plans* is the heuristic quality that Bowlby attributes to attachment planning. He writes that "many of the mental processes of which we are most keenly conscious" involve "making a novel plan" (*Attachment* 82). This planning is heuristic and therefore *fallible:* it involves "considered (though not necessarily well-judged) planning of behaviour" (117). In a move that can be compared with the depiction of heuristics in *Passages* and *Plans,* a key heuristic method is to transfer an existing Plan, making minor modifications to tailor it to a specific individual: "the pattern becomes increasingly a property of the child himself, which means that he tends to impose it, or some derivative of it, upon new relationships" (Bowlby, *Secure Base* 127). This is similar to how an IPS makes minor adjustments to fit a program to a given data set.

It has been previously argued in this chapter that the prevalence of inflexible routines in the Engines led to similarly high levels of cognitive-behavioural inflexibility being depicted in *Passages.* This nineteenth-century context offers an indication of how the correspondingly high levels of inflexibility in mid-twentieth-century computing were paralleled in attachment theory. The developmental narrative foregrounded by attachment theory after 1969 is therefore similar to the narrative of cognitive-behavioural development that Babbage extrapolated from correspondences between his Engines: the child begins by establishing attachment behaviour as inflexible "chain" or list structures, with these inflexible routines forming the basis of subsequent behavioural flexibility within "plan hierarchies".

The extent of the similarity between pathological and normative states on this model is indicated by the fact that this model associates attachment pathologies and inflexible Plans. Imposing inflexible attachment Plans is described by Bowlby as engendering "inappropriate actions" and "conflict" (*Making and Breaking* 168):

> The psychological state may be likened to a computer that, once programmed, produces its results automatically . . . should an error have crept in, however, its correction not only demands skilled attention but may prove troublesome and slow to achieve. (Bowlby, *Loss* 55)

At the same time, normative attachment planning encompasses "imposing" a largely inflexible structure. I would argue that these correspondences between normative and pathological states derive from the computational foundations of *Plans.* This chapter has identified a comparable dynamic in *Passages,* one that results in similarities between the model of flexible cognition and behaviour depicted in this text and the cognitive-behavioural pathologies of *Economy*. It would therefore appear to be the case that the model of normative cognition and behaviour foregrounded by attachment theory shares similarities with cognitive-behavioural pathologies attributed to nineteenth-century

factories. It is one of the aims of this thesis to show that comparisons with nineteenth-century thinking can uncover troubling implications of the attachment model.

Comparing attachment theory with the pedagogical narratives of *Passages* and *Plans* also suggests correspondences between normative and incestuous attachment pedagogies. Although Bowlby believed some rudimentary attachment behaviours- for instance, smiling- to be innate, he claimed that most attachment Plans were learnt (*Making and Breaking* 51):

> The processes by which such attitudes and forms of behaviour are acquired are presumably those of observational learning and thus no different to those by which other complex forms of behaviour, including useful skill, are acquired. (167)

In both *Passages* and *Plans,* obtaining Plans from pedagogues forms a major component of learning. Similarly, Bowlby observes that we learn attachment Plans from caregivers (*Separation* 418): *"*much that is learned derives from imitating what mother does*"* (*Attachment* 225).

These largely inflexible Plans determine the structure of the child's subsequent attachment behaviour: "once a sequence of behaviour has become organised, it tends to persist . . . The precise form that any particular piece of behaviour takes and the sequence within which it is first organised are thus of the greatest consequence for its future" (*Attachment* 160). This suggests that a result of its computational underpinnings, there is a tendency in attachment theory to represent learning as a "stamping in" of largely inflexible routines*.* On this basis, the normative pedagogies of attachment theory can be regarded as comparable to the incestuous pedagogies of the factory system in *Economy.*

A further similarity with the incestuous pedagogies of *Economy* is the fact that the Bowlbian pedagogue not only provides largely inflexible Plans, but also the heuristic rules that determine their combination. As Fonagy and Target state, the computer metaphor

"assume[s] that cognitive processes are rule-based manipulations of symbols" (421).

Similarly, when formulating an attachment Plan, the child utilises rules learnt from

caregivers in a largely inflexible manner: they are "not unlikely to adopt some, at least, of

the methods she herself employs" (Bowlby, *Attachment* 356). This makes these pedagogies

similar to those described in mid-nineteenth-century accounts of the factory system.

This chapter has sought to show that comparable computational expressions of a

tradition of representing cognitive-behavioural flexibility as a flexible arrangement of

inflexible units emerged in the mid-twentieth and mid-nineteenth century. It is my

contention that correspondences between these models can form the basis of a historically

sensitive application of attachment theory to nineteenth-century literature and culture.

The next chapter seeks to offer a further illustration of this by comparing nineteenth-

century depictions of learning through play and those of recent attachment theory.

The Child-Machine at Play: Play, Child Development and Computational Models in

Babbage, Eliot, Turing and Attachment Theory

In his critique of Victorian attitudes to play, *The World in Play: Portraits of a Victorian Concept* (2011)*,* historian Matthew Kaiser identifies a logic that he terms "play as paideia": "At its core is the sentimental notion, a truism today, that play is intrinsically productive and normative, that children and young animals, in particular, learn, adapt, and develop through life-enabling play" (30). Kaiser claims that the "Victorians adored this logic" (30). Kaiser's logic of "play as paideia" is similar to the "rhetoric of play as progress" described by play theorist Brian Sutton-Smith (9-10): *"*The main concern is to show that increases in the complexity of play-skill- physical, mental, imaginative or social- lead to increases in some parallel kind of human growth or adaptation" (18). Sutton-Smith, however*,* identifies this rhetoric in child development literature from the mid-twentieth century onwards.

A logic almost exclusively applied to children, this understanding of play as progress has exerted considerable influence upon recent theories of child development (Sutton-Smith 9-10; D. Cohen 1-2). As *paideia* has been used to refer to a range of concepts within play theory, I will use Sutton-Smith's "play as progress" rather than Kaiser's "play as paideia" in this chapter. The previous chapter sought to illustrate how, in the mid-nineteenth and mid-twentieth centuries, computing technology provided a conceptual framework with which to represent cognitive-behavioural flexibility as a flexible arrangement of inflexible units. This final chapter aims to show that computing also lent support to the belief that play is necessary in order to develop the type of cognitive-behavioural flexibility that this model foregrounds.

This chapter seeks to illustrate that allowing computers to play in the mid-nineteenth and mid-twentieth centuries helped to establish a dominant logic of play as progress. This chapter also aims to trace how computing shaped perceptions of the specific

developmental patterns enabled by play. The mid-nineteenth century, however, was not the first period in which play was regarded as developmentally significant. Play occupied a central place in the pedagogical thought of the late eighteenth century, particularly in the work of Friedrich Froebel (1782-1852), Maria Edgeworth (1768-1849) and Jean-Jacques Rousseau (1712- 1778). This chapter contends that from the mid-nineteenth century onwards an established logic of play as progress was reshaped by new technologies, resulting in the organic metaphors of Froebel's "child-garden" being substituted for a computational model.

Like the previous chapter, this chapter is characterised by a reverse chronological movement. I hope to illustrate that this is another instance in which this interpretative framework can reveal previously overlooked aspects of both nineteenth- and twentieth-century thinking. This chapter begins with an exploration of the significance of play for the theories of machine learning advanced by the British computer scientist Alan Turing (1912-1954). Although numerous computer scientists and historians including Cristiano Castelfranchi, Susan Sterrett and Elizabeth Wilson have provided extensive discussion of a range of concepts and issues associated with Turing's theories of machine intelligence, the pedagogical significance of play in his work has not yet been discussed. There have also been claims that Turing "wasn't seriously . . . us[ing] AI programs to clarify and develop specific psychological theories" (Boden 180).

The next part of the chapter is designed to show that Turing's thinking on the relationship between machine and human learning has shaped the attachment understanding of how play facilitates the development of cognitive-behavioural flexibility. Rather than focusing on the work of a particular individual working in the field of attachment theory, this chapter instead examines a strand of recent attachment thinking that identifies play as a crucial factor in the development of cognitive-behavioural flexibility. This is, as far as I am aware, the first time that these correspondences between

Turing's work and attachment theory have been identified. This chapter seeks to contribute to the historicization of attachment theory by revealing the role of computing in shaping the attachment logic of play as progress.

The second half of this chapter explores similarities between computing technology, attachment theory, and a computational logic of play as progress in the nineteenth century. During the mid-nineteenth century Babbage utilised the Engines as the conceptual basis for a game-playing machine that he named "Automaton". I want to show that Babbage's description of Automaton can be compared with Turing's theories regarding the significance of play for human and machine intelligence. Several historians have discussed Babbage's work as an antecedent of modern computer chess, including George Atkinson and Alex Bell. Historian Devin Monnens has even offered suggestions as to how Babbage envisaged Automaton's construction. What has been absent from this discussion, however, is any consideration of similarities between Babbage's theories of machine play and models of cognitive-behavioural development.

In "Babbage's Dancer and the Impresarios of Mechanism" Simon Schaffer explores the socio-political ramifications of where "intelligence" is understood to be located in relation to machines. He discusses the capacity of Babbage's "games machine" for "random moves programmed in advance", and its consequent ability to suggest a guiding intelligence behind apparently random occurrences (62). He does not, however, consider these "random moves" in terms of a flexible combination of inflexible units, or consider Automaton's implications for a model of play as progress. Historian Margaret Boden has explicitly denied Automaton's significance for models of human mental processing: "had he built it, it would have been a technologist's toy, not a psychologist's model" (151). This chapter aims to show that Babbage draws parallels between theories of machine play and cognitive-behavioural models in a similar manner to twentieth-century attachment theory.

The penultimate section of this chapter offers a reading of *Passages* that gives additional consideration to the developmental narratives contained within this text. I want to show that comparing *Passages* with the pedagogical models discussed in this chapter can reveal new aspects of Babbage's depiction of pedagogical methods. This chapter then concludes with a discussion of the influence of computing upon George Eliot's depiction of play behaviours and pedagogy in *The Mill on the Floss* (1860). This section argues that that Eliot identifies play as a means of cultivating forms of cognitive-behavioural flexibility associated with the computational model described in this thesis. This section also seeks to illustrate that Eliot's analysis of the cultural implications of this model in *Mill* can offer a framework with which to identify similar correspondences in attachment theory.

Turing and the Child-Machine at Play

In the early 1950s Turing explored the possibilities of machine intelligence using a famous thought-experiment. Turing hypothesised that a digital computer- a "child-machine"- could be transformed into a more sophisticated one "by a suitable selection of the experiences to which it was subjected. This might be called 'education'" ("Computing Machinery" 456; "Heretical Theory" 257). For Turing, pedagogy represented a means whereby a computer capable of "imitat[ing] an adult human mind" could be developed ("Computing Machinery" 455). This section seeks to draw attention to Turing's hypothesis that computational complexity and flexibility could be established through playful pedagogies.

Turing discusses the concept of a child-machine in the papers "Computing Machinery and Intelligence" (1950) and "Intelligent Machinery: A Heretical Theory" (1951), although in the latter the phrase "child-machine" is not used. Ideas relevant to this discussion are also explored in the papers "Can Digital Computers Think?" (1951) and "Chess" (1953), and in the lecture Turing delivered to the Royal Astronomical Society in

1947, "Lecture on the Automatic Computing Engine". A further paper entitled "Intelligent Machinery" (1948) was published posthumously. I will use the phrase "Intelligent Machinery" to designate the 1948 paper, and "Heretical Theory" to designate the paper written in 1951.

Turing wrote that "[o]ne could not send the creature to school without the other children making excessive fun of it. It must be given some tuition" ("Computing Machinery" 456): **"**This training may be regarded as not unlike putting instruction tables into a machine. One must not expect a machine to do a great deal of building up of instruction tables on its own" (Turing, "Lecture" 394). As stated previously, the phrase "instruction table" is another way of referring to programs. Turing imagined that a machine might be constructed that, given "certain initial instruction tables . . . might, on occasion, if good reason arose, modify those tables (393):

> We may also sometimes speak of a machine modifying itself, or of a
> machine changing its own instructions . . . according to our conventions the
> 'machine' is completely described by the relation between its possible
> configurations at consecutive moments.
>
> (Turing, "Intelligent Machinery" 419)

Turing wrote that if a computer had the ability to flexibly modify its instruction tables by altering the configuration of the inflexible subroutines from which they were constructed, "one is obliged to regard the machine as showing intelligence" ("Lecture", 393).

Play is figured by Turing as instrumental in developing this capacity, with the child-machine "occupy[ing] its time mostly in playing games" ("Heretical Theory" 257). Turing observed that this play would be "necessarily intellectual in character", with suitable games including tic-tac-toe and GO (257). As detailed in the previous chapter, this predilection for formal games involving rule-bound combinations of discrete states was characteristic of mid-century computing. In the learning process that Turing describes the child-machine

stores data in "indexes of experiences" (258). The child-machine initially stores data such as

"the patterns of men or parts of a GO board that had occurred" (258). In the next stage of

its development, it records "important parts of the configuration of the machine at each

moment": "in other words it would begin to remember what its thoughts had been" (258).

Turing outlines how a child-machine might investigate how certain "thoughts" or

configurations were derived in order to refine the implementation of its own procedures.

The previous chapter discussed how the architecture of programs is dictated by rules that

determine the relationship between component instructions: "Important amongst such

imperatives will be ones that regulate the order in which the rules of the logical system

concerned are to be applied" (Turing, "Computing Machinery" 458). Turing writes that the

child-machine would be taught these rules by its "schoolmaster": "I suggest that the

education of the machine should be entrusted to some highly competent schoolmaster"

("Heretical Theory" 257); "these [rules] might be 'given by authority'" ("Computing

Machinery" 458). As Sterrett observes, Turing "seems to think of education as a special

kind of interference: it involves a teacher who intentionally tries to affect the behaviour of

the machine" (706).

Where the child-machine differs from most mid-century computers is that its

education eventually allows it to devise its own procedural rules (Turing, "Digital

Computers" 482):

> When a choice has to be made as to what to do next features of the
>
> present situation are looked up in the indexes available, and the previous
>
> choice in the similar situations, and the outcome, good or bad, is
>
> discovered . . . At first probably some quite crude rule will suffice, e.g., to
>
> do whichever has the greatest number of votes in its favour. At a very late
>
> stage the whole question of procedure in such cases will probably have

been investigated by the machine itself, and this may result in some highly

sophisticated and, one hopes, highly satisfactory, form of rule.

(Turing, "Computing Machinery" 458)

The rules the child-machine is equipped to formulate as a result of its education are

heuristic in character. Heuristic methods in computing are fallible but unambiguous

procedures (or "rules") for selecting an instruction when there are several legal courses of

action: "For at each stage . . . there is a large number of alternative steps, any one of which

one is permitted to apply as far as obedience to the rules of the logical system is

concerned" (458). As a means of determining a course of action when the choice to be

made is nondeterministic, heuristic rules are fundamental to games.

Turing depicts play as integral to the education of a machine capable of formulating

its own heuristic methods. He observes that when a chess problem "admits of several

solutions" the machine should have the ability to "choose at random" or "according to an

arbitary additional condition" ("Chess" 573). Machine learning in this context consists of

devising increasingly sophisticated rules to govern such choices:

> Could one make a machine to play chess, and to improve its play, game by
>
> game, profiting by its experience? . . . it would be quite possible to
>
> *programme the machine to try out variations in its method of play* (e.g.
>
> variations in piece-value) and adopt the one giving the most satisfactory
>
> results. *This could certainly be described as learning* . . . It might also be
>
> possible to programme the machine to *search for new types of*
>
> *combination* in chess. (575, emphasis added)

This increased sophistication in selecting certain heuristic strategies for gameplay is

explicitly described here as "learning". This quote would seem to suggest that Turing saw

correspondences between play and pedagogical methods.

Turing also suggests that heuristic techniques utilised in play have a purpose beyond acting as a mechanism to enable nondeterministic choice. Turing observed that a random data generator, or "random element", could be programmed into a child-machine "to generate possibilities among which some search process is then employed" (Sterrett 705): "one such instruction might for instance be, 'Throw the die and put the resulting number into store 1000'" (Turing, "Computing Machinery" 438). This "store 1000" might form part of an instruction table, with the resultant combination generating non-predetermined machine behaviours.

In generating random data the child-machine performs an action similar to throwing a die, as if determining its move in a game, whilst in "Chess" Turing describes "a machine . . . which would play random legal moves" (569). From being initially confined to a specific instance of gameplay, the child-machine is subsequently able to use techniques learnt in play to determine its responses in other situations in which it is necessary to form combinations of inflexible procedural instructions, with "the whole question of procedure in such cases . . . hav[ing] been investigated by the machine itself" (Turing, "Heretical Theory" 258).

Turing proposed that the child-machine's heuristic behaviour should be referred to as "partially random" ("Intelligent Machinery" 416). This designation would appear to derive from the fact that the routines upon which the child-machine bases its heuristic strategies are "given by authority"- in other words, by human programmers. As Turing notes, the combinations of states formed by the child-machine also depends upon how it has been taught to evaluate the outcome of its decisions:

> there should be two keys that can be manipulated by the schoolteacher,
> and which represent the ideas of pleasure and pain. At later stages in
> education the machine would recognise certain other conditions as

> desirable owing to their being constantly associated in the past with
>
> pleasure, and likewise certain others as undesirable.
>
> ("Heretical Theory" 259)

As Sterrett observes, Turing depicts the structure given by pedagogues as instrumental in enabling the child-machine to develop in the direction of intelligence (704):

> Intelligent behaviour presumably consists in a departure from the
>
> completely disciplined behaviour involved in computation, but a rather
>
> slight one, which does not give rise to random behaviour, or to pointless
>
> repetitive loops. (Turing, "Computing Machinery" 459)

Turing suggests that if no structure is given to the machine's less "disciplined" behaviours, then they will emerge as fragmented and non-functional.

Owing to their rule-bound nature, formal games provided Turing with a means of exploring the pedagogical implications of structured flexibility in machines: "it would be quite possible to *programme the machine to try out variations in its method of play* . . . This could *certainly be described as learning".* The human programmer furnishes the computer with a program that authorises it to "autonomously" vary its own procedures in a manner designed to increase the sophistication of its gameplay. The subsequent development of the machine is determined to a significant extent by this initial programming.

Turing nevertheless maintained that routines generated in the manner described above represented the child-machine's own expression of its learning:

> Certainly the machine can only do what we do order it to perform . . . But
>
> there is no need to suppose that, when we give it its orders we know what
>
> we are doing, what the consequences of these orders are going to be . . . If
>
> we give the machine a program that results in its doing something
>
> interesting which we had not anticipated I should be inclined to say that
>
> the machine *had* originated something...

("Digital Computers" 486, emphasis in original)

Turing also recapitulates this argument in the context of machine play: "If this [chess program] produced results that were quite new, and also interesting to the programmer, who should have the credit?" ("Chess" 575). On several occasions Turing also uses a comparison with pedagogy to explain how a computer might derive novel behaviours from deterministic programs: "It would be like a pupil who had learnt much from his master, but had added much more by his own work" ("Lecture" 393; see also "Digital Computers" 485).

Turing observed, however, that sophisticated behaviours could be simulated in a child-machine by allowing schoolteachers and programmers to entirely determine its behaviour ("Heretical Theory" 257). A machine could even play chess using a deterministic instruction table (Turing, "Chess" 571):

> It would be quite easy to arrange the experiences in such a way that they automatically caused the structure of the machine to build up into a previously intended form, and this would be obviously a gross form of cheating, almost on a par with having a man inside the machine. (Turing, "Heretical Theory 257)

This concept of such pedagogies as being "on a par with having a man inside the machine" parallels Ferenczi's claim that the incestuously educated child is compelled to internalise the idiom of the aggressor. Although the heuristic rules originated by the child-machine have their basis in routines provided by programmers and educators, this capacity still offers security against incestuous pedagogies: "the behaviour of the machine not being by any means completely determined by the experiences to which it was subjected" (259).

It is my contention that Turing also sought to draw attention to these parallels between human and machine learning as a means of reflecting upon the nature of human mental processing:

> I will not say much about how this process of 'programming a machine to think' is to be done . . . I will only say this, that I believe the process should bear a close relation to that of teaching . . . The whole thinking process is mysterious to us, but I believe that the attempt to make a thinking machine will help us greatly in finding out how we think ourselves.
>
> ("Digital Computers" 486)

Although in the "Chess" paper Turing cautions that the manner in which computers form combinations of moves "is not quite representative of learning as we know it" (575), elsewhere in his work the parallels between human and machine learning are strongly stated:

> A human graduate has had contact with human beings for twenty years or more. This contact has throughout been modifying his behaviour pattern. His teachers have been intentionally trying to modify it. At the end of that period a large number standard routines will have been superimposed . . . He is then in a position to try out new combinations of these routines, to make slight variations on them, and to apply them in new ways.
>
> ("Intelligent Machinery" 421)

Turing applies to his "human graduate" a computational model in which development consists of devising novel methods of combining preprogramed "standard routines". Turing was aware that the lines of demarcation separating human and machine learning in his work were highly fluid. He concludes a discussion of machine learning in the "Heretical Theory" paper by stating that further examination of the topic would constitute "nothing more than an analysis of actual methods of education applied to human children" (259). Although in this particular instance Turing shifts focus away from "methods of education applied to human children", the next section proposes that his theories influenced the attachment model of the didactic and developmental significance of play.

Attachment Theory: The Child (Machine) at Play

It appears that recent work in attachment theory has continued to foreground the

computational model of cognition and behaviour that Bowlby introduced to the field in the

1960s. In a volume regarding attachment behaviour and neuroscience published in 2008,

clinical psychologist Susan Hart writes:

> Children develop adaptation patterns that correspond to their current level
>
> of mental organisation. This takes place through functional differentiation
>
> and hierarchical integration . . . The child's early adaptive patterns are
>
> successfully reorganised at different times in life. (59)

> In a simplified sense . . . higher order functions are always based on lower-
>
> order functions, while lower-order functions may be independent of
>
> higher-order functions. (13)

Simple "functions" are represented in Hart's account as discrete entities that can be

combined to create complex cognitive-behavioural "organisations": "The child develops as

a result of neural reorganisation and increasing complexity" (59). These combinations,

however, do not destroy the integrity of the simpler units, which may be highly inflexible

(13). I would therefore suggest that recent attachment theory continues to share

similarities with the architecture of mid-century computing.

This section aims to show that this model has also been used by recent theorists of

child development to depict cognitive-behavioural processes associated with play. For

instance, the influential developmental psychologist Daniel N. Stern writes in his paper

"The Goal and Structure of Maternal Play" (1974) that:

> Play between mother and infant, like almost any naturally occurring
>
> interpersonal event, can be conceptualised in terms of a hierarchical

structure in which smaller units of behaviour combine to form larger

organisational units, which together constitute the next larger units… (402)

The largest unit is the entire play period. This is subdivided into several

"game" sequences wherein each game is determined by the mother's

creating *different recombinations of her behaviours in distinctive sequences*

. . . Each attention episode is for the infant equivalent to a period of a

presentation of *discrete maternal behaviours*, each of which forms the

fourth and smallest unit, called maternal acts. (407, emphasis added)

Stern claims that children's play possesses a similar structure (407). Discrete units of play

behaviour combine to create larger units, which can subsequently be regarded as

"distinctive sequences". It is possible to perceive that complex play here is structured in a

similar manner to behavioural complexity in computers. Another comparison with

computing is that behavioural flexibility consists of the flexible combination and

recombination of a finite number of behavioural units: "Each new game involves novel

recombinations of a finite set of behaviours" (416).

It is my contention that computing has not only provided attachment theory with a

model of how play is structured, but has also determined its understanding of play as

progress. One explanation for this is that the theoretical volumes from which attachment

theory derived its computational models demonstrate Turing's influence. The previous

chapter traced how *Attachment* was influenced by *Plans and the Structure of Behaviour*, a

text that cites Turing as a source for its theoretical model (46, 167-68). In turn, Stern's

paper explicitly names *Attachment* as a source (404, 419). A further explanation is that

these ideas were disseminated directly to an audience working in the field of psychology,

as "Computing Machinery and Intelligence"- the paper in which the child-machine is

discussed- was published in the journal *Mind* in 1950.

The previous section sought to show that Turing highlighted the importance of play to the development of heuristic competencies that enable the child-machine to flexibly combine inflexible units of behaviour. I would suggest that there are strong similarities between this computational model and the logic of play as progress that Stern describes:

> The more games with which a mother can interest and delight an infant, the more practice he will have . . . in different interactive situations involving more sense modalities in more patterns . . . Each new game involves recombinations of a finite set of behaviours . . . play is a creative act, in that it consists of novel transformations of behaviour, or in this case, behavioural sequencing . . . very often an unplanned maternal act is avidly responded to by the infant and can become the 'theme' around which a new game is constructed. (416)

Turing hypothesised that a random element could provide the child-machine with a means of generating new behaviours that could then be evaluated and stored in memory. Similarly, the child depicted by Stern uses the structure of a random event designated by its caregiver as a means of determining modifications to its own behaviour: "an *unplanned* maternal act . . . can become the 'theme' around which a new game is *constructed*". There appears to be a tendency in clinical practice to create physical parallels of this model, with tests used to study the development of cognitive-behavioural capacities through play encouraging children to form combinations of individual construction blocks or mosaic pieces, or to switch between discrete sets of playing cards (Arend, Gove and Sroufe 953; Cragg and Chevalier 211; Grossmann et al., "Sensitive and Challenging Play" 316).

A further comparison with computational models is that the departure from disciplined behaviour that characterises play in attachment theory is relatively slight, with "free play" depicted as involving minor modifications to a finite number of routines. Caregivers in attachment theory are figured as "external organisers" responsible for

providing this structure in the form of "guidance, scaffolding, and teaching" (Zimmermann et al. 332; Grossmann et al. "Sensitive and Challenging Play" 316). I wish to suggest that this belief in the necessity of "scaffolding" parallels Turing's argument that nondeterministic decisions must be structured in order for behaviour to generate developmental progression rather than "pointless repetitive loops".

It would appear, however, that this application of the computational model has not been without its difficulties. As demonstrated by the Sensitive and Challenging Interactive Play (SCIP) scale, attachment theory has been forced to demarcate between structured flexibility and the imposition of inflexible play patterns (Grossman et al. "Sensitive and Challenging Play", 31). The positively regarded polarity of the SCIP scale has been labelled "Responsive-Didactic", where "scaffolding during teaching interactions" is "responsive and emotionally attuned" (Shannon et al. 80, 95). The other polarity is "Negative-Intrusive", characterised by "high structuring . . . intrusiveness, and inflexibility" (95). As discussed above, Turing observed that play behaviours might be simulated in a computer by providing it with an entirely deterministic set of rules. The "Negative-Intrusive" caregiver forces the child to play in a similarly deterministic manner. This inflexible play can be compared with the incestuous pedagogies described in previous chapters.

Yet although it denounces play that is too prescriptive, attachment theory also stresses the need for children's play to be regulated by "*external* organisers". Paralleling Turing's concerns, in recent years there has been much discussion of the risks of self-modifying software: "trial and error in revising one's own code are about as hazardous as trial and error in brain surgery . . . experiments in self-modification will be fraught with the risks of self-mutilation" (Suber). We love the computer, so we must prevent it from injuring itself by placing a degree of "responsibility for the evaluation and modification . . . outside the software product itself" (Clark and Osterweil 30): "the beings —human or machine— who love a machine, or who designed it, coded it, or raised it, will be those most inclined to

save it from itself" (Suber). However, as Suber observes, this has become a coercive

rationale for controlling the computer. A similar logic structures attachment theory: we

love the child (machine), so we cannot allow it to modify itself into a behavioural

fragmentation that represents the other polarity of trauma on this model. We mitigate this

trauma in the context of play by making the disaggregation of cognitive-behavioural

structures in the service of creative living a scaffolded one. Yet the comparison with

computing would suggest that the boundary between scaffolding and controlling play is a

hard line to hold, perhaps explaining the need for such instruments as the SCIP scale.

I want to show that there have also been other difficulties that have arisen as a

result of applying this computational model to human children. In the child-machine

sophisticated play behaviours correspond to a general capacity for computational

flexibility. This would later mature into a paradigm in mid-century computing known as

"generalist AI", founded on the premise that skills developed in one domain would readily

generate similar competencies in others (Garnham 7). On this basis, making a computer

smarter at chess should lead to improved performance in areas such as mathematics and

logic. Similarly, the idea that skills for organising discrete units learnt in play contribute to a

general capacity for cognitive- behavioural flexibility has achieved significant currency in

recent attachment theory:

> *Much of human exploratory behaviour is playful* . . . Security of exploration
>
> seems to rest on (1) a child's *ability to organise emotions and behaviours*
>
> *open-mindedly* . . . and (2) the child's confidence in an attachment figures'
>
> availability and helpfulness, should help be needed.
>
> (Grossmann et al. "A Wider View" 858-59, emphasis added)

This thinking possesses strong correspondences with the generalist logic of mid-century

computing. It argues that the child, as it develops, will use cognitive-behavioural skills

learnt in play to flexibly organise behaviours across contexts: "Play is meaningful action . . .

it is the means by which children progressively explore the world to formulate and organise concepts" (Rodning, Beckwith and Howard 276).

> The coordination of affect, cognition and behaviour is closely tied to the problem of generating and coordinating flexible adaptive responses to demands . . . Through its play and exploration, promoted by its effective attachment relationship, the infant is acquiring experiences which will promote positive adaptation in the next developmental period.
>
> (Waters and Sroufe 8-9)

These quotes appear to suggest that the generalist aspects of Turing's theories of machine learning have influenced the attachment understanding of how futurity is encoded in play.

Yet by the 1970s the lack of progress in implementing generalist AI had precipitated a crisis of faith in the ability of competencies developed in one domain to engender corresponding sophistication in other domains (Garnham 7). Cultivating domain-specific abilities subsequently became the focus of AI research (Dreyfus 14-16). The demise of the generalist model has been paralleled in the concerns of some theorists of child development. For instance, Sutton-Smith has suggested that this confidence that an increase in the sophistication of play behaviours facilitates a corresponding development of general cognitive-behavioural capabilities may result in caregivers unconsciously generating skill transfers that would otherwise not occur (40). I would argue that attachment theory as a discipline has experienced difficulties in responding to the limitations of the generalist model, with the logic of generalist AI continuing to determine attachment thinking.

Babbage's Automaton: Another Child-Machine at Play

This section seeks to illustrate that the child-machine described by Turing was not the first

instance in which a computer shaped ideas about the developmental purpose of play.

Babbage in *Passages* states that his intention in designing "Automaton" was "the

contrivance of a machine that should be able to play a game of purely intellectual skill

successfully" (465), with the game chosen "tit-tat-to [tic-tac-toe]" (467). Babbage

conceived the idea for this machine in 1844, returning to the project at sporadic intervals

during the following two decades (Monnens 2). Although it appears Babbage initially

intended to construct Automaton, it remained a thought-experiment: "You say nothing of

Tic-tac-toe [Automaton] in yr [*sic*] last [letter]. I am alarmed lest it should never be

<u>accomplished</u>" (Lovelace, qtd. Toole 340, emphasis in original).

In a chapter in *Passages* entitled "Games of Skill", Babbage writes that the first

stage in designing the machine was to record all possible configurations of O and X (468).

Monnens writes that in a diagram dated 1844 Babbage depicted each board position

associated with an axis that could occupy one of three positions corresponding to empty

space, O or X (5). Twenty-seven discrete positions are therefore possible (Babbage,

Passages 468). Each of these can be interpreted as an inflexible unit of machine behaviour

that can be combined to generate various board configurations. Babbage writes that

Automaton was based upon "various principles . . . in my published and unpublished

papers", and an underlying principle of the Analytical Engine can be observed here (465).

Paralleling the manner in which complexity is generated in this computer, Automaton's

capacity for gameplay is not described by the number of discrete states that it can effect-

which in the case of tic-tac-toe Babbage describes as "comparatively insignificant"- but by

"the myriads of combinations which even the simplest games included" (466).

Babbage in "Games of Skill" emphasises the importance of heuristics to the flexible combination of inflexible states in gameplay. He outlines a procedure to enable Automaton to make nondetermistic choices within the parameters stipulated by the rules of the game:

1. Is the position of men, as placed before him [Automaton] on the board, a possible position? that is, one which is consistent with the rules of the game?

2. If so, has Automaton already lost the game?

3. If not, has Automaton won the game?

4. If not, can he win at the next move? If so, make that move.

5. If not, could his adversary, if he had the move, win the game.

6. If so, Automaton must prevent him if possible.

7. If his adversary cannot win the game at his next move, Automaton must examine whether he can make such a move that, if he were allowed to have two such moves in succession, he could at the second move have *two* different ways of winning the game; and each of these cases failing, Automaton must look forward to three or more successive moves. (467)

Paralleling Turing's depictions of machine play, a means of evaluating the results of potential configurations (moves) is essential in order to implement this heuristic routine effectively. Although Babbage did not publish a description of a mechanism to evaluate board positions, Monnens identifies a diagram dated August 1848 of being of particular interest. This diagram represents a grid, where each square is assigned a value, and all horizontal, vertical and diagonal rows add up to fifteen. Monnens suggests that this "magic square" could be used to evaluate board positions: "After adding up each of the eight possible lines, relative values could be checked. Rows missing only one number would therefore be more valuable than rows missing two or three" (6).

Babbage's theoretical interest in gameplay preceded Automaton by several decades. In 1817 he published an article entitled "An Account of Euler's Method of Solving a Problem, Relative to the Move of the Knight at the Game of Chess". Although this article was unsigned Babbage included it in lists of his printed works, and its provenance has since been accepted by Babbage scholars (Van Sinderen 173). In this paper Babbage describes an algorithm that can be used to play a game now referred to as "Knight's Tour". This game demands that, using only legal moves, the knight piece must visit every square on a chessboard without repeating any square ("Euler's Method" 72). Babbage writes that a number of "courses", or combinations of moves, can solve this problem (72). Babbage treats each square of the chessboard as a discrete state, with the knight piece moving from state to state. Each of these courses can be compared to an algorithm in their capacity to determine combinations of discrete states.

Babbage observes that although elements of these routines remain inflexible, alternative pathways can be "discover[ed] by trial": "the square at which the knight finishes his course, may be changed in several ways, without altering the square from which he started" (73). Babbage writes that the game concludes when the knight re-enters the first square or the square next to it (72). One algorithm has the knight moving through a sequence of squares beginning on 1 and ending on 32, a sequence that includes the move 31-64. Babbage notes that this routine can be modified by moving from 64 to 51 when the knight arrives at this position. After this, the routine to determine the next move may proceed as before, ending on 52. Because moving from this position to the first square is a legal move, Babbage- by making allowable "transformations" in a largely inflexible routine- changes the course ending on an adjacent square to a re-entering course (72). Babbage here explores a structured flexibility that would prove fundamental to his subsequent work in computing. There is evidence that Ada Lovelace also influenced Babbage's thinking regarding Automaton. Historian Betty Toole records that Lovelace and Babbage shared a

fascination with the mathematics of games, and that Lovelace had started to develop "a process for writing out a winning strategy for a game in mathematical terms" (116). In 1840, Lovelace asked Babbage whether he believed a winning strategy for peg solitaire could "admi[t] of being put into a mathematical Formula" (qtd. Toole 118).

Babbage writes that when designing Automaton, he reviewed means whereby he had dealt with contingencies in the Analytical Engine (*Passages* 469). Yet considering the combination of discrete states in gameplay led Babbage to devise an additional approach to machine heuristics. Atkinson identifies the use of a "random element" in Automaton (41):

> Whenever two moves, which we may call A and B, were equally conducive to winning the game, the automaton was made to consult the record of the number of games he had won. If that number happened to be even, he was directed to take the course A; if it were odd, he was to take the course B.
>
> If there were three moves equally possible, the automaton was directed to divide the number of games the number of games he had won by three. In this case the numbers 0, 1 or 2 might be the remainder, and the machine was directed to take the course A, B, or C accordingly.
>
> (Babbage, *Passages* 469)

I want to show that the "random" decisions implemented by Automaton are only "partially random", making them comparable to the "random" decisions executed by Turing's child-machine. When effecting a decision Automaton uses preprogramed routines, such as subjecting the number of won games to a simple division operation. Also, before this occurs, probable solutions are determined using the heuristic routine described above. This is what Schaffer is referring to when he describes "random moves programmed in advance" (see also Swade, *Difference Engine* 179). These "random" decisions are also circumscribed by the rules of the game. If a combination falls outside these parameters,

play cannot continue. The first test performed by Automaton assesses whether a given configuration is "one consistent with the rules of the game". Another comparison with Turing's child-machine is, therefore, that the departure from "disciplined" behaviour must be restricted in order to prevent play from becoming chaotic.

Babbage indicates that a random element has the potential to generate gameplay superior to that achievable using unmodifiable routines. This can be compared with his recollection of playing chess against an expert named Brande, who had read "almost every book on the subject": "if I played any of the ordinary openings, such as are found in the books, I was sure to be beaten" (*Passages* 36). Babbage, however, eventually discovers a way to optimise his chances "by making early in the game a move so bad that it had not been mentioned in any treatise" (36). Brande's learnt routines can be regarded as similar to a deterministic algorithm programmed in a game-playing machine. The ability to make non-predetermined combinations- "not mentioned in any treatise"- is a manifestation of intelligence that proves more effective than Brande's inflexible play. I would suggest that this apparently incidental episode demonstrates Babbage's awareness of the significance of a random element for both gameplay and cognitive-behavioural flexibility.

There is evidence that Babbage and Lovelace discussed the idea of making random combinations of discrete states in the Analytical Engine in order to generate unpredictable machine behaviours and thus "hit upon . . . new methods" (Lovelace 283): "We might even invent laws for series or formulae in an arbitrary manner, and set the engine to work upon them, and thus deduce numerical results we might not otherwise have thought of obtaining" (283). This use of a random element is similar to that described by Turing. Although Lovelace regarded the formation of such combinations as "a kind of philosophical *amusement*" (283, emphasis added), the Brande episode suggests that Babbage perceived serious consequences for machine intelligence in such games.

That Babbage regarded Automaton as a "child-machine" is indicated by the fact that he imagined its play being represented externally by a mechanical child:

> I imagined two children playing against each other, accompanied by a lamb and a cock. That the child who won the game might clap his hands while the cock was crowing, after which, that the child who was beaten might cry and wring his hands whilst the lamb began bleating. (*Passages* 468)

This comparison is further emphasised by Babbage's identification of "tic-tat-to" as a game "played by little children" (467). Automaton does not, however, offer a perfect parallel with Turing's child-machine. A fundamental difference is the latter's capacity to use play as the starting point from which to develop computational complexity and flexibility across a range of contexts.

I want to argue that the sketch suggests that Babbage had considered such ideas, even if he was unable to implement them. As we have seen, this is another instance in which Babbage depicts correspondences between children and computers. The sketch begins with the child-Engine executing a simple routine involving the manipulation of marbles. In what is surely a reference to his discussions with Lovelace, Babbage writes that similar combinations could be effected by a "young lady with the balls of her solitaire board" (*Passages* 50). It has been argued previously that the child's competence in manipulating these discrete units corresponds to its ability to manipulate numerical digits. This in turn forms the basis for the child's subsequent cognitive-behavioural flexibility. It is my contention that the sketch suggests that Babbage was able to use concepts deriving from Automaton and the Engines in order to foreground a computational logic of play as progress similar to that of attachment theory.

In "Computing Machinery and Intelligence"- the paper in which the child-machine theory is most comprehensively stated- Turing identifies the Analytical Engine as a digital computer, crediting Babbage with "all the essential ideas" (439). Turing argues that a

characteristic feature of this class of machines is that given enough storage capacity and speed, a digital computer should be able to imitate any other digital computer. They are "universal" machines:

> The Analytical Engine was a universal digital computer, so that, if its storage capacity and speed were adequate, it could by suitable programming be made to mimic the machine in question.
>
> ("Computing Machinery" 450)

This statement implies that if its operational limitations could be overcome, the Analytical Engine could theoretically develop in a similar manner to Turing's child machine. There is evidence that nineteenth-century observers also believed Automaton to be capable of learning. In 1880, economist William Stanley Jevons wrote:

> Charles Babbage proposed to make an automaton chess-player which should register mechanically the number of games lost and gained in consequence of every possible kind of move. Thus, the longer the automaton went on playing games, the more experienced it would become by the accumulation of experimental results. (251-52)

This section has sought to illustrate that Babbage had identified the possibility of a machine with the qualities described by Jevons and Turing, even if he was unable to construct such a machine. It has also claimed that these insights into machine games allowed Babbage to theorise the developmental importance of play in a manner comparable to much twentieth- and twenty-first-century thinking on this subject.

Computational Models of Suboptimal Pedagogy in *Passages*

Building upon the analysis of the sketch in the previous chapter, this section offers an extended reading of *Passages* that gives additional consideration to the developmental

narratives contained within this text. This thesis has sought to demonstrate that computing

technology in the nineteenth, twentieth and twenty-first centuries resulted in a

pedagogical model that portrays structured flexibility as optimal for both machine and

human development. The purpose of this section is to illustrate that the computationally-

inflected models of playful pedagogies discussed in this chapter can deepen our

understanding of Babbage's depiction of suboptimal pedagogy in *Passages.* I want to show

that these narratives depict pedagogical methods similar to those that recent attachment

theory associates with a lack of "guidance, scaffolding and teaching" and an "intrusive" or

"high-structuring" approach.

Babbage in *Passages* records experiencing a lack of structure in his early education.

During his childhood Babbage suffered from "violent fevers" (10). Out of concern for the

fragile state of his health, he was "placed under the care of a clergyman . . . with

instructions to attend; but, not to press too much knowledge upon me: a mission which he

faithfully accomplished" (10). Babbage describes how "my mind, receiving but little

instruction, began, I imagine, to prey upon itself" (14). He records imagining himself subject

to physical maladies as a result of "great idleness" (10): "Listless and unoccupied, I

imagined I had a head-ache" (14, emphasis in original).

This would appear to be similar to the damage that a computer can inflict upon its

own program without sufficient restrictions being placed upon its capacity for self-

modification. This chapter has sought to illustrate that the risks of self-modifying software

have influenced perceptions of the necessity of pedagogical "scaffolding" in attachment

theory. Although it is unlikely that Babbage possessed the same comprehension of self-

modifying software as a modern computer scientist, his detailed programs for Automaton

illustrate that he understood that even a nondeterministic program requires structure in

order to be functional. As I have argued is the case in the sketch, I want to suggest that

Babbage's comprehension of the need to rigorously structure programs informs the pedagogical narratives contained in *Passages.*

Having previously been provided with negligible pedagogical structure, Babbage attempts to institute his own after being transferred to a London school. Babbage records how he, in the company of "one of my school-fellows", would "get up every morning at three o'clock, light a fire in the school-room, and work until five or half-past five. We accomplished this pretty regularly for several months" (19). Through this program of studies Babbage institutes a system that fulfils a similar role to the caregiver in attachment theory, whose role is to function as an "external organiser" for the child's behaviours by providing appropriate pedagogical "scaffolding".

The regularity of this system, however, is disrupted by the unstructured play of the boys that subsequently join their "night party": "three or four other boys . . . joined our party, and, as I had anticipated, no work was done. We all got to play; we let off *fire-works* in the play-ground, and were of course discovered" (21, emphasis added). As discussed previously in this chapter, Turing argued that if no structure is given to a computer's less disciplined behaviours, then fragmentary and unproductive actions are likely to result. Machine play that facilitates computational development is structured play. Similarly, the lack of structure imposed upon the play behaviours of Babbage's companions results in an explosive fragmentation of the pedagogical program that he sought to establish. Babbage describes how he was scolded by his master for instituting this "*irregular* system" (21, emphasis added). It appears that despite his most concerted efforts, the pedagogical structure that Babbage craved continued to elude him**.**

Babbage continued to experience inadequate pedagogical scaffolding in key areas of his studies, including the mathematics he was "[p]assionately fond of" (26). He records how, prior to his entrance at Cambridge, he was "under the guidance of an Oxford tutor, who undertook to superintend my classical studies only" (25). Babbage attempts to

compensate for this lack of scaffolding and teaching by instituting his own regime of self-instruction. This can be compared with his system of self-instruction at the London school. Babbage recalls how he "instructed myself by means of Ward's 'Young Mathematician's Guide' . . . I now employed all my leisure in studying such mathematical works" (26). Yet just as before, these attempts to create pedagogical structure for himself prove unsatisfactory. Babbage describes himself as feeling profoundly the absence of a source of pedagogical support: "I had, however, met with many difficulties, and I looked forward with intense delight to the certainty of having them all removed on my arrival at Cambridge" (26).

Despite his hope of receiving scaffolding and guidance from the program of studies at Cambridge, Babbage continued to lack support for his intellectual development. Yet whereas Babbage's previous educational experiences were characterised by a lack of structure, the pedagogy he describes at Cambridge can be compared with modes of interaction that attachment theory associates with the "Negative-Intrusive" polarity, in which the pedagogue displays "high structuring . . . intrusiveness, and inflexibility". This thesis has argued that as a result of their basis in similar computational models, *Passages* and attachment theory regard as optimal pedagogies that enable the learner to develop their own procedural rules within a framework of structured flexibility. It has also sought to illustrate that this computational model regards pedagogies that are predicated upon inflexibility as suboptimal.

Babbage writes that a few days after his arrival at Cambridge, "I went to my public tutor Hudson, to ask the explanation of one of my mathematical difficulties. He listened to my question, said it would not be asked in the Senate House, *and was no sort of consequence, and advised me to get up the earlier subjects of the university studies*" (27, emphasis added). Instead of being provided with scaffolding for his intellectual development, Babbage is instead instructed to confine himself rigidly to the inflexible

programme of studies dictated by the University. This inflexibility is depicted as characteristic of the pedagogical culture at Cambridge in this period: Babbage describes approaching another lecturer, who "treated the question just the same way" (27). Faced with this programmatic inflexibility, Babbage describes how he rapidly "acquired a distaste for the *routine* of the studies of the place" (27, emphasis added). Rather than providing Babbage with a program of studies that would enable him to develop his own procedural rules within a framework of structured flexibility, Babbage's tutors subject him to pedagogical routines characterised by inflexibility.

I want to show that it is possible to trace comparable fluctuations between a lack of scaffolding and intrusive attempts to inflexibly direct developmental processes in the narrative that *Passages* provides of the British Government's involvement with the project to construct the Difference Engine. When describing the project Babbage makes recourse to the language of developmental narratives, referring to its purpose as "*maturing* an engine of almost *intellectual power*" (105, emphasis added). Paralleling the failures of Babbage's education, however, it is argued in *Passages* that the construction of the Engine was jeopardised by the Government's failure to provide adequate scaffolding at the commencement of the project in the early 1820s: "it seemed to be admitted that it was not possible to prescribe any very definite system, and that much must be left to Mr. Babbage's own judgment" (71). The initial lack of guidance provided by the Government and the Royal Society is cited several times in *Passages* as a reason for the ultimate failure of the project: "it does not appear, from the Report of the Royal Society, that *any plan, terms* or *conditions* had been pointed out by that body" (71, emphasis in original); "Lord Goderich . . . admitted that the understanding of 1823 was not very definite" (73).

By the late 1820s Babbage was demanding that the Government undertake a more proactive role in the supervision of the project and its costs. In 1829 Babbage wrote to the Chancellor of the Exchequer Henry Goulburn, stating that "to prevent the recurrence of

difficulty from any remaining indistinctness . . . he wished to propose some general

arrangements for expediting the completion of the Engine" (75). That Babbage was seeking

to place a greater degree of responsibility for the management of the project in

Governmental hands is indicated by his suggestions "[t]hat the Engine should be

considered as the property of Government" and "[t]hat professional engineers should be

appointed by Government to examine the charges made for the work" (76). The

Government, however, was reluctant to undertake these increased responsibilities:

Goulburn wrote to Lord Ashley in 1829 that "we (the Government) could not adopt the

course which Mr. Babbage had pointed out . . . without considerable inconvenience" (76).

They instead instructed Babbage to proceed according to their "original intention", but it is

recorded in *Passages* that this once again proved problematic due to a lack of guidance: "it

certainly does not appear . . . that the 'original intention' was then in any degree more

apparent than it was at the commencement of the undertaking" (77).

      After numerous entreaties, Babbage was eventually successful in persuading the

Government to agree to undertake this supervisory role. In 1830 the Government declared

the Engine their property and appointed professional engineers to examine the accounts

(80): "Thus, after considerable discussion, the doubts arising from the indefiniteness of the

understanding with the Chancellor of the Exchequer, in July, 1823, were at length

removed" (80). Yet only a few years would elapse before Babbage was once again

experiencing difficulties with the Government's level of intervention in the project. In the

mid-1830s Babbage applied to the Government for guidance concerning improvements

suggested by his designs for the Analytical Engine:

> the Analytical Engine could not *exist* without inventing for it a method of
>
> mechanical addition possessed of the utmost simplicity . . . if such
>
> simplifications should be discovered, it might happen that the *Analytical*
>
> Engine would execute more rapidly the calculations for which the

> *Difference* Engine was intend; or that the *Difference* Engine itself would be
>
> superseded by a far simpler mode of construction . . . To withhold these
>
> new views from the Government, and under such circumstances to have
>
> allowed the construction of the Engine to be resumed, would have been
>
> improper… (84, emphasis in original)

It appears that Babbage had hoped that the Government would provide guidance and

scaffolding whilst the design of his calculating Engines underwent a period of development:

he sought a "temporary suspension, until the character of the new views should be more

fully developed" (85).

I would suggest that Babbage was seeking the support of the Government in

making flexible modifications to previously inflexible Plans:

> The necessary science and skill specially acquire in executing such works
>
> must also, as experience is gained, suggest deviations from, and changes in,
>
> the original plan of those works; and the adoption or rejection of such
>
> changes, especially under circumstances similar to those in which I was
>
> placed, often involves questions of the greatest difficulty and anxiety. (103)

Paralleling the manner in which minor modifications are made to the largely inflexible Plans

of the Analytical Engine, Babbage describes a process in which an "original plan" is

modified by undergoing a series of "deviations" from its original inflexible form. This thesis

has argued that because of their correspondences with a fragmentation that this model

understands to be pathological, these modifications are often depicted as accompanied by

a degree of distress. This can be compared with the "anxiety" that Babbage describes when

faced with "the adoption or rejection of such changes".

Babbage writes in the "Mathematical Powers" paper that "any neglect would be

absolutely unpardonable in combining the proper cards" (47). In other words, it is an

"unpardonable" form of "neglect" to provide a computer with an inadequate program to

guide its behaviours. As discussed previously, these behaviours in the Analytical Engine include modifications to programs. Similarly, Babbage appears to have regarded it as the role of the Government to provide scaffolding for the flexible development of his plans:

> It was obviously of the greatest importance to Mr. Babbage that a final decision should be made by the Government . . . Without such a decision Mr. Babbage felt that he should be impeded in any plans he might form, and liable to the most serious interruptions if he should venture to enter upon the execution of them. (*Passages* 90-91)

Babbage states that if left without sufficient guidance from the Government, not only will he be "*impeded* in any *plans he might form*", but the plans that result will also be fragmentary, being "liable to the most serious *interruptions*". Yet the Government, displaying understandable impatience after over a decade of delays and expense, instructed Babbage in 1836 that "he should feel himself bound to look to the completion of the first machine" (88). *Passages* depicts the Government's previous lack of guidance being supplanted by a rigidly inflexible approach to the development of the Difference Engine. I would suggest that Babbage's attempts during this period to engineer a greater degree of computational flexibility also intensified his consciousness of pedagogical inflexibility as a suboptimal approach.

Babbage felt that the Government had misconstrued his request as an application to construct the Analytical Engine (88). He wrote to the Government again, reiterating his query about constructing a new Difference Engine with the improvements suggested by the Analytical (90). Yet the Government are described as reverting to their former strategy of leaving Babbage without guidance: "for more than a year and a half no further measures appear to have been adopted by the Government respecting the Engines" (90). In 1838 Babbage, "wearied with this delay", appealed to the First Lord of the Treasury, Lord

Melbourne (91): "He asked, not for any favour, but for that which it was an injustice to withhold- a decision" (91).

By this stage Babbage was seeking answers to more fundamental questions regarding the Government's willingness to support the development of the Difference Engine. In a letter to the Chancellor of the Exchequer Thomas Spring Rice, to whom the matter had been referred, Babbage described "the question he wished to have settled":

> *Whether the Government required him to superintend the completion of the Difference Engine, which had been suspended during the last five years, according to the original plan and principles; or whether they intended to discontinue it altogether?* (92, emphasis in original)

Babbage presents the Government with a stark choice that reflects their inadequate caregiving. The choice they must make is either to proceed rigidly according to an outmoded plan, or to face the collapse of the project. This choice between behavioural rigidity and the atomisation of a plan can be compared with the effect of the pedagogical methods that I claim Babbage derived from the Difference Engine. Babbage's sense that he is no longer equipped to exercise his own judgement as a result of developmental failures also parallels the effect of incestuous pedagogies. It would appear that previous Governmental failures had left Babbage unable to make a "conditional branch" similar to those executed by the Analytical Engine: regarding "*the courses* pointed out by the Chancellor of the Exchequer", Babbage observes that "his past experience having taught him *not to rely upon his own judgment* on matters of that nature, he should be very reluctant to offer any opinion" (92, emphasis added).

In late 1841 Babbage "determined upon renewing his application for a decision", this time approaching the First Lord of the Treasury, Robert Peel (93). After another year had passed with no communication aside from a cursory note from Peel, Babbage wrote again in October 1842 "requesting an early decision" (93). Peel finally responded on 4th

November 1842, promising to communicate with Goulburn and to reach a joint decision.

Later that day, Babbage received a letter stating that they had decided upon "abandoning

the completion of the machine" (94). Goulburn informed Babbage that the Government

had revoked their claim to the machine, in the "hope" that "they might in some degree

assist him in his future exertions in the cause of science" This gesture of "assistance"

following the abandonment of the project presents an ironic contrast with *Passages*'

descriptions of Governmental neglect during the period in which they were ostensibly

providing scaffolding for the development of the Engine. Babbage, however, refused to

accept this abandonment of both inventor and machine, declining their offer to revoke

their claim to the Engine, and arguing that he himself had "claims on their consideration"

(94). Babbage justified these claims for further support by referring to the "anxiety and

injury he had experienced by the delay of eight years in the decision of the Government"

(95).

On the 11th November, Babbage "obtained an interview" with Peel (94). During

this meeting, Babbage would suffer a humiliating withdrawal of the last vestiges of

scaffolding provided by Government:

> The result of this interview was entirely unsatisfactory. Mr. Babbage went
>
> to it prepared . . . to have pointed out two courses, by either of which it
>
> was probable that not only a Difference Engine, but even the Analytical
>
> Engine, might in a few years have been completed. The state of Sir Robert
>
> Peel's information on the subject . . . prevented Mr. Babbage from making
>
> any allusion to either of those plans. (95)

Babbage's intention appears to have been that the Government would assist him in making

a structured decision between "two courses". The structured flexibility that this decision

involves can be regarded as similar to a conditional branch in computing. Babbage,

however, is depicted as once again failing to receive adequate scaffolding to support the

development of his planning. This is described as preventing the emergence of the more sophisticated and flexible forms of (machine) behaviour that could have developed had the Government been willing to offer this support.

This section has sought to show that the narrative in *Passages* attributes the developmental failings of the Engines to the failure of the Government to provide adequate structure for their development. This narrative of Governmental failures shares a similar chronology with the narrative of Babbage's experiences of pedagogical neglect, with inadequate scaffolding being superseded by an intrusive, high-structuring approach. Correspondingly, the Government's failure to provide adequate scaffolding is described as encompassing not only the Engine, but Babbage himself: the Government was guilty of "ignoring the existence of the Difference Engine and its inventor" (148). This "much-abused Difference Engine" forms a parallel with Babbage (110), who "experienced only loss and neglect" from the Government (106). This section has sought to illustrate that the computationally-inflected models of playful pedagogy discussed in this chapter can contribute to our understanding of the depiction of suboptimal pedagogy in *Passages.* The final part of this chapter seeks to highlight similar depictions of this model of inadequate pedagogical scaffolding in Eliot's novel *The Mill on the Floss.*

The Mill on the Floss: Playful Pedagogies and Incestuous Educations

The purpose of this final section is to show that play in *Mill* is figured as optimal or suboptimal according to the extent to which it facilitates cognitive-behavioural development on a model that figures normative flexible behaviour as an arrangement of inflexible units. This section therefore argues that Eliot in *Mill* foregrounds a logic of play as progress similar to that which Babbage derived from the Engines and Automaton. This section also suggests that Eliot in *Mill* depicts this computational model together with ideas

deriving from Herbert Spencer's *Education: Intellectual, Moral and Physical* (1861). This was an influential pedagogical text whose chapters were published as a series of articles in various British journals between 1854 and 1859.

A large proportion of *Mill* is devoted to the childhood of its protagonists, Maggie Tulliver and her brother Tom, allowing Eliot to depict a range of play behaviours across various contexts. This allows stable features of their play to be observed. Maggie's spontaneous play-acts often consist of structural violence towards objects: she licks paint off a lozenge box, scatters a house of cards, and puts her head through a kite (Eliot, *Mill* 32, 75). Laura Emery claims that these acts express Maggie's subconscious aggression towards her brother, but there is evidence that this aggression also serves another, more generative purpose (25-26). Maggie's play often involves deconstructing objects with a segmented or layered form to reveal their composite units: Maggie scatters the individual cards that compose a card pyramid, tears through the quadrants of a kite, and peels away a layer of paint to perceive an underlying structure. Maggie's play can therefore be compared with that which Spencer identifies as integral to the child's "self-education": "the delight taken in biting of corals and the pulling to pieces of toys" (65). In the logic of play as progress that this model foregrounds, the purpose of play is to teach techniques for decomposing and reconfiguring cognitive-behavioural units. Spencer and Eliot articulate a similar rationale to recent attachment theory by paralleling the development of such skills with play-objects that invite the child to enact this reconfiguration of discrete units.

Although only around four years her senior, by dictating the form of much of her play Tom acts as play-companion for Maggie (Eliot, *Mill* 29). Maggie believes Tom to be skilled in opening padlocks and gates, operations which suggest a reversible process of conjoining and dissociation (35). Yet despite his promise as a play-companion, Tom consistently punishes Maggie for structural modifications made in play. This is even the case when the structure in question is highly unstable:

> Maggie, starting up hurriedly from her place on the floor, and upsetting
>
> Tom's wonderful [playing card] pagoda . . . Maggie stood in dismay and
>
> terror while Tom got up from the floor and walked away, pale, from the
>
> scattered ruins of his pagoda… (75-76)

A playing-card house is composed of discrete units, and possesses a hierarchical structure similar to the pyramids that the child-Engine forms in *Passages*. Maggie struggles to engineer a final structural completion from the units she is given, something interpreted by Tom as a weakness: "Tom could build perfect pyramids of houses; but Maggie's would never bear the laying on of the roof" (75). Maggie is taught that structural revision is destructive, annihilating play-object, play-companion, and future opportunity for play: "you pushed your head through my kite, all for nothing . . . you shan't go fishing with me tomorrow" (32). Tom can see no purpose in such fragmentation: it is "all for nothing".

Tom projects his discomfort regarding structural modification onto Maggie, as illustrated by this episode where he makes a game out of splitting a jam-puff:

> "O my buttons!" With this interjection the knife descended on the puff and
>
> it was in two, but the result was not satisfactory to Tom . . . "I'll have that
>
> with the jam run out,' said Maggie . . .
>
> "You may have it if it comes to you fair, but I shan't give it to you without.
>
> Right or left- you choose, now . . . You keep your eyes shut, now, or else
>
> you shan't have any."
>
> . . . She shut her eyes quite closed till Tom told her to "say which" . . .
>
> "Oh please, Tom, have it; I don't mind- I like the other- please take this."
>
> "No, I shan't," said Tom, almost crossly, beginning on his own inferior
>
> piece.
>
> Maggie, thinking it was no use to contend further, began too . . .

"Oh, you greedy thing!" said Tom, when she had swallowed the last

morsel. Maggie turned quite pale. (40)

Tom begins by making a structural division with his knife, but the result is "not

satisfactory". Despite this inauspicious start, Tom invites Maggie to play a game involving a

"random" decision between two discrete states: right hand or left hand. Her decision,

however, is intensively structured by Tom, who dictates its form (eyes shut "now"/choose

hand "now"). I would argue that this episode demonstrates Eliot's awareness that play is at

most partially random. Her sense of its structured flexibility appears to be as acute as

Babbage and Turing's. Yet even this amount of flexibility proves too much for Tom to bear,

and Maggie must bear the brunt of his discomfort with the uncertain outcome of heuristic

methods. In an episode that can be compared with Babbage's illustration in the sketch,

Maggie is described as inept at playing with "marls (marbles)" (29). The inflexible play Tom

engineers does not allow her to develop skills for effectively manipulating discrete units.

Maggie's consciousness of creative potential when a structure is decomposed and

reconfigured is gradually eroded: she dismisses patchwork as "foolish work . . . tearing

things to pieces to sew'em together again" (13).

Eliot identifies two types of unsatisfactory pedagogical intervention in *Mill*: "one is,

the enjoyment of the reverend gentleman's undivided neglect; the other is, the endurance

of the reverend gentleman's undivided attention" (120). Similarly, Spencer in *Education*

foregrounds structure, but not *too* much structure:

And as, in supplying aliment, and clothing . . . without at all interfering

with the spontaneous development of the limbs and viscera, either in their

order or mode; so, they [parents and teachers] may supply sounds for

imitation, objects for examination, books for reading, problems for solution

. . . without in any way disturbing the normal process of mental evolution;

or rather, may greatly facilitate that process. (69)

The level of pedagogical intervention that Spencer regards as optimal corresponds to the computational logic of scaffolding in attachment theory. Maggie, however, experiences fluctuations between undivided attention and undivided neglect in her play interactions. Rigidly controlling of their joint play, Tom is also often absent for long periods at school, or simply rejecting: "he always represented it as a great favour on his part to let Maggie trot by his side on his pleasure excursions" (Eliot, *Mill* 126).

Examples of undivided attention given to Maggie's play by adults are few, and function to constrain her play within inflexible parameters. After accidently crushing a cake, which, undoubtedly based upon her experiences with Tom, Maggie perceives to be the end of her own play, she contrives to ask her cousin Lucy to request a tune from her uncle's musical snuff-box. Maggie, who "think[s] any barrel-organ splendid", is literally moved by its internal movement, the snuff-box containing a miniature version of this instrument (339):

> when the magic music ceased, she jumped up, and, running towards Tom, put her arm around his neck . . . I must tell you that he had his glass of cowslip wine in his hand, and that she jerked him so as to make him spill half of it . . .
>
> "Why don't you sit still, Maggie?" her mother said, peevishly. (81-82)

In the Analytical Engine barrels similar to those used in barrel organs are used to determine the sequencing of machine behaviours and instructions, including instructions communicated by Operation cards: it is notable that Maggie's play results in the rearrangement of Tom's "cards". I want to argue that this image of the music box is comparable to Silas' "computational" routine, in that it suggests a conceptual similarity with the Babbage Engines. Yet it is ultimately Maggie's play, not the mechanism of the snuff-box, which generates non-predetermined behaviours. Maggie uses the structure of the play situation as a "random element" to aid her in forming new behavioural

combinations. Yet once again Maggie offends by possessing any behavioural flexibility, even the structured kind.

Eliot depicts a complex relationship between the undivided attention and undivided neglect Maggie receives in play interactions with Tom and adult caregivers: "aunt Pullet gave permission [for outdoor play], only enjoining them not to go off the paved walks in the garden" (82). This "stick to the paths" routine represents an inflexible play schema similar to the programme that Turing describes to simulate gameplay using a predetermined set of rules. The paradox is that this routine enables Maggie's caregivers to absent themselves from the task of providing further structure for her play, having provided an inflexible "programme" that can run in their absence. Tom also finds it too challenging to provide structured flexibility for Maggie, confining himself to "stick to the path"-type routines. His attempt to provide Maggie with structured flexibility in the jam-puff episode quickly reverts back to programmatic control: he cannot tolerate her as a "random element".

Although Maggie is permitted to simulate play using inflexible routines, I want to show that Eliot parallels Turing and attachment theory in her implicit judgment that such play does not support the development of cognitive-behavioural flexibility. There is evidence in the novel that Tom's cognitive-behavioural traits are the result of incestuous pedagogies and unsatisfactory play experiences. Tom's habitual play objects- a knife and a cord- suggest a latent recognition of the processes of division (knife) and combination (biding cord) figured in this logic as the purpose of play (125). This desire for reversible processes of association and detachment corresponds to the habitual phrase with which Tom expresses excitement: "O my buttons!" (40, 142). Despite using this phrase immediately before dividing the jam-puff, Tom cannot capitalise upon its insight: "If he broke the lash of his father's gig-whip by lashing the gate, he couldn't help it- the whip shouldn't have got caught in the hinge" (57). A gate is an object with two distinct "states".

Tom is equipped with an instrument (knife/gate) to form discrete units, or states, and an instrument (cord) to effect their combination by binding. Instead, his play obstructs the "hinging" point at which movement between states could occur, whilst simultaneously destroying the object that could temporarily bind them.

Tom, like Maggie, requires assistance in applying the heuristics suggested by his play. It is clear, however, that Tom cannot seek this from his formal education. Although Tom's tutor Mr. Stelling possesses a "certain hearty kindness", this does not prevent his pedagogical methods from being incestuous (148):

> Mr Stelling was not the man to enfeeble or emasculate his pupil's mind by simplifying and explaining . . . with smattering, extraneous information, such as is given to girls. (124)

> Mr Stelling's duty was to teach the lad in the only right way- indeed, he knew no other: he had not wasted his time in the acquirement of anything abnormal. (122)

Stelling refuses to decompose structures of knowledge into their constituent parts, as to do so would contravene his system of "*solid* instruction" (121, emphasis added). This inflexible method, however, produces the decontextualised fragments, or "smattering", he wishes to avoid. The way in which units of knowledge can be brought into relation remain obscure: "though by hard labour he [Stelling] could get particular declensions into his [Tom's] brain, anything so abstract *as the relation between cases* . . . could by no means get a lodgement" (124, emphasis added). With a scattering of decontextualised fragments and a solidified mass of material too inflexible to apply, Tom is left "to scramble through life with some fragments of more or less relevant knowledge, and a great deal of strictly relevant ignorance" (148). Stelling's methods therefore generate pathologies of fragmentation and decontextualisation similar to those associated with incestuous pedagogy.

Stelling's refusal to "simplify" reinforces the anxiety regarding structural decomposition that Tom inherits from his parents. After the "breaking down" of his father's fortunes (171), Tom's mother laments that "I wanted you to have all o' this pattern[ed cloth]" and expresses fears that her china will be broken (178, 183). Despite these discouragements, Tom continues to search for a satisfactory play experience, purchasing a Dutch doll and sugar-candy for Stelling's daughter:

> he liked to think how Laura would put out her lips and her tiny hands for the bits of sugar-candy; and, to give the greater keenness to these pleasures of imagination, he took out the parcel, made a small hole in the paper, and bit off a crystal or two, which had so solacing an effect . . . that he repeated the process more than once on his way. (140)

Tom is "solace[d]" for his lack of satisfactory play by nipping off individual units from the visibly crystalline structure of the sugar-candy, whilst simultaneously making tiny alterations to the once unitary surface of the paper. He can only bear to experience such play, however, when projected through another's experience. I cannot help wondering about the "emasculating" play that Tom desires with the jointed Dutch doll. The flexible arrangement of discrete units it represents seems to burn a hole in the pocket where he stashes his play-objects: stored there, it constitutes a "ray of expected pleasure" (140).

Tom's play must also compensate for another of the pathologies of incestuous pedagogy, a failure to teach skills for combining cognitive-behavioural units. This quote indicates that play affords a concrete experience of how discrete units combine:

> he [Tom] could throw a stone right into the centre of a given ripple, he could guess to a fraction how many lengths of his stick would take to reach across the playground, and could draw almost perfect squares on his slate without measurement. But Mr. Stelling took no note of these things: he only observed that Tom's faculties failed him before the abstractions hideously symbolised to him in

the pages of the Eton Grammar, and that he was a state bordering on idiocy with

regard to the demonstration that two given triangles must be equal- though he

could discern with great promptitude and certainty that they *were* equal. (122)

His eyes were apt to get dim over the page . . . his fingers played absently in his

pocket with his great knife and his coil of whip-cord, and other relics of the past.

(125)

Understanding how discrete units combine is integral to the arithmetical and grammatical

rules that Eliot associates with Tom's play: in ascertaining how many discrete stick-lengths

combine to produce a certain length, he is performing simple geometry. Tom "*play*[s]" with

his knife and whip whilst he struggles with abstract grammatical rules, suggesting a vague

comprehension that the play-behaviours they symbolise could potentially be of assistance

to him in his difficulties.

There is evidence in *Mill* that Eliot understood cognitive-behavioural competencies

to be transferable: "when you get a thoroughly educated man . . . he's at no loss to take up

any branch of instruction. When a workman knows the use of his tools, he can make a door

as well as a window" (20). Eliot in this quote appears to foreground a pedagogical model

comparable to the generalist aspects of recent attachment theory. According to this logic,

Tom should be capable of utilising his thoughts regarding configurations made during play

as a means of discovering heuristic methods that form the basis of a generalised cognitive-

behavioural flexibility: "What was once thought of as purposeless action, or play, or

mischief, as the case might be, is now recognised as the process of acquiring a knowledge

on which all after knowledge is based" (Spencer 63).

Similarly, in *Mill*, lack of heuristic ability in play corresponds to a general lack of

heuristic ability. Eliot observes that Tom regards his Latin exercises as "a kind of puzzle that

could only be found out by a lucky chance" (146), and that "The state of mind in which you

take a billiard-cue or a dice-box in your hand is one of sober certainty" compared with Mr. Tulliver's attempts to solve the "puzzling thing of which school to pick" (147, 8). As Megan Norcia observes in her history of puzzle play and its relation to imperial ideologies, jigsaws were widely used in the mid-nineteenth century as a means of teaching heuristics (3, 17).[17] What the Tullivers lack, however, is the ability possessed by Automaton and the child-machine to evaluate the results of a given heuristic. Because of this absence of an interpretative mechanism, their application of heuristic methods is subject to the vagaries of "lucky chance".

To satisfy his need for play, Tom identifies military drill as a compromise. For him and his instructor it is a source of "high mutual pleasure" (150): "'Heads up!' he added, in a tone of stern command, which delighted Tom" (151). Drill enables each "playful" movement to be inflexible, with predetermined combinations taking the place of heuristic ability. I would argue that because this play is similar to Stelling's incestuous pedagogies, it avoids being equated with any "abnormality". Its militaristic aspect also staves off any suspicion of an "emasculating" taint, with Tom heightening its phallic dimension by imploring his instructor to teach him the "sword-exercise" (152). Spencer's reasoning as to why gymnastics fails as a substitute for play can also be applied to this context (171). The child's "natural, spontaneous exercise having been forbidden", the prescriptive movements of gymnastics produce behaviour "less varied than those accompanying juvenile sports" (171). Gymnastics does not allow the child to exert agency in modifying their behaviours. Paralleling Tom's experience of drill, the behavioural sequencing it involves is predicated on "artificiality" (171).

When Tom attempts to implement these play behaviours independently, he is faced with a mortifying lack of control:

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[17] The use of the word "puzzle" to describe the toy is first recorded in 1858 (Norcia 4).

> "I'm the Duke of Wellington! March!" stamping forward with the right leg a
>
> little bent . . . "One-two" said Tom, resolutely, thought at "two" his wrist
>
> trembled a little. "Three" came more slowly, and with it the sword swung
>
> downwards . . . The sword had fallen, with its edge on Tom's foot, and in a
>
> moment after, he had fallen too. (Eliot, *Mill* 158)

The pacing of this episode emphasises Tom's difficulty in managing transitions between
discrete units of behaviour, the "One", "Two" and "Three". As argued previously,
incestuous pedagogies are understood to weaken this capacity- a deficiency that is
embodied in Tom's trembling arm and buckling leg. As the alcoholism of Tom's drill-master
suggests, a diminishing of cognitive-behavioural agency is the other face of pedagogies that
demand behavioural rigidity (150). This fear of losing cognitive-behavioural agency
exacerbates Tom's discomfort with play: he turns "pale" when Maggie scatters his pagoda,
and finds the result of the jam-puff division "not satisfactory".

I would argue that these experiences result in Tom subjecting Maggie to incestuous
pedagogies. Even Maggie's mother, largely indifferent to her children's play, understands
that there is something pathological in the way Maggie plays "like a Bedlam creatur' [*sic*]"
(12). Maggie vividly describes her predicament:

> It is with me as I used to think it would be with the poor uneasy white bear
>
> I saw at the show. I thought he must have got so stupid with the habit of
>
> turning backwards and forwards in that narrow space, that he would keep
>
> doing it if they set him free. (327-28)

Maggie, like the bear at the show, has ostensibly been present at the scene of play during
her childhood. During this time, however, she has been subject to inflexible, cage-like
conditions that have disturbed her cognitive-behavioural development: Maggie indicates
this when she imagines the bear growing "stupid" with the "habits" he has developed. Even
now her childhood play is behind her, its lasting effects lead her to believe that she will

never recover a satisfactory developmental experience. She remains cognitively trapped within the conditions of suboptimal play even when ostensibly "set . . . free" from them.

In the computational logic of play as progress described in this chapter, competencies learnt in play are understood to produce a corresponding increase in cognitive-behavioural ability in other contexts. In a corresponding fashion, Tom in adulthood exhibits habits resulting from his incestuous education and lack of satisfactory play: he remains "unbending, unmodifiable" (425). He also continues to experience Maggie as a "random element" that threatens to throw the pagoda of his rigidly constructed selfhood into disarray:

> He [Tom] . . . said, in the tone of a *kind pedagogue* . . . "you have *no judgement and self-command* . . . a brother, who goes out into the world and mixes with men, necessarily knows better what is right and respectable for his sister than she can know herself."
>
> (344-45, emphasis added).

With his incestuous pedagogy depriving Maggie of independent "judgement and self-command", Tom's solution is to apply his former strategy of controlling any element of Maggie's behaviour that might be left in play.

The sibling incest theme in the novel has been explored by numerous critics including Joseph Boone, Deborah Nord, and David Smith. Tom's relationship with Maggie can be regarded as a form of asymmetrical incest, where an individual uses force or intimidation to compel one younger or weaker into incestuous acts. As demonstrated by the jam-puff episode, Maggie is forced by Tom to "play" in ways she finds distressing, finding it "no use to contend". The pathologies that Tom generates in the course of these play encounters correspond to those that Ferenczi attributed to incest trauma, including the imprinting of the aggressor's idiom. As Elizabeth Ermarth has observed, Tom makes Maggie's choice for her, "literally requiring her to speak the words he gives her" (597). I

would therefore argue that Eliot's depiction of the consequences of incestuous pedagogies remains stable across her novels.

Maggie can be compared to the child described by Ferenczi who, seeking only play and passive tenderness from its caregiver, becomes subject to incest trauma: "carried away by the daughter's sexual play, [he] had raped her" (*Diary* 165). This asymmetry is indicated by the fact that Tom's pedagogies imaginatively make Maggie "wife", paralleling Ferenczi's belief that the victim of incest trauma is forced to fulfil a spousal role towards their aggressor: "[Tom] meant always to take care of her, make her his housekeeper, and punish her when she did wrong" (Eliot, *Mill* 35). Tom conceptualises the futurity of Maggie's play in terms of her operating as a subservient wife-substitute, whilst imposing upon her in a similarly incestuous way in the present. This image reveals Tom's dependence on Maggie for the upkeep of his cognitive-behavioural structures: he demands that she keep his (card) house in order.

The remainder of this section is intended to show that these childhood traumas leave Maggie vulnerable to similar traumatisation in her subsequent relationships with Philip Wakem and Stephen Guest. Philip's methods as "*brother* and *teacher*" prove similar to the incestuous pedagogies visited upon Maggie by Tom in their childhood play (289, emphasis added). A comparison that can be made with *Deronda* is that all subsequent aggressors in *Mill* are figured as similar to the first: Maggie has a dream in which Philip metamorphoses into Tom (413). His apparent ability to tolerate structural revision makes Philip initially appear promising as a play-companion: "'Oh yes,' said Philip, 'it's very easy [to draw]. You've only got to look well at things, and draw them over and over again. What you do wrong once you can alter next time'" (142). Maggie's desire for an adequate caregiver is intense, motivating her religious fervour: "I think we are only like children, who some one who is wiser is taking care of" (288).This need, along with Philip's desire that she regard him as "brother and teacher", gradually encourages Maggie to approach him with

"playful" intention (291): "Maggie felt herself a child again" (264). He promises to liberate Maggie from the effect of incestuous pedagogies: "It makes me wretched to see you benumbing and cramping your nature" (289).

Philip, however, recognises in himself an attitude towards Maggie that savours of "the baseness of compulsion" (363). As Johnstone has recognised, Philip exerts pressure upon Maggie to conform to his perspectives and desires (52). Philip views Maggie as a machine he can programme using an appropriate play routine: "He laid his plan and calculated all his moves with the fervid deliberation of a chess-player" (371). These "calculated . . . moves" are similar to the predetermined and inflexible routines that left nothing in play for Maggie during her childhood. Tom's incestuous pedagogies leave Maggie vulnerable to this "compulsion": she feels a "childish contrition" when Philip scolds her (Eliot, *Mill* 363). In a similar manner to Tom, Philip looks to Maggie as a means of providing himself with cognitive-behavioural structure: "I'm cursed with susceptibility in every direction, and effectively faculty in none . . . there is one thing: a passion answers as well as a faculty" (287). Philip's confession leaves "her own discontent vibrating as it used to do" (287). Maggie, present at the sword incident, has already witnessed that this high-structuring attitude veils a loss of cognitive- behavioural agency.

Philip's attitude towards Maggie suggests another facet of the white bear image. The play of her companions depends on rigid forms of behaviour being imposed upon her: to provide such pleasures, she herself must be caged. Ermarth recognises that Philip makes demands on Maggie, but understands the nature of his request to be that "she be herself and trust her instincts" (596). Although this is what Philip ostensibly demands, I want to suggest that his "playful" pedagogies produce the opposite effect. Rather than developing her independent judgment, their joint play leaves Maggie structurally reliant upon Philip's idiom: "I had need have you always to find fault with me and teach me" (Eliot, *Mill* 363).

Eliot emphasises that Maggie is a "child" in play with Philip, seeking the tenderness lacking in her brother: "what a dear, good brother you would have been" (288). It is my contention that Philip's subsequent confession of a sexual attraction to Maggie constitutes a tipping point in the novel between incestuous pedagogy and incest trauma. Peggy Johnstone expresses scepticism when "Eliot claims Maggie's innocence of his intentions" (51), but I would argue that Maggie's ignorance of a sexual motivation for Philip's play is consistent with a Ferenczian understanding of the mechanics of incest trauma (Eliot, *Mill* 294). Ironically, this sexualisation of Maggie's play coincides with what appears to be a transfer of her imaginative play to a corresponding context:

> "I'm determined to read no more books where the blond-haired women carry away all the happiness . . . If you could give me some story, now, where the dark woman triumphs, it would restore the balance."
>
> "Well, perhaps you will avenge the dark women in your own person, and carry away all the love from your cousin Lucy." . . .
>
> "Philip, that is not pretty of you, to apply my nonsense to anything real", said Maggie, looking hurt.
>
> (Eliot, *Mill* 292)

Philip, however, makes this transfer of Maggie's play, not Maggie herself. Maggie finds this application of her play discomfiting, paralleling Sutton-Smith's concern that certain play transfers constitute cognitive-behavioural impositions. This is not Maggie's own expression of her learning, but another manifestation of play as incestuous pedagogy. This does not necessarily represent a rejection of the type of developmental narrative that would later be associated with generalist AI, as this section has sought to illustrate that *Mill* emphasises the wider relevance of skills learnt in play. I would instead argue that Eliot regards these incestuous transfers as a perversion of an optimal course of development, rather than an instance in which the developmental model itself is undermined.

Maggie's relationship with Stephen Guest can be compared with her relationships with Tom and Philip, in that it begins as an intersection between play and pedagogy. Maggie meets Stephen when staying at her cousin Lucy's home expressly for the purpose of structured play: Lucy insists on placing Maggie "under a *discipline* of pleasure" (328, emphasis added). Immediately attracted to Maggie, Stephen is amused to find that she regards him as a combination of play-companion and pedagogue: "as if he had been the snuffiest of old professors" (334). Eliot emphasises that boating is a favourite shared play activity of Maggie and Stephen: "she likes it better than anything" (403). However, as in the white bear image, the image that represents Maggie's play is also the image of her trauma. In *Deronda*, the incestuously traumatised Gwendolen uses the image of a boat to articulate her fears regarding the loss of her own agency: "Other people allowed themselves to be made slaves of, and to have their lives blown hither and thither like empty ships in which no will was present" (34). In a similar image, Maggie in *Mill* expresses her desire to learn cognitive-behavioural agency through play when she expresses a desire to steer the boat: "I shall not be satisfied until I can manage both oars" (336). Immediately after making this statement, however, Maggie loses her footing and Stephen takes hold of her with a "firm grasp" (336). Maggie's play once again leaves her in the grip of another.

Stephen's incestuous pedagogies culminate in another boat journey:

> Maggie felt that she was being led down the garden among the roses, being helped with firm tender care into the boat . . . by this stronger presence that seemed to bear her along without any act of her own will… (407)

> Maggie was hardly conscious of having said or done anything decisive. All yielding is attended by a less vivid consciousness than resistance . . . it is the submergence of our own personality by another. (410)

Maggie's own idiom is thus submerged in Stephen's. Maggie drifts along with him until she

is unable to see a way to recover cognitive-behavioural agency: "the recoil of her fatigued

sensations from the impracticable difficulty of getting out of the boat . . . helped to bring

her into a more complete subjection" (410). The "choices" Maggie makes are not

structured decisions that permit a degree of agency, but are predetermined and inflexible.

Maggie is conscious enough of this fact to complain to Stephen that "You have wanted to

deprive me of any choice" (409). Paralleling Ferenczi's descriptions of incest trauma,

Maggie experiences his incestuous passion as aggression: Maggie perceives the

"suppressed rage" veiled by his "pleading" (409). Maggie's most intense feeling towards

Stephen is also rage: when he kisses her, she "quiver[s] with rage and humiliation" (388).

Maggie's ineffectual aggression against her incestuous aggressor represents the

pathological substitute for the creative aggression of her childhood play.

I want to suggest that through the Guests' identity as industrialists and mill-

owners, Eliot draws parallels between the perversion of Maggie's play and the traumas of

factory workers. The industrial machine represented the antithesis of the child-machine

for Turing, with an inflexible sequence of operations characterising "most machinery

developed for commercial purposes" ("Heretical Theory" 256). When conditions are

optimal, play defends against the child becoming a "commercial machine" with capacities

similar to those of the worker in Babbage's factory system. Michael Steig identifies in *Mill* a

desire for a mechanised body, linking this to the anal retentive trait (48). I would suggest

that the type of mechanised body imagined here, however, carries very different meanings.

Maggie is accustomed to such loss of agency: "there was an unspeakable charm in

being told what to do, and having everything decided for her" (Eliot, *Mill* 410). It is familiar

in the true sense of the word: "she almost desired to endure the severity of Tom's reproof,

to submit in patient silence" (425). Johnstone explains Maggie's "weakness for substituting

another's will" by claiming that she avoids culpability for her decisions by attributing them

to others (54). Yet the most telling phrase here is Maggie's "never consented": "my whole soul has never consented- it does not consent now" (420). As argued in the first chapter, Eliot figures this "never consented" as both a symbol of resistance to the incestuous aggressor and a recognition that such consent is negated by their internal and external presence. "I don't consent" is tantamount to "I *can't* consent", something Maggie is acutely aware of: "Don't try to prevail with me again. I *couldn't* choose yesterday" (416, emphasis added). Maggie is unable to experience meaningful decision-making in her childhood play: she only makes a choice in the jam-puff episode because it is "no use to contend further". As a result, Eliot depicts Maggie in adulthood as lacking in the cognitive-behavioural attributes that would make her consent meaningful.

This chapter has sought to show that perceptions of developmentally significant play were shaped during the nineteenth, twentieth and twenty-first centuries by a computational expression of a tradition of conceptualising the structure of cognition and behaviour. It is my contention that reflecting on the meanings of this tradition in the nineteenth century can reveal the tensions that continue to beset this model, including the correspondences that it foregrounds between incestuous and playful pedagogies. The conclusion that follows offers an interpretation of how these tensions are negotiated in the recent film *The LEGO® Movie* (2014).

Conclusion

This thesis set out to consider the ways in which a specifically computational expression of a tradition of representing cognitive-behavioural flexibility was elaborated during the period 1830 to the present. It has sought to draw attention to the computational concepts that shaped the articulation of this tradition in the mid-nineteenth and the mid-twentieth centuries, and has explored the pedagogical practices that have historically been associated with this computational model. This thesis has endeavoured to show that this computational model continues to determine our understanding of what constitutes normative development and optimal pedagogical practice via the conceptual foundations of attachment theory in mid-twentieth-century computing. It has also claimed that a result of its computational origins, our current thinking about child development features similar paradoxes and tensions to those first identified in the nineteenth century by Eliot and her contemporaries. I wish to conclude by demonstrating that this is the case in the recent film the *LEGO® Movie* (2014). I want to show that in this film, computational models result in similarities between depictions of factory labour and models of normative cognitive-behavioural development.

        In this film, the majority of the animated LEGO figurines are absorbed into legion upon legion of fundamentally interchangeable, blue-collar workers: in this case, of course, construction workers. As cultural sociologist Matthias Zick Varul has observed, these LEGO figurines can be regarded as "disciplined and deskilled worker[s]" (7). As such, they share similarities with the factory workers depicted in *Economy.* The functioning of these LEGO workers can be compared with the execution of an inflexible program in a computer. They receive a set of inflexible instructions from the manufacturer who oversees the system, the evocatively named "Lord Business", communicated in the form of booklets similar to those provided in boxes of LEGO. The instructions in these booklets are composed of an inflexible

sequence of discrete symbol-based instructions, which dictate how to form combinations of discrete and inflexible units. Each booklet can therefore be regarded as similar to an inflexible program in a computer.

That the instructions found in boxes of LEGO share correspondences with computer programs is perhaps not surprising, as this is a toy which has close ties to computing technology. This toy underwent development during a period which saw the rapid proliferation of computing technology, with the patent for the LEGO brick in its current form in being issued in 1958 ("Toy of the Century"). The correspondences between this toy and computational models were highlighted when LEGO began their long-standing association with the Massachusetts Institute of Technology (MIT) in the 1980s (Rollins xx). One of the products of this collaboration was an educational platform which would teach a simple programming language, known as Logo, using LEGO bricks (Martin et al. 12). This was known as the "LEGO® tc Logo" system (12).

The current incarnation of this system, marketed as "LEGO® Education WeDo", claims that LEGO bricks are the ideal vehicle for teaching skills necessary for the construction of algorithms. These include "solving problems by decomposing them into smaller parts" and "using sequence, selection and repetition in programs" ("LEGO® Education"). The manner in which individual LEGO bricks constitute discrete "primitive" units which can be unambiguously identified as belonging to a specific "type" gives them a similarity with the elementary information processes which constitute the "building blocks" of computer programs. These parallels with computer programs are further compounded by the fact that complexity in the LEGO system is achieved by forming combinations of discrete units according to a set of procedural rules. I would therefore suggest that the

LEGO system is computational in character: computer scientist Giulio Ferrari has even

provided a description of how to construct a "LEGO Turing Machine" (107).[18]

Because the program executed by the construction workers in the film is entirely

predetermined and inflexible, it can run automatically to Lord Business' precise

specifications in his absence. These workers have been taught a select portion of the

computational skills that the LEGO Group believes are taught by engaging with this toy:

"sequence . . . and repetition". This enables the behaviour of these workers to be externally

regulated in a similar manner to how Babbage sought to regulate the behaviour of workers

in *Economy*, namely, by being forced to follow predetermined and inflexible sequences of

discrete instructions corresponding to those found in a computer with the capabilities of

the Difference Engine. As Babbage was aware, parallels exist between the type of inflexible

program that can run automatically in a computer and the task of programming a worker

to execute an inflexible sequence of functions.

It is emphasised that it is in the interest of Lord Business to enforce this inflexibility.

Using a similar logic to Babbage in *Economy*, Lord Business perceives that if he is to retain

absolute control over the system of production, then the individual worker must not

develop the agency to make "combinations" (of LEGO bricks) independently. This is

interpreted in a delightfully literal manner: if workers fail to execute the inflexible program

stipulated by Lord Business, the individual units from which they themselves are composed

are literally glued in place. Lord Business thus enforces the specific distribution of cognitive-

behavioural habits that I have argued Babbage in *Economy* came to regard as necessary as

a result of his researches in computing.

Those opposing the inflexible regime of Lord Business are the "master builders",

their name evoking their artisan status. Because of their capacity to combine inflexible

units flexibly, repeatedly decomposing and reconfiguring structures in response to various

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[18] The phrase "Turing machines" is also used to refer to "universal machines".

contingencies, these individuals move outside the (literally) immobilising logic that is imposed upon the majority of workers. The activities of the master builders would appear to provide a vivid illustration of the tradition described in this thesis, as the LEGO bricks from which they construct their dynamic sculptures are by their very nature inflexible and standardised components. I would argue that the structures generated by the master builders offer a physical expression of this tradition of representing flexible cognition and behaviour as a flexible arrangement of inflexible units.

I want to show that the master builders can also be regarded as enacting the model of total yet temporary flexibility which characterises the specifically computational expression of the tradition described in this thesis. The modular structures that the master builders construct from inflexible standardised components have the capacity to exist in one inflexible form for an indefinite length of time- for instance, maintaining the form of a fighter jet or a submarine. Yet this inflexibility is nevertheless temporary, as these components retain their potential to be reconfigured as various contingencies dictate. The computationally-inflected dynamic between flexibility and inflexibility that the master builders enact can be compared with the movement between inflexible verticals in the Analytical Engine which allows for partial decomposition and reconfiguration in the interim.

The patent for which the LEGO Group successfully applied in 1958 concerned the stud-and-tube coupling that was designed to enable a secure connection between individual bricks ("LEGO Group History"). The fact that during this period in its history the LEGO Group chose to expend an appreciable amount of resources ensuring that the bricks they produced had the capacity to enact a degree of total inflexibility would appear to suggest that that the specifically computational model of flexibility described in this thesis has influenced perceptions of the model of flexible recombination that this toy invites. The temporary inflexibility permitted by this stud-and-tube coupling functions in a similar manner to the "algorithmic glue" so important to complexity and flexibility in computing.

Fig. 11. LEGO® Skier-Skieur-Skifahrer. Photo used with permission. ©2015 The LEGO Group.

When constructing complex models, many LEGO booklets suggest that the child begin by forming a series of smaller components from individual bricks. These structures are then treated as "inflexible" components which can be joined together to form a larger model, paralleling the construction of complexity in computers (see fig. 11). This suggests that individual bricks are regarded as a type of "primitive" unit which can be combined to generate units corresponding to the symbol structures of mid-century computing.

A further comparison with computing is that the flexibility that such inflexible and standardised components afford can by its very nature only ever be partial. This thesis has argued, however, that the ostensibly minor distinction between the capacity to execute an inflexible arrangement of inflexible units and the capacity to engineer a total yet temporary inflexibility is understood to constitute a step of significant magnitude in developmental

terms. This is similar to the distinction that the child in *Passages* experiences between functioning with the capacities of a Difference Engine and with those of an Analytical Engine. In this particular instance, the ability to decompose and restructure temporarily fixed constellations of units is understood to offer a prophylactic against a lifetime of factory work. I would therefore argue that the computational logic of *The LEGO® Movie* corresponds to that which I have claimed structures *Silas Marner*, where the incapacity of workers to flexibly organise inflexible units results in their subjection to modes of labour similar to those depicted in *Economy.*

Varul also notes the presence within the film of a drive towards "creative destruction, recombination without much consideration for the initial instructions" (7), which he interprets as a defensive reaction against what he terms the "necrocapitalism" of Lord Business (8). According to Varul, Lord Business's modus operandi is to prevent the frozen products of dead labour- capital- from being broken up in order to be revived as living labour: "He wants to fixate the status quo quite literally-using superglue" (8). Varul parallels the force which revives dead labour with the Navajo myth of the trickster-Coyote who incites humans to undergo creative renewal through his introduction of irregularity and surprise into the universe, aligning the qualities of this mythical trickster figure with those of the human child (6): "children are natural born tricksters" (7). He then proceeds to claim that this trickster impulse is comparable to Joseph Schumpeter's "entrepreneurial function", a phrase designating economic innovators who disturb existing business practice and in the process transform market conditions (7). Varul argues that the capacity of LEGO to encompass both creative rearrangement and ossified formal perfection constitutes a medium appropriate for the expression of both these attitudes (6).

I would suggest, however, that the model of flexible recombination depicted in *The LEGO® Movie* corresponds to the computational model of cognitive-behavioural flexibility discussed in this thesis. It is my contention that the particular expression of this

computational model in *The LEGO® Movie* also highlights correspondences similar to those which this thesis has sought to draw attention to. These include correspondences between the execution of an inflexible and modular program composed of discrete instructions and the cognitive-behavioural capacities necessary for factory labour.

Since the 1950s the LEGO Group have identified correspondences between computing technology, child development and the type of play that LEGO affords. From its inception, the LEGO System of Play was marketed as having an educational benefit ("Toy of the Century"). Following the collaboration with MIT, claims regarding the educational benefits of LEGO have attained a stronger computational inflection still. Paralleling Turing's belief in the capacity of domain-specific skills to contribute to a general capacity for computational flexibility, it has been argued that programming using the LEGO-Logo system "supports the development of general and domain-specific skills" (Edwards, Coddington and Caterina 35).

I would argue that *The LEGO® Movie* is premised upon the computational narrative of cognitive-behavioural development described in this thesis. It transpires that the animated "LEGO world" in the film is a gigantic playset situated in the basement of a house. In the film's frame narrative, which depicts events occurring in the "real world" rather than the animated *"*LEGO world", adults are perceived as wanting to play in inflexible ways. The father of the film's child protagonist desires to construct an immovable world out of LEGO by gluing his sculptures in place*,* and cannot tolerate his child's destructive/creative interventions within this space. Something that the father finds particularly distressing is the child's propensity to flexibly join together inflexible units from different playsets in order to create structures not found in any booklet. The child has to teach the adult that it is ultimately a pathological act to engage in the pursuit of absolute inflexibility. The child subsequently enters into a pedagogical relationship with its own caregiver, teaching the adult what constitutes developmentally normative play on this computational model.

This thesis has argued that in *Passages,* however, the child has to be taught by the adult to play in more flexible ways, as the child initially wishes to play in ways that are repetitive and rigidly programmatic. Instead of the child's "wild" psyche being a place of endless creativity, it could be argued that the child in *Passages* emerges a ready-made factory worker. What saves the child from this fate is that it is taught to think in more flexible ways by adults. This is closer to the narrative of the animated segment of the film- that the industrial worker can be saved from becoming a factory drone by being taught the cognitive-behavioural capacities embodied by the master builder. This is the trajectory undergone by the film's animated protagonist, the former construction worker Emmet. Having been encouraged under the regime of Lord Business to interpret his programmatic labour as a play activity, Emmet is taught by one of the master builders, Wyldstyle, that within this logic such forms of play are pathological. The rigid forms of play experienced by Emmet prior to this pedagogical intervention can be compared to the "stick to the path" routines that prove detrimental to Maggie's cognitive-behavioural development in *Mill*.

Having developed skills to flexibly arrange inflexible units as a result of Wyldstyle's didactic interventions, Emmet, along with the other master builders, communicates these capacities to other workers and mounts a communal challenge against Lord Business. By this point in the film, Lord Business has threatened to explode the LEGO world if his authority to enforce an inflexible structure is undermined. I would suggest that this absolute fragmentation constitutes a predictable response to the breakdown of this inflexible system, shatter being the obverse of pathological inflexibility on this model. At the same time, the film concludes with the LEGO world on the cusp of another fragmentation when the sister of the child protagonist launches a playful assault upon her brother's creations using her own Duplo® playsets. Faced with this demonstration of playful aggression, the occupants of the LEGO world succumb to panic and disarray. Their distress can be compared with that experienced by Tom when faced with his sister

Maggie's destruction of his play objects. This would appear to support the claim that this computational model encodes of a degree of traumatic fragmentation as the prerequisite for cognitive-behavioural flexibility.

When Varul states "children are *natural born* tricksters" he is replicating an ideal of childhood which has its roots in the Romantic period, one profoundly at odds with the developmental narratives that I argue derive from computing. Whereas the conception of childhood associated with the Romantic era is one of "innocence, spontaneity and unfettered imagination" (Grenby 182), it has been claimed in this thesis that the untutored impulse of the child on this computational model is to play in a repetitive and inflexibly programmatic manner. This is exemplified by the sketch, where prior to Babbage's didactic interventions the child's "spontaneous" play consists of the execution of inflexible routines.

I therefore want to suggest that tensions exist between how we fantasise the cognitive condition of childhood and the cognitive-behavioural models that we have arrived at through the influence of computing technology. Brian Sutton-Smith claims that children's play frequently tends towards the "banal and repetitive", modes of play which undermine the cultural logic that "flexibility is play's main function" (31). It is my contention that *The LEGO® Movie* negotiates these tensions by displacing them onto an animated figure. Emmet is content to execute inflexible play routines until he is taught by a Babbagesque engineer- a "master builder"- that these forms of play are pathological if left undeveloped. I would argue that this makes Emmet's developmental narrative comparable to that of the child in the sketch.

This thesis has claimed that this computational model implies that children become ready-made factory workers unless they develop in certain optimal ways, drawing attention to this logic in *Silas Marner* and *The Mill on the Floss*. The correspondences with factory labour encoded within this computational model could be said to underlie the appeal of handmade wooden toys, as a tangible referent to the artisan status which is associated

with the normative polarity of this model. This is indicated by Mokulock, a wooden version of LEGO that offers children the opportunity to hone their combinatorial skills whilst isolating them from all taint of the factory. Just how entangled the materiality of these artisanal objects has become with this logic is indicated by the statement by the manufacturers of Mokulock that "Wood can help enhance creativity" ("Mokulock"). This conclusion has argued that the *LEGO® Movie* and Mokulock suggest that we have yet to reconcile the tensions associated with this computational model of child development.

This thesis has focused upon the depiction of this computational model in the fiction of George Eliot, with the aim of illustrating that Eliot critiques this expression of a tradition of conceptualising flexible cognition and behaviour in ways that are relevant to both nineteenth- and twentieth-century thinking. This concluding section would appear to suggest that this computational model is also relevant for the study of twentieth- and twenty-first-century literary and film texts. This comparison of *The LEGO® Movie* with the developmental narratives foregrounded by Babbage and Eliot indicates that it might also be a productive strategy to draw parallels between the computational expression of this tradition in the literature and culture of the nineteenth century and expressions of this tradition in twentieth-century literature and culture.

I would also propose that there is much to be gained in tracing this computational expression of a tradition of representing flexible cognition and behaviour in recent attachment literature relating to school-based practice. This thesis has sought to trace how this computational model influenced nineteenth-century perceptions of what constitutes normative pedagogy within the classroom setting, focusing upon public schools and the half-time system. I would suggest that a similar consideration of the manner in which perceptions of optimal school-based practice have been influenced by computing in the twentieth and twenty-first centuries would offer a useful means of elaborating upon the analysis contained with this thesis.

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