Diagnostic reasoning in medical students using a simulated environment

Wesley Scott-Smith

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ABSTRACT

Diagnostic ability occupies a pre-eminent position in the skills of a doctor in modern society. Underpinning this attribute is a number of cognitive strategies which are gradually developed through a mixture of experience, acquired knowledge and training. These strategies include *processing and structuring information, decision making, and the emergence of higher cognitive skills*. The apprenticeship model in medicine assumes that students assimilate such skills during training, without ever questioning how they view or engage with the diagnostic role.

The conceptual focus of this study is to use dimensional analysis (DA) to build theory from the perspective or '*lens of the medical student*'. This will use *symbolic interactionism* as its theoretical framework. DA acknowledges the relationship between the researcher's perspective and experience, the data and the participants using a constructivist, relativist epistemological philosophy.

Filmed data has been analysed from real time simulated consultations between 3rd year medical students and a trained actor working from a standardised case (dyspepsia). Each participant completed a filmed consultation and a discussion of diagnostic ideas based upon the history alone. Diagnoses were re-evaluated in light of further examination data and the filming watched back with the researcher using a reflexive discussion approach. Nine participants completed the study providing a rich diet of interactive and reflective data from the simulations focussing upon diagnostic ideas.

Emergent themes point to the *central organising theory of intermediary cognitive adaptation* during an important transition in the curriculum. This is characterised by the use of learnt cognitive strategies which act as failsafe mechanisms in maintaining process within the simulation. However, there are examples of naive cognition in applying aspects of conditional reasoning and interpreting clinical probability rules. The diagnostic process is driven by the clinical history with little integration of the physical examination features.

This finding may explain *the emergence of cognitive errors during undergraduate training*, and links normative theory with diagnostic errors seen in clinical practice.

Reconstruction of clinical skills and diagnostic thought through reflective analysis are evident. Under the right conditions, simulations can provoke a constructive (intrinsic) perspective on cognitive skills which can advance professional development in the diagnostic reasoning process.

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GLOSSARY OF TERMS

CP 101 (Clinical Practice module 101) is an extensive module running throughout year 1, introducing students to the basic skills of clinical skills. The researcher is the Module Lead for both CP 101 and 201.

CP 201 (Clinical Practice Module 201) is the equivalent module for year 2 which continues and augments themes from CP101.

CR (Clinical reasoning): the context dependent, generic decision making processes related to professional practice encompassing the dimensions of knowledge, cognition, reflective enquiry, and metacognition.

DA (Dimensional Analysis); a version of 2nd generation Grounded Theory attributed to the work of Leonard Schatzman.

DR (Diagnostic Reasoning) reasoning applied to the process of formulating diagnoses within clinical practice.

DTI (Diagnostic Thinking Inventory): a 41 item validated inventory analysing flexibility and structure in cognition when thinking about making a diagnosis.

Epistemology is the study of knowledge, in this study particularly what is meant by a diagnosis and what knowledge contributes towards making a diagnosis.

GTM or GTT (Grounded Theory Method or Technique): a rigorous qualitative research methodology proposed by Glaser & Strauss in 1967 using constant comparative analysis as a way of conducting a research enquiry. It emphasises that theory must emerge from the data, not prior knowledge.

Narrative Reasoning studies what people say, how they say it and the interpretation of what is said (e.g. the medical history).

Ontology is the study of being, and involves the individual's perception of their changing role and identity influenced by context and professional development.

Phase 1: The first two years of the curriculum comprising six systems based modules, and two (extensive) clinical practice modules running in tandem.

Phase 2: Years 3 and 4 in the curriculum when ward based clinical rotations begin involving more face to face contact with patients.

SI (Symbolic Interactionism): sociological theory of human interaction proposed originally by Mead (1934) and extended by Blumer (1969), based upon the principles that '*humans act towards things based upon the meanings they have for them; meanings are handled in and modified through an interpretative process and by the person dealing with the things that they encounter'.*

SP (Standardised Patient); a patient or actor working from a standardised scenario, who is trained to deliver symptoms (and signs) in a consistent manner for the purpose of training or teaching.

Author's Declaration

I, Wesley Scott-Smith confirm that the material in this thesis is my own work, and where other sources of information have been used, they are referenced and acknowledged accordingly.
Dr. Wesley Scott-Smith, April 2013.

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1 Chapter 1: Introduction to the thesis

1.1 Professional and personal perspectives-why am I doing this research?

The essence of good patient care relies upon the diagnostic reasoning process to enable sound decision making in clinical practice, and it remains an essential attribute for all clinicians in the development of their individual expertise, and also in minimising diagnostic error (Norman, 2000; Heneghan *et al*, 2009; Norman & Eva, 2010). *But how is this attribute shaped and formed? Where do we learn the cognitive skills that are clearly so fundamental to the formulation of diagnoses and why are some doctors better than others?* Is the skill of reasoning in clinical practice merely an extension of the power of natural analysis in considering the attributes of a narrative and the meaning of events (Schatzman, 1991)? Such questions have been asked many times by research papers attempting to find a way to reduce human error in the reasoning process, as flawed cognition accounts for most diagnostic errors in practice (Graber, 2005). If expert cognition could be condensed and transferred through teaching that is more effective, then human fallibility in decision making might be minimised.

Decision making in professional practice encompasses a number of interactive and complex skills under the generic term of clinical reasoning (CR), and these skills are gradually embedded in clinical practice (Higgs *et al*, 2008: 3-6). Such attributes embrace and facilitate the complicated issues which predicate decisions and judgements in patient care, and one of the central processes is diagnostic reasoning, which describes the cognitive processes which contribute towards reaching a plausible (and defendable) diagnosis to explain a range of symptoms and signs. This research study will focus upon this process and how it is viewed through the eyes of 3rd year medical students grappling with one of their early exposures to stand-alone

decision making through the experience of the simulated consultation integral to this study.

By adopting this perspective, the study places itself in a qualitative research paradigm with the emphasis firmly on the experience of the undergraduate medical student. Research in the complementary paradigms of information processing and judgement theory (which will be discussed later in this chapter) usually *objectify* decision making in the diagnostic process, and considerably less research has been devoted to exploring the perspective of the learner and how they view their role and responsibilities in this process. This informs one of the main questions within this thesis: *How is the diagnostic process constructed from a student's perspective and how might this influence teaching at the relevant stage?*

As a teacher interested in developing diagnostic reasoning in the curriculum what do I know about their views of diagnostic strategies? It is conceivable that I am making considerable assumptions about how students view one of the central processes of medicine and therefore committing the cardinal error of 'forcing my views' or theory upon the research process and in my teaching (Glaser, 1978).

The origins of this thesis arose from trying to develop a new mnemonic strategy that would act as an aide memoire for novice students covering the key parameters of a consultation. Within the last stage of this mnemonic strategy was a diagnostic component; however, there was a nagging question about its development and application. *The major problem with propagating the new mnemonic was the inability to put myself in the position of the student using it*. *I could see its potential use but could they?*

A research method was required to unlock their views on the diagnostic process and the features thereof, before deciding that this mnemonic would have some application. It was suggested that as a researcher, I had to align my perspective with that of the student cohort before further development might occur. Consequently, the research method and conceptual framework needed to reflect the student perspective

and what they understood about diagnostic reasoning; this pointed towards using a form of grounded theory method called Dimensional Analysis to explore emergent themes from the simulations. The mnemonic idea was shelved to concentrate upon achieving a greater understanding of what medical students think about the diagnostic reasoning process.

One of the assumptions that could have influenced my views within the research process is the idea of theoretical anchorage (prior experience and knowledge), which will be discussed further in Chapter 2 (Schatzman in Maines, 1991; Kools *et al*, 1996). To illustrate how prior knowledge might sway data analysis, it is worth briefly considering the integrated curriculum approach which this medical school has adopted. It is known that integration of biosciences with early patient contact confers a number of benefits (O'Brien *et al*, 2001; Woods *et al*, 2005; Diemers *et al*, 2008), however I cannot assume that the findings in my study will necessarily endorse this view; indeed the findings might suggest another perspective which hitherto has not been considered.

Therefore recognising what impact this sort of assumption might have upon the study became an essential component of the research process for this thesis i.e. *reflexivity*. This ensures that the researcher is aware of their own meanings and perspectives for things based upon personal and professional experience, and therefore how this might influence the research process (Schatzman in Morse, 2009: 93). In addition, I have the benefit of many years of experiential learning through patient contact to draw upon, which sensitises me to analysing actions and thoughts from a specific perspective, and this expertise places me some distance from the medical students who do not have the same clinical knowledge, life experience or professional expertise.

To explore the mental landscape of formative ideas on reasoning requires a methodology which encourages the participants to open up about their ideas and thoughts without foreclosure from the research process. Medicine relies heavily upon

personal connections and interpretations, and there is a growing voice to connect research in medical education to issues of social theory and cognitive psychology, thereby enabling us to analyse what is going on in the diagnostic process from different domains (Bunniss & Kelly, 2010; Norman, 2011).

Symbolic Interactionism was chosen as the theoretical framework as it is intimately connected with the development of Dimensional Analysis (DA) through the Chicago School of Psychology. The central tenets of SI address the questions within the study which will be explained in greater depth later, but in essence this focuses upon meanings and interaction (Blumer, 1969). One of the core statements that underpins SI is that '*humans act towards things based upon the meanings they have for them',* and this statement underpins one of the sub-questions in this study i.e. '*How is the diagnostic process constructed from the perspective of a medical student?* Does the term diagnostic reasoning mean anything to them, and can they analyse their role in this process through a reflexive discussion?

Furthermore, *why might this study be relevant to current practice and theory? What might be gained from listening to the student perspective?* Firstly, it is important that a teacher of medicine, and in particular of diagnostic reasoning, be immersed in the issues which contextualise student learning. This should include current theories on expertise and cognition, but also of social theory and interaction through the simulation. Immersion in the situated learning environment of the student should facilitate a greater understanding of how they are developing the skills relevant to clinical practice, rather than assume that something else is happening. Secondly, the study should be credible and useful in creating a perspective through the lived experiences of the student, rather than that of the researcher. The latter often typifies quantitative methods which assess the various attributes of reasoning, when the 'means end' is achieving the correct diagnosis (the 'Holy Grail'), rather than an appreciation of the factors which contribute towards forming a range of possible diagnoses.

Medical teachers often reiterate the view that the most significant information contributing to diagnostic formulation comes from taking the clinical history, rather than the clinical examination or indeed investigations, although this evidence is dated and arose from the context of secondary care in Neurology (Hampton *et al*, 1975). The first sub-question will address this very issue in order to determine whether this assumption is true for these 3rd year students (*'establish what features of a simulated consultation provide most information to the students to assimilate and process towards a tentative diagnosis').* Equally the normative theory on the development of cognitive expertise tells us how causal links between different data sets merge to form illness scripts for individual illnesses (Feltovich & Barrows, 1984; Schmidt *et al*, ibid), but what does this concept actually mean to a third year student when all the jargon is removed?

Similarly, we may categorise the students according to the theory of skills acquisition as 'novices' or 'advanced beginners' (Benner, 1984; Dreyfus & Dreyfus, 1986), by virtue of where they situated within the curriculum, but without finding out how they think we will never know whether we are correct, or indeed provide the appropriate learning strategies for that stage of development. Through answering some of the research questions in this study, current theory may be confirmed, challenged or developed along a different pathway. It is anticipated that a greater insight will have been gained into the student's perspective of the role of making a diagnosis and the features which underpin that complex process.

1.1.1 What issues will be discussed in this thesis?

The very essence of this study is to explore how medical students view the diagnostic process, and what it means for them. It will employ a qualitative methodology called Dimensional Analysis to explore the emergent properties in data collected from a simulated consultation and a reflexive discussion.

Chapter 1 will contextualise the historical background to medical education in the UK, the ethos behind integrated curricula, and the transitions that exist within undergraduate programmes in spite of intentional integration, and finally the local context which situates the participants.

Chapter 2 will provide the background to the theories on cognitive expertise alongside the research paradigms that underpin the current views on diagnostic reasoning. This will lead onto how simulation studies can be used in exploring the cognitive attributes that are the focus of this thesis, and finally reiterate the original research questions developed through the Research Process Approval (RPA).

Chapter 3 explores the conceptual framework of symbolic interactionism and its close relationship with the methodological approach based upon one of variants of Grounded Theory i.e. Dimensional Analysis (DA).

Chapter 4 will discuss the benefits derived from the rehearsal study, the recruitment process, the use of a standardised case scenario for the simulated consultation, and discuss the relevant ethical issues including insider research.

Chapter 5 will demonstrate data analysis using the theme of cognitive mechanism as an example, and explore the stages of DA through illustrations from the transcripts.

Chapter 6 will explore the case findings which achieved theoretical saturation and Chapter 7 will discuss the evolution of the substantive theory which emerges through the findings in conjunction with other theories.

1.2 The context of medical education in the United Kingdom

During the last 20 years the field of medical education has changed considerably, primarily in response to the directives from the governing body, the General Medical Council (*Tomorrow's Doctors*, 1993; 2003; 2009; *Good Medical Practice*, 2006; *Redefining Good Medical Practice*, 2013). In tandem it has adapted to sociological changes that have shaped how we perceive the role of medicine alongside the emergence of the 'audit society', consumerism, and evidence based practice, and of course in the context of spiralling healthcare costs in the National Health Service (Ham, 1999:33; Trinder & Reynolds, 2000:1-15). The following introduction provides a brief insight into the forces that have shaped changes in medical education in the United Kingdom during that period.

The pressure created by the increasing cost of NHS care was a key factor driving changes in health policy. Perhaps the most radical changes undertaken by any political administration in the UK was pursued by the Thatcher government in recognising that the ever increasing expenditure on the NHS required better governance, and the most significant long term measure was introduced through the Griffiths report in 1983 (Ham, 1999:29). The report highlighted the need for better and effective business management in the NHS, and included a proposal that hospital doctors should '*accept the management responsibility which goes with clinical freedom'* (Griffiths report, NHS Management Inquiry, DHSS, 1983:18).

Such a radical measure was fuelled by the emergence of major funding pressures which had plagued previous political administrations, and further reforms were set out in the White Paper, *Working for Patients* in 1989, which included a number of efficiency measures in response to spiralling costs (Secretary of State for Health and others, 1989a). *Working for Patients* also aimed to make doctors more accountable for their performance (Ham, ibid, 37), and although at the time this was primarily aimed at clinical performance, the ethos included medical education in terms of

preparing medical students for future practice. The subsequent introduction of annual appraisals and revalidation for doctors can be traced back to the emergence of public accountability during this period.

Alongside this ethos was the increasing focus upon the use of *evidence based practice* in medicine during the 1990s. This included the re-evaluation of medical interventions that were either ineffective, expensive or were limited in application (Giddens, 1991; 1994). Although this was primarily defined and driven by the profession, in some ways can be seen as the profession's response to the rise of managerialism which emerged from political directives. It also reflected the sociological drift towards what became known as the *audit society* alongside the rise of consumerism, which re-examined traditional practice and explains a more rigorous application of science (Power, 1997: 43-44; Trinder & Reynolds, 2000: 7).

In many ways this was fuelled by a mistrust of the medical profession and contemporary science, with a context of questioning doctor's competencies following high profile issues such as the Bristol Royal Infirmary Inquiry, which analysed deaths arising from surgical practice from 1984 to 1995 (Secretary for Health, 2001). As a result of this and other notable cases the GMC came under significant scrutiny to '*put its house in order'* and to introduce systematic safeguards in practice, and to train doctors with better skills, particularly those with more effective communications skills. The response to these social influences can be seen in the reports from the GMC both upon clinical practice (Good Medical Practice, 2006), but also undergraduate medical education through the iterations of *Tomorrow's Doctors* from 1993 onwards (ibid).

1.2.1 What has been the impact of these changes on medical education?

It is worth briefly exploring the historical developments in curricular changes over the last century in order to explain the directions adopted in both curriculum design and broader pedagogical ideas. The origins of the split between preclinical and clinical training periods in undergraduate education can be traced back to the Flexner report on the state of medical education in the USA and Canada (1910). Flexner proposed that following a period of embedding training in '*formal analytical reasoning, the kind of thinking integral to the natural sciences'*, there should be a phase of clinical training based in hospitals where students would learn to collect and evaluate data from patients under appropriate expert supervision.

This idea spawned the basis for conventional undergraduate medical programmes of the early 20th century with a well demarcated preclinical/clinical split. Subsequent changes in direction and ethos have been motivated by analysing how students learn most effectively, with defined objectives in the curriculum (Miller, 1961: Simpson, 1972), including systems based teaching with active student involvement (Cox & Ewan, 1982; Newble & Cannon, 1983). This has been in response to the changing emphasis towards outcomes, societal values, and the medical schools' responsibilities towards preparing the next generation of doctors (Grant in Swanick, 2010: 1-14). Through the influence of the first iteration of *Tomorrow's Doctors (1993),* the GMC has sought to move the emphasis away from the conventional approach of memorising and reproducing factual data towards the ideas of developing more critical, independent thought alongside increased opportunities to interact with patients.

Outcomes for medical curricula in the UK are directly linked to the graduate outcomes contained within the latest iteration of *Tomorrow's Doctors* (2009), split between three main outcomes; *the doctor as a scholar and a scientist*; *the doctor as a practitioner; the doctor as a professional.* In 1993, the first iteration outlined the expectations and

recommendations for revising the curriculum framework and promoting a *core curriculum* at undergraduate level in UK medical schools, and the impact of the aforementioned sociological trends were more evident in subsequent iterations. Amongst the principal recommendations in 1993 were proposals such as introducing '*systems based'* teaching, and *integrating* contributions from scientific and clinical knowledge in an attempt to eliminate the preclinical/clinical divide that existed in conventional programmes. Critical evaluation of evidence was to be encouraged alongside the introduction of special study modules (SSC) promoting learning in depth. Interdisciplinary synthesis was to be achieved through true integration of both horizontal and vertical themes in the curriculum. In parallel, more opportunities to interact with patients would be provided. Some medical schools undertook significant revision of their undergraduate programmes (e.g. Manchester, Liverpool and Glasgow) and embraced Problem Based learning (PBL) which promotes integrated learning and clinical reasoning.

The objectives for undergraduate education enshrined within *Tomorrow's Doctors* comprised three goals under the headings of i) *knowledge and understanding*, ii) *Skills* demonstrating competency (e.g. history taking and examination), and iii) *attitudes.* These objectives only allude to the cognitive skills that would be involved in reaching '*a provisional assessment of a patient's problem*, and *developing the capacity for self audit'*. In Annex A of Tomorrow's Doctors entitled, 'Attributes of the independent practitioner', the following statement encapsulates the aspirations for a qualified doctor; '*the reasoning and judgement in the application of knowledge to the analysis and interpretation of data, and in defining the nature of a problem'* (1993).

These are indeed very sophisticated aspirations which barely hint at the complexity of achieving those qualities. Critical thinking, clinical judgement, and the concept of reflection are fundamental qualities espoused of the independent practitioner. Therein lies the debate between the GMC's drive towards achieving competencies and

defining standards, alongside the development of more complex cognitive skills inherent in concepts such as reasoning, judgement and metacognition. These terms encompass higher cognitive functions which link decision making and problem solving. Indeed, metacognition is sometimes called the '*seventh sense'* which promotes implicit, unconscious skills to the forefront of the conscious mind space (Nisbet & Schucksmith, 1984).

Maudsley and Strivens examined the tensions between achieving competencies espoused by the GMC, and the ethos of critical thinking in their discussion paper reviewing terms and concepts (2000). Within their paper the following comment crystallises this argument; '*Barnett argued that pushing higher education towards the vocabulary of competence merely replaces one closed ideological view of higher education, i.e. academic competence serving cognitive culture, with another, i.e. one dimensional, operational competence serving the economy*' (Barnett, 1994).

With subsequent guidelines, the GMC has pushed the agenda of undergraduate education towards defined competencies in order to validate transparency and accountability in the public domain. However, this tends to espouse the construct of *competence involving performance synonymous with skill alone*, thus concentrating upon specific practical procedures for many outcomes (Tomorrow's Doctors, 2003; 2009: Wolf, 1989).This belies the complexity of expertise, particularly decision making and problem solving. The defined outcomes required of the emergent graduate in 2003 focus around clearly defined clinical, practical, and communication skills, with further refinement in the 2009 iteration, however the terms used to describe cognitive skills are far more ambiguous.

1.2.2 The Integrated Curriculum approach

The international and national drivers in education explored in the previous section provide the logical reasons behind the adoption a *spiral, integrated* curriculum design chosen many UK medical schools, and this structure is often delivered through systems based teaching, with vertical and horizontal integration of both modular teaching and core concepts. The spiral model was first described by Bruner with the specific intention aim of revisiting themes within the curriculum in ever increasing depth and complexity (Bruner, 1977; Harden & Stamper, 1999). Vertical themes in this type of model represent key skills and competencies such as clinical method (communication and examination skills), therapeutics, ethical issues, population studies, and professionalism.

The philosophy of *integration* has significant foundation in studies of cognition which describe how doctors utilise both biomedical and clinical knowledge together in making diagnostic judgements. Basic biomedical knowledge is *encapsulated* in explanations for illness by clinicians who appear to make diagnoses at a syndrome level (Patel *et al*, 1988; Boshuizen & Schmidt, 1992; Norman, 2000). Expertise is gained by developing elaborate networks of knowledge which include the features of biomedical knowledge, clinical knowledge and experience.

The features on individual illnesses are often incorporated into a mental picture or construct called an *Illness script*, which is based on the accumulated exposure to the same illness over time, becoming more refined with subsequent exposures (Feltovich & Barrows, 1984). This allows rapid processing of new case features by comparing with the stored default script i.e. pattern recognition (also called non analytical reasoning), and is heavily reliant upon prior exposure to similar cases in a particular domain, or 'formal' clinical knowledge. For more difficult or complex cases, slower analytical reasoning becomes the operative mode where biomedical and mechanistic explanations assume greater importance (Eva & Norman, 2005).

Early exposure to clinical cases alongside biomedical teaching helps facilitate the formation of encapsulated knowledge and improve diagnostic skill acquisition, and this is the premise for integrating basic science with clinical exposure (Boshuizen & Schmidt, ibid: Eva, 2005). *Early patient contact* has been shown to confer a number of benefits such as improved acquisition and retention of knowledge, better understanding of the impact of disease on patients' lives, enhanced professional socialisation, and increased motivation to learn (Prince *et al*, 2000: Diemers *et al*, 2008; Dornan & Bundy, 2004). Evidence about real patient contact improving analytical and non analytical reasoning skills has been reported (Diemers, *ibid*), however students also report difficulties in transferring biomedical knowledge to clinical problems (Prince, ibid; Patel *et al*, 1988).

It has been suggested that making explicit links between patient problems and basic science are pivotal for students to make connections more effective (van de Wiel *et al,* 1999; Woods *et al*, 2005). A quantitative modelling approach has been used to illustrate the relative contribution between biomedical knowledge (BK) and clinical cognition (CC) towards diagnostic justification in students from an integrated curriculum (Cianciolo *et al*, 2013). Academic performance in the bioscience component of year 1 & 2 was captured from basic science examinations and used alongside assessment of clinical cognition (information gathering and interpretation) from SP examinations. This was compared to subsequent performance in the 4th year competency examination comprising 14 SP cases, none of which require diagnostic justification (DJ). Both BK and CC were found to have a moderate relationship with DJ in the 4th year examination; however, BK had a stronger statistical relationship, suggesting that this was influencing the higher-quality diagnostic explanations. It was therefore suggested that the clinical exposures in their curriculum were not yet sufficient to influence clinical cognition coupled to pattern recognition. It will be interesting to see if there is any resonance amongst our participants' thinking.

1.2.3 Transitions in the curriculum

Even with contemporary integrated medical programmes designed to provide the early clinical exposure to patients (thereby promoting the integration of biomedical knowledge with clinical experiences), there is often a significant **transition** between 'pre-clinical' and 'clinical 'training. The 'pre-clinical period' in more conventional programmes covers the basic biomedical sciences (usually 2 years or the equivalent to Phase 1 in this curriculum; see **Figure A**), and the clinical attachments which typify the 'clinical period' involve significant immersion in patient contact in the multiple domains of medicine (Phases 2 and 3).

This is the first of ***three significant transitions*** described in medical training i.e. the trajectory in medical education called the '*medical continuum'* (Teunissen & Westerman, 2011), and the origins of the first transition can be seen in Flexner's report , '*the preclinical stage of training should be followed by a clinical phase in teaching hospitals* (1910). The participants in this study are situated at this transitional point about the embark upon hospital based rotations where there is increased exposure to 'stand alone' practice i.e. less facilitation requiring more independent thought and responsibility, but without authority in decision making or management. Although programme design has aimed at reducing this transition by earlier patient contact, it still exists as a period when there is more exposure to un-facilitated contact with patients, and expectations in behaviour change and role, including a move towards more self-directed, adult learning. Indeed some studies suggest that students feel this transition is still too abrupt without adequate facilitation (Prince *et al*, 2005).

In Teunissen & Westerman's critical review of the literature about the pre-clinical/clinical transition, some colleges have introduced specific courses or modules to facilitate this transition, and inform students of the likely ramifications of a change in context and practice (ibid). This approach is based upon a transition being viewed

as a specific point in time, rather than a dynamic phase which is different for each individual in any given cohort. The abstract from this review contains a key phrase, '*turning a transition from a threat into a learning opportunity*', and suggests that educational strategies should be used to facilitate coping skills, converting negative emotions often quoted during this stage into positive opportunities (O'Brien *et al,* 2007).

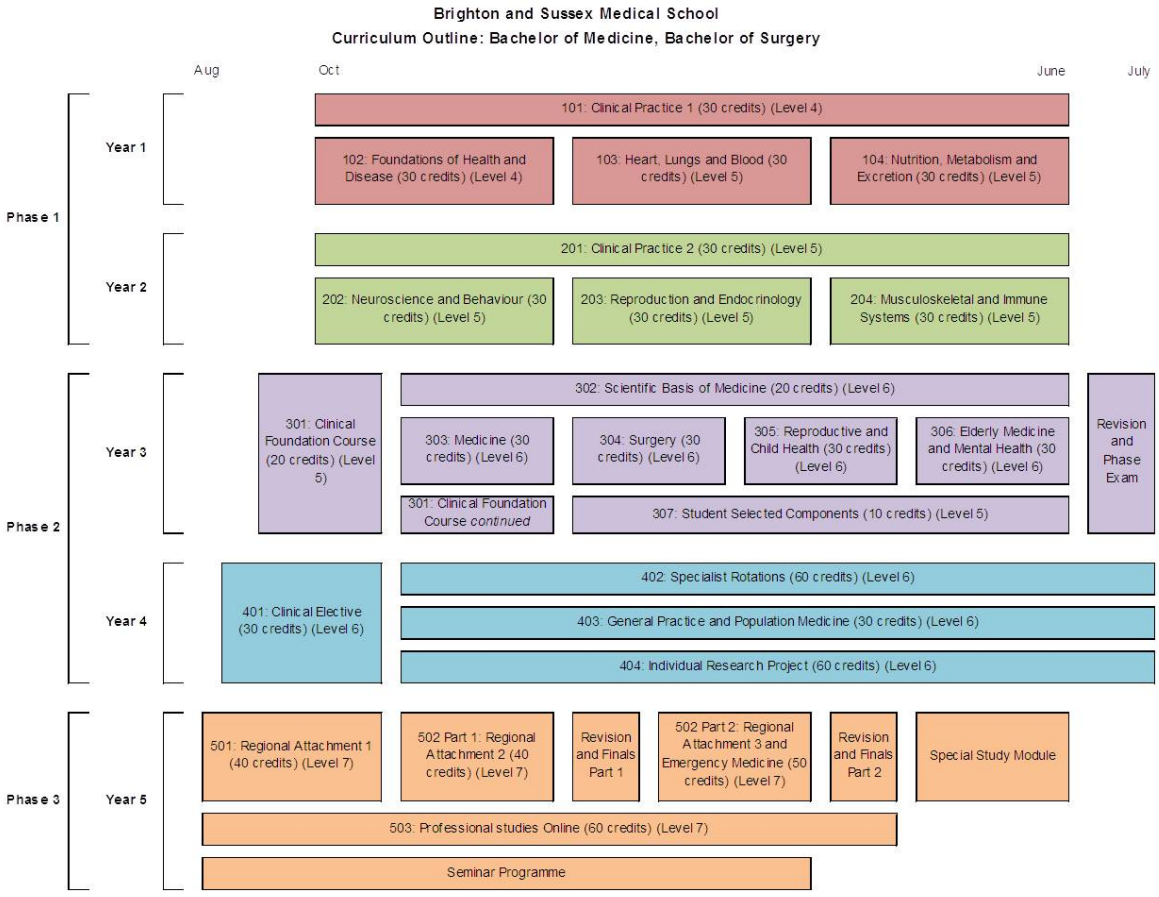
Findings drawn from mainly qualitative studies (usually focus groups, interviews and questionnaires) highlight issues and stressors encountered by students, ranging from understanding roles and responsibilities, engaging with more effective self-directed learning, putting theory into practice, and applying theoretical knowledge to clinical reasoning (van Hell *et al*, 2000: Prince, ibid; O'Brien, ibid; Babaria *et al*, 2009). Preclinical knowledge and skills did not appear to influence the perceived stress of the transition, yet mature students appeared to cope better, were less likely to feel daunted (Schacklady *et al*, 2009), and exemplified more effective self-regulated learning capacities sometimes seen in students educated through PBL courses, although evidence remains mixed (White, 2007). Studies often focus upon conceptualising the differences between PBL and conventional curriculum designs, and results remain mixed, failing to justify the integrated thinking expected from PBL courses (Prince *et al*, 2000; Hayes *et al*, 2004).

The second transition occurs at the point of qualification between a final year student and junior doctor (Foundation Year 1), and the last occurs at the end of the speciality training period and appointment as a consultant/independent practitioner. Each stage can be accompanied by changing demands in role, expectations, stress and emotional coping strategies, as well as adaptations in learning (Helmers *et al,* 1997; Prince, ibid). Transitions also present potential opportunities for rapid personal development when behaviour can alter through the various challenges, and thinking is refashioned through new experiences.

1.2.4 The medical school curriculum (local context)

It is important to situate the participants involved in the study within the integrated model adopted by this medical school, which uses interlinked modular teaching with both *vertical* and *horizontal* integration, including face to face contact to patients from week 2 of the programme in the clinical practice modules, CP 101 and 201. Teaching in the community setting at this stage of the curriculum is governed by well-defined learning outcomes for each visit to achieve equitable learning amongst the student cohort that links with five modular themes: *Development of communication skills, clinical skills, the wider context of the NHS and society, population medicine, and multi-disciplinary team working*.

Figure A. The medical school curriculum



Community based teaching occurs in four out of the five years within the curriculum, however the philosophy in years 1 and 2 (*Phase 1*) is based upon gaining basic experience in generic clinical practice, rather than specialist General Practice per se (**Figure A**). Included in the experiences are studies where students make several visits to a family with a newborn infant (Year1), and a patient with a chronic illness (Year 2), and these provide opportunities to integrate knowledge with practice, meet other healthcare professionals and develop knowledge about the care in the community.

The volunteers for this study will have completed contact time in the clinical practice modules amounting to 264 hours in total, which includes 36 hours in primary care with their GP tutors, 30 hours in secondary care placements, and 30 hrs in skills based workshops. Primary care teaching is linked with modular activities and students are exposed to patients with specific diseases which illustrate systems based teaching. Therefore *face to face contact with patients* amounts to a maximum of *90 hours* during Phase 1 teaching, but in reality is less due to the constraints and safeguarding applied to clinical exposure at this early stage of development i.e. supervision framed through careful facilitation by experienced clinicians.

Diagnostic reasoning was introduced as an explicit theme in Phase1 of the curriculum 3 years ago, mid way through the second year. The aim was to introduce an awareness of decision making modalities using a filmed example, with the aspiration that this would implant key ideas on formulating diagnoses ahead of more extensive exposure to clinical practice in the ward based attachments during Year 3. A core lecture mid way through year 2 was integrated with a specific experience in the GP attachments where students were exposed to a brief *Case Based Discussion* (CbD), to be assimilated subsequently into their professional portfolio. The explicit outcome was to write about using simple diagnostic strategies based upon their meeting with a patient in practice. The spiral curriculum for reasoning begins with this core session

and is linked vertically with subsequent diagnostic discussions at the end of each clinical attachment in *Phase 2* (years 3 & 4).

The key ideas were to introduce students to the various *modes* of reasoning, including analytical reasoning, pattern recognition, and the value of scheme inductive reasoning using clinical examples to illustrate underlying ideas (see 1.3 for further discussion of these terms). Written Clinical Reasoning Problems (CRPs) were used in facilitated group work to propagate ideas from a core lecture. The hidden agenda was to develop the understanding of metacognition in being able to bring cognitive processes to conscious level whilst trying to solve these CRPs (Nisbet & Schucksmith, 1984).

Three ideas underpinned the pragmatic *'take home'* messages for the students. Firstly, the idea of '*weighting*' various components of a medical history in terms of their relative importance to the possible diagnoses; secondly, looking for links between data within the history (propositional linkage), and the concept of *chunking* features together which relate to illness script formation (Cowan, 2001; Feltovich & Barrows, ibid). Finally to emphasise that faulty data gathering contributes towards the main reason for diagnostic error (Graber, ibid).

Within these ideas was the theme of evaluating the relative importance of various bits of clinical information (weighting) encapsulated by the Lens Model and Judgement Theory which will discussed in Chapter 2 (Brunswik, 1956; Hammond, 1996). These describe how individual interpretation of data may influence diagnostic judgement, and where error can ensue. The resonance with symbolic interactionism (SI) is all too apparent in that individuals make sense of their world through various interactions with others and the meaning that things have for them (in this case the meanings that individual symptoms and signs have in the context of a presumptive diagnosis).

This introduction to diagnostic reasoning can be seen as both deconstructing a daunting role for students and clarifying expertise (Hodgkinson, 1995), or what Schon described as 'technical rationality' (1987). However, it is espousing ways of thinking

about personal judgments in the context of diagnostic thoughts and therefore is 'allowing competence to understand itself' i.e. informing metacompetence which is the intuitive approach to decision making (Schon, ibid; Fleming, 1991). It is also acknowledging an element of uncertainty that pervades the skill of diagnostic reasoning as briefly mentioned in *Tomorrow's Doctors* (2009).

In resume, the participants involved in this study are students from a medical school in the UK which has adopted an integrated, spiral curriculum. These students have successfully completed two years of undergraduate study across 8 integrated modules covering the main body systems, and they have been exposed to early patient contact amounting to a maximum of 90 hours as part of the two clinical practice modules delivered extensively across each year in Phase 1 of the curriculum. The curriculum introduces the foundations of diagnostic reasoning in year 2, raising awareness of cognitive strategies at a basic level.

2 Chapter 2: Cognitive Expertise and Reasoning

2.1 The historical context of research in clinical reasoning

Chapter 1 illustrates the changes in society and medical education which have influenced the structure, delivery and ethos underpinning modern medical courses. The origins of the competency-based culture are easy to understand when viewed through the societal pressures on the governing body, explaining the focus upon measurable competencies, although less attention appears to have been devoted to the development of cognitive skills within teaching compared to technical skills. There exists a considerable body of theoretical research on the various attributes of clinical reasoning in medicine and other domains of healthcare; however, the discussion below will concentrate upon those that have particular resonance to the specific skill of diagnostic reasoning. The continuum of cognitive expertise and the normative processes involved in this maturation will also be considered alongside the current theories which apply to the development of reasoning in undergraduate medical students.

The development of clinical reasoning has been approached through two different theoretical paradigms, the first being '*processing theory'* exemplified by Elstein's group using Hypothetico-deductive reasoning (Elstein et al, 1978). In essence, this seeks to understand how clinicians process information from the patient in suggesting possible hypotheses which explain the illness. The second approach is through '*structural*' theory i.e. how structuring and organising information in the mind helps produce diagnostic solutions (Lesgold *et al*, 1989: Schmidt *et al*, 1990: Schmidt & Rikers, 2007). In general, these are described as the *normative* processes which explain changes in cognition associated with the different stages in professional

development, determined by progressively enriched causal pathways linking various facets of the patient's problem (symptoms, signs, risk factors, etc).

The historical perspective of research into clinical reasoning illustrates the apparently diverse areas of exploration which are gradually being subsumed into a more accepted, inclusive opinion. Current evidence suggests that the process of diagnostic reasoning is a combination of **analytic** and **non-analytic reasoning** (NAR) working in tandem, or what is called *Dual Process Theory* (Norman & Eva, 2010; Pelaccia, 2011). The relative contribution of each component is largely determined by the context i.e. situated learning, the operating variables which apply to each case, and importantly the level of expertise of the clinician (Lave & Wenger, 2007). This brings together the inseparable issues of cognitive development and case based exposure (i.e. prior contact with patients) which in particular underpins NAR. This study aims to determine how novices in medicine view the diagnostic process from their perspective at a stage when cased based exposure is very limited. The twin paradigms of *information processing* and *decision making* are now recognised as part of the multiple levels of the decision-making space, contextualised by the task environment , and summed up by the description of' *the sum of thinking and decision making processes associated with clinical practice*' (Higgs, 2006; Higgs & Jones, 2008: Ch 1).

Other sources have discussed the more specific features of the generic reasoning process including ethical reasoning (Neuhas, 1988), narrative reasoning (Bruner, 1986; Benner *et al,* 1992), collaborative reasoning (Coulter, 2005), conditional reasoning (Fleming, 1991a), multidisciplinary reasoning, (Loftus, 2006), interactive reasoning (Edwards *et al*, 1998), and teaching as reasoning (Sluijs, 1991). The process of diagnostic reasoning features heavily in the information processing paradigm and encompasses the decision making process surrounding diagnostic formulation or hypotheses, and how doctors arrive at such decisions (Elstein, 2000).

Judgement and decisions that are based upon the information gathered are described in the decision making paradigm best encapsulated by *Judgement Theory* (Brunswik, 1956; Hammond, 1996), Significantly less has been written about the decision making processes involved in the subsequent *management* of cases once diagnosis has been reached (Monajemi *et al,* 2007). Indeed reaching a correct diagnosis appears to be the 'Holy Grail' in many research papers.

Historically the reasoning process has involved a number of interpretations or models, and these include issues such as *content specificity* (reasoning ability varies across case types), the expertise level of the clinician, and the impact of *heuristics and bias* in decision making (Patel *et al*, 1986; McLaughlin *et al*, 2007; Norman & Eva, 2010; Durning *et al*, 2011). Early research in the 1970s contrasted two models, *hypothetical-deductive reasoning* (analytical) and *pattern recognition* (also known as non-analytical, or categorisation using analogy). The former generally employs deductive or backwards reasoning moving from a series of observations about a patient (symptoms, signs, risk factors, etc) towards a generalisation or hypothesis that best summed up those features (Barrows *et al*, 1978; Elstein *et al*, 1978). Analytical thinking was the method generally ascribed to novices, or was used by experts with more difficult and complex cases where slower evolution of hypotheses occurred to represent symptoms and signs were considered in the search for a diagnostic label.

The generation of hypotheses is dependent upon a four stage process starting with the *acquisition of verbal and non-verbal cues* from the patient which might inform or trigger the *generation of a plausible hypothesis to explain the patient's problem*. Cues amount to information of any type from personal characteristics, risk behaviour, pre-encounter data such as the threshold for consultation amongst others, as well as the more obvious symptoms and signs of disease. With the exception of pre-encounter data there is a mixture of cues that have been assimilated into the case scenario for the SP e.g. episodic epigastric pain, substance misuse, and use of drugs implicated

in causing dyspepsia. The data analysis will serve to illustrate how these various cues are represented in the thought processes of the participants.

Early generation of a small number of hypotheses serves to limit the demand on working memory. It also directs further collection of information to refine and validate the possible diagnoses, called *cue interpretation* and *hypothesis evaluation*. Hypothesis generation is usually limited to 3-5 individual hypotheses to represent a solution to the problem in hand, and this helps to minimise the strain put on the active work space of the mind. This may have particular resonance for novices embarking upon their first exposure to making definitive diagnostic decisions in this study.

The hypotheses generated may not initially relate to a specific, well rounded diagnosis in the first place but may represent anatomical or physiological explanations, particularly from novice practitioners. This represents the '*essentialist'* view adopted by novices that signs and symptoms arise from a pathological process that can be identified and rectified, and the *'nominalist'* perspective that experts usually hold which is that disease is a collection of abnormalities that arise together (Campbell *et al* ,1979: Norman, 2000).

Pattern recognition or NAR is regarded as the faster and more efficient method of reasoning and usually employed by experts with significant case based experience. They utilise the memories of similar cases as mental constructs which exemplfy a specific illness or disease, also called '*illness scripts'* based upon the original concept of templates or abstract prototypes (Rosch & Mervis, 1975; Cantor *et al,* 1980; Feltovich & Barrows, 1984). In this respect, prototypes serve as multi-faceted descriptors of an illness where most, but not necessarily all of the clinical features are represented in the symptoms and signs within any one patient.

Within this illness script there are inherent semantic links and relationships developed from the various perspectives of biomedical, epidemiological, and clinical features. For example, a patient with a urinary infection (UTI) may have several symptoms including frequency of micturition, urge, nocturia, haematuria, and a fever, and this

pattern of symptoms/signs would represent a significant part of the typical picture of this illness. Most of these symptoms are seen in the majority of patients, but not necessarily all. The 'weighting' or relative contribution towards the formation of the possible diagnosis from each symptom or sign can also be viewed from the perspective of Len's theory (see **Figure B** on page 33). If the various features being considered are labelled as X1(fever), X2 (haematuria), and X3 (frequency) using this example, then these features may reflect most of the cues contributing towards the diagnosis of a urinary tract infection, but not all are necessarily present in each case of the actual condition i.e. the validation of condition A (Hammond, ibid). *Human fallibility* affects both the collection of the data (cues) from the history and examination, and the interpretation of the data sets (judgement of condition A or how the clinician utilises the cues).

Memories of similar cases called 'exemplars' which have been subsumed into one default script (the 'norm') are accessed instantaneously from long term memory for comparison to the new case, whether this is a typical presentation or an illness or not (Bordage & Lemieux, 1991). This approach includes what is sometimes called the '*Aunt Minnie'* phenomenon-someone who you would recognize immediately, or the 'spot diagnoses' of something that one has seen many times before and represent about 20% of diagnoses in General Practice, particularly in dermatological conditions (Sackett *et al*, 1995; Heneghan *et al*, 2009).

Alongside the hypothetico-deductive model another analytical model has emerged more recently from research proposing the concept of *scheme-inductive reasoning* based upon organised structures for learning, but not necessarily specific to diagnostic reasoning (McLaughlin *et al,* 2002; Coderre *et al*, 2003). These structures provide a generic framework for problem solving employing road maps or decision trees which help distinguish the decision making choice at various points (called nodes). Schemes provide the 'big picture' or scaffolding onto which other information can be assimilated, edited or elaborated.

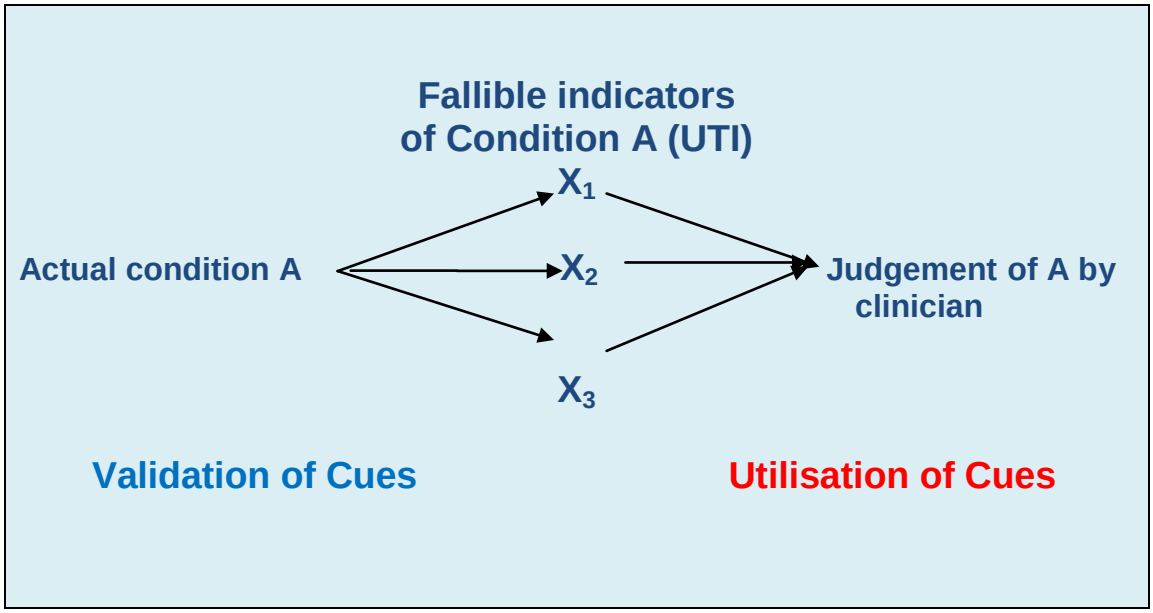
Mnemonic strategies provide the clearest example of scheme driven reasoning and reflect their popularity in teaching across all domains. Their dual impact is observed in limiting the potential overload on short term memory capacity (Cowan, 2001), but also in facilitating encoding and retrieval of information from memory (Bellezza, 1996). A plethora of studies has shown that mnemonic strategies have a direct effect and beneficial impact upon the ability to remember a number of diverse areas, including recall and recognition of factual information (McCormick & Levin, 1987; Levin, 1993; Carney & Levin, 2000).

Two examples of schemes feature during the discussions of the case findings in this thesis: firstly, the use of a mnemonic strategy called *SOCRATES* which is taught in the curriculum as an aide memoire for the features of pain; **S**ite, **O**nset, **C**haracter**, R**adiation**, A**ssociated features, **T**iming, **E**xacerbating features and **S**everity. The other is the *Traditional Medical History (TMH),* used as a format for collecting data during the consultation. This is based upon a time honoured and universally accepted structure of sections starting with the history of the presenting complaint, past medical history, drug history and allergies, social history, and the systems review (the latter acting as a 'sieve' to pick up related symptoms from other body systems).

The application of schemes has obvious resonance in the clinical practice setting where novices are exposed to multiple sources of information about a patient with little clinical knowledge to utilise, and therefore cognitive strategies often act as *failsafe mechanisms* (Gale & Marsden, 1984). Schemes are reflected in current guidelines or clinical prediction rules (algorithms), which are based upon current evidence (Grimmer & Loftus in Higgs *et al*, 2008; Ch 28). The advantage of scheme inductive reasoning is that it can be made available to novices for use in clinical cases at an early stage of expertise development, whereas pattern recognition is primarily available only to experts based upon years of practice.

These three models are used interchangeably in medical problem solving although it is clear that pattern recognition and scheme-inductive strategies confer greater diagnostic success compared to hypothetico-deductive reasoning (Coderre, ibid; Blissett *et al* ,2012). They represent the information processing paradigm that emphasises how data is collected, rather than the interpretation and subsequent decision that is subsequently made based upon the data.

Figure B: Representation of Lens Theory (after Brunswik)



This was first proposed in Brunswik's Lens theory (**Figure B**) and subsequently developed by the work of Hammond on *Judgement Theory* (Brunswik, 1956; Hammond, 1996). Indeed research has suggested that there is no association between the amounts of data generated from a case and the efficacy of subsequent data interpretation (Elstein *et al*, ibid). The Lens Model puts forward two key areas in judgement theory; firstly that a clinician being presented with condition A (represented by the actual symptoms/signs of $X_{1\text{-}3}$) makes a decision about validating the cues for this condition.

Those cues are open to bias such as data gathering skills and the historical features presented by the patient (the fallible indicators of the condition e.g. a patient with a heart attack may *not have* the key indicator of chest pain). The right hand side of the lens model represents how the clinician *interprets* these features towards making a diagnostic judgement for condition A, and this interpretation is again fallible.

Errors in decision making have been attributed to four main causes (Graber, 2005; Berner & Graber, 2008);

- *Faulty data collection* e.g. poor history taking (which can improve with practice)
- *Reasoning based upon inadequate or outdated knowledge*(using evidence based medicine)
- *Faulty data interpretation*(or the utilisation of cues in Judgement theory); this does not always improve with experience
- *Faulty data verification*

Amongst these causes '*premature closure'* is the most common error i.e. 'the tendency to stop considering other diagnostic possibilities after reaching one diagnosis' (Norman & Eva, ibid), and is correlated with incomplete history taking and examination, bias towards one diagnosis, and failure to consider the correct diagnosis. The psychological principle underpinning errors in decision making is the theory of Bounded or Limited Rationality (Newell & Simon, 1972), which puts forward the idea that issues such as the limitations of working memory and information processing capabilities mean that human error is inevitable.

Common examples of error have been suggested to arise from the following causes (Croskerry, 2000; Norman & Eva, 2010); *Premature closure* i.e. closing down on one diagnosis too soon and not collecting information about competing alternatives (Graber, 2005); *Base rate neglect* i.e. failure in probabilistic reasoning and estimation of true rate of a specific illness; *Representative bias* i.e. missing atypical features

due to focussing on prototypical disease manifestation; *Confirmation bias*: endency to acquire too much confirmatory information rather than data that may refute the diagnosis (Wolf *et al* in Dowie and Elstein, 1988): *Order effects*: the sequence in which information is given i.e. better recall of information at the very beginning and very end of consultation, rather than material mentioned in the middle (Bergus *et al*, 1995);*Conservatism* or anchoring effects i.e. heuristic error based upon revising diagnostic opinion up or down from an initial anchor point that is inaccurate (Edwards, 1968). Lastly, the most significant, *incorrect interpretation,* involving the persistent inclusion of data into one diagnostic solution when in fact it supports another which is not considered (Elstein *et al,* 1978). The potential traps for the novice student in diagnostic reasoning are manifestly evident.

The various models of clinical reasoning are not mutually exclusive and are generally regarded as being used in tandem in the form of '*Dual Process Theory'* (Epstein S, 1994: Hammond KR, 1996). This view emphasises the triggers from minimal, contextual cues that becomes interwoven with more deliberate, analytical thoughts. 'Intuitive' cues come from rapid, readily accessible pattern recognition from previous exposures to similar events, something rarely vocalised by clinicians when substantiating decisions (teasing out and analysing the comment, "*the patient didn't appear normal*"). The advantage of including this approach in teaching is to deliberately expose the subtle cues which contextualise events which usually remain poorly vocalised, and are often subsumed under the umbrella of intuition and wrongly attributed to 'gut feelings' about patients or events. Subtle cues are therefore often ignored and barely discussed or understood in the evolution of decision making.

One further contextual complication to the development of reasoning skills is that learners progress through a number of *transitional stages*. This is reflected in their cognitive skills development which demonstrates maturity in the reasoning process (Schmidt *et al*, 1990), and secondly the impact of curriculum design upon changes in

clinical exposure and context, typified by the transition between early, conventional pre-clinical teaching and subsequent work based clinical attachments in various settings (Teunissen& Westerman, ibid).

Situated learning describes the gradual acquisition of cognitive and social skills derived from face to face practice through a progressive apprenticeship experience. Part of this process involves increasing assimilation into the team responsible for patient care, also known as legitimate peripheral participation (Lave & Wenger, 1991; 2007). The participants in this study are still peripheral to direct clinical care, and the limited exposure to patient contact experienced in the two years prior to this study will have provided few opportunities to practice diagnostic reasoning. Indeed even after intensive training in clinical reasoning, students from Problem Based curricula (PBL) where CR is an inherent part of teaching, comment upon difficult ties in *gathering, interpreting, and weighting relevant data, synthesising information and organising it hierarchically* (van Gessel *et al*, 2003).

2.2 The spectrum of cognitive expertise

Under outcome 2 in *Tomorrow's Doctors* (2009), entitled '*The doctor as a practitioner'*, the expectation is that graduates will be able '*to synthesise problems and define likely diagnoses, and make clinical judgements based upon available evidence in spite of situations of uncertainty*' (subsection 14; e and f). This brief summary of cognitive skills focusses around diagnostic judgement yet encompasses an almost seismic change in cognition from the perspective of the novice student entering medical school. It glosses over the immense shift from early facilitated practice immersed in basic procedural mechanisms (e.g. clinical skills tuition) towards the' high road' of autonomous decision making. Inevitably, this moves aspirations away from measurable competencies and into the field of 'fuzzy logic' which attempts to represent expert decision making.

Where does this place the participants in this study on this spectrum? What is expected from this stage of development in terms of diagnostic cognition? The **theories of professional expertise** provide different perspectives which explain the various factors that contextualise this domain. Amongst these theories are the paradigms of clinical decision making explained in section 2.1. These represent the *information processing* model (i.e. how information is gathered and processed), and *judgement theory* which explains how decisions are made once that information has been processed. This encompasses aspects of human fallibility, heuristic mechanisms and the influence of bias in subsequent judgements (Brunswik, 1956; Norman, 2000).

Furthermore, the variety of decision making modes was described in Cognitive Continuum Theory (Hammond, 1980). Here 'quasi-rational' modes range from the overtly analytical mode of decision analysis dependent upon system aided judgement e.g. evidence based guidelines for practice, towards the more intuitive model based upon patterns and experience (Elstein *et al*, 1978).

Two other models have particular resonance with this study, firstly the ideas enshrined in the '*Reflective Practitioner*' which provides an alternative explanation to the limitations of technical rationality' (Schon, 1983: Eraut, 1994: 142-148). He suggested that within ill-defined situations the practitioner resorts to an intuitive mode of thought which is creative, and reflects professional artistry built upon reflection. His ideas of '*reflection in action'* and '*reflection upon action*' are tacit assumptions that underpin the role of portfolios which encourage looking back at experiences with a view to improving future practice (Dewey, 1933). These ideas are espoused in the undergraduate curriculum at the medical school in Phase 1 and the effects of facilitating this ethos may well have an impact upon the reflective discussions.

Figure C. Summary of the skills acquisition model (Dreyfus & Dreyfus)

Level	Features
Level 1 (Novice)	Cannot use discretionary judgement and learns rules for action according to specific characteristics of a situation
Level 2 (Advanced Beginner)	Can perform acceptably and, from prior experience, will notice recurrent, relevant, general characteristics of a situation, but needs support to prioritise
Level 3 (Competent)	Lacks speed and flexibility but analyses, prioritises, and plans action, and assumes mastery and ability to cope with contingencies
Level 4 (Proficient)	Perceives situations as wholes, not just aspects, is guided by situationally dependent maxims, and recognises abnormality
Level 5 (Expert)	Only resorts to analytical tools, rules, and maxims in novel situations, and can see what is possible and what is not worth pursuing

Lastly, the Dreyfus model of skills acquisition may provide a global framework with which the cognitive expertise of the participants may be viewed (**Figure C**). This has been effectively paraphrased by Benner in the field of nursing, and provides a structure to which our participants might be aligned (Benner, 1984; Dreyfus & Dreyfus, 1986; Benner *et al*, 1996).

For the participants in this study the emergent data and properties will hopefully describe attributes in cognition which support a judgment about their developmental position along this spectrum of expertise. It may answer questions about their reliance upon guidelines and provide examples of discretionary judgment within the simulation. The Dreyfus model of expertise provides far more complexity in reacting to, and coping with situations within clinical practice than can be explained by the achievement of defined, technical competencies, and reveals an unspoken curriculum of expertise which is rarely articulated.

This statement encapsulates the attitudes towards, and the difficulties in engaging with the idea of cognitive competencies within a medical curriculum. *How do you measure high level, complex cognition and judgements other than in a global sense and who defines the parameters of such cognition?* As Eraut points out the Dreyfus model rarely quotes standard, competency-based tasks but focuses upon the whole process distilled from the learning experience which are contextually driven (Eraut, 1994: 125).

However deconstructing professional expertise and distilling the process into a series of competencies or routine tasks has advantages for the professional bodies such as the GMC, in that it makes professional practice more transparent for external scrutiny, and clarifies roles for novices by distinguishing functional levels (Blane, 1986; Hodkinson, 1995). The counter argument is that competency based approaches may miss the link to meta-competence i.e. metacognition and reasoning (Fleming, 1991), and has led some commentators to suggest that '*the competence movement in curriculum design is little more than an economically driven derivative of the behavioural school'* (Hyland, 1993).

Eraut's perspective of learning professional processes are highly relevant at this point, proposing that the journey towards expertise encompasses not only propositional knowledge ('knowing that'), process knowledge ('knowing how'), but these are combined with personal knowledge and interpretation of experience (Eraut,

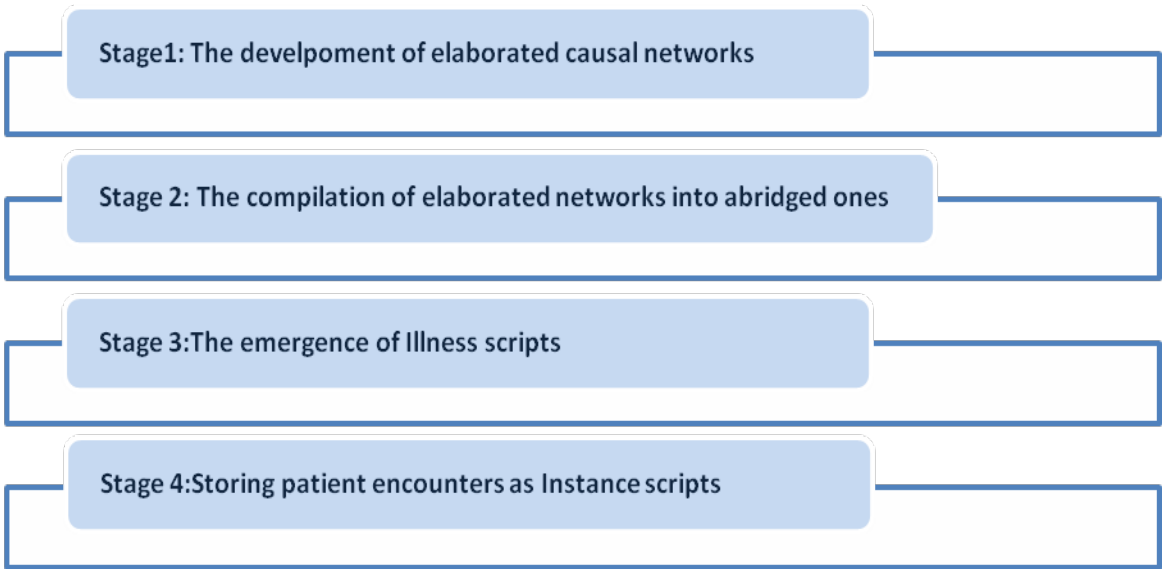
ibid, 100-122; Ryle, 1949). It could be said that the participants of this study have gained limited resources at this stage of their development, having experienced significant propositional input (biomedical science), some process knowledge of how to take a medical history and examine a patient, mixed with limited personal and experiential knowledge (exposure to patients). This mix would align our participants to Level 1 in Benner's model in the face to face clinical setting, unless they have prior training in healthcare settings (an exclusion clause in the recruitment process).

Through probing the perspective of the decision making processes used by the participants during a simulated consultation, it should become apparent what level of thought processes are being used, and how this influences diagnostic decisions, if indeed they are being considered. The aim is not to explore deconstructed consultation skills, but to build a picture of the thought processes involved in trying to make a diagnosis at a *crucial transition* in the medical curriculum where cognitive skills are stretched by changing the context of learning and responsibilities i.e. the transition from preclinical teaching to ward based clinical attachments. It strives to create an effective theory which encapsulates some of the professional issues at this particular stage.

2.3 The normative theory of cognitive expertise

The *normative process* was first proposed by the Four Stage theory of cognitive expertise, composed of four interlinked stages of development in terms of how medical students think about case representation (Schmidt *et al*, 1990), which is closely related to accruing clinical knowledge through patient contact and therefore the transitions within any curriculum (**Figure D**). *What it does not describe are the ramifications of departures from this normative process, assuming that these phases will merge effortlessly throughout professional development.* Since errors in cognition are important to subsequent diagnostic decisions, where do these errors originate and are they preventable at an early stage?

Figure D: The 'Four Stage' theory of cognitive expertise (from Schmidt)



The first stage of this model represents *the development of elaborated causal networks*, whereby the different features of an illness or disease are gradually linked together as an increasingly complex cognitive package, which gives clearer understanding of the processes involved (Lakoff, 1987). The emergent networks help explain the links and relationships between things i.e. symptoms, signs,

pathophysiological features, etc. In this respect is allied to the approach of symbolic interactionism, except that medical training aspires to give the same meaning to disease processes across any given cohort (Blumer, 1969).

The second stage illustrates the refinement of such causal networks into *abridged* ones, and is heavily dependent upon patient contact to suggest diagnostic labels for various symptoms and signs under more effective, higher level causal networks. During this stage shortcuts are developed in reasoning when the student has become more familiar with some of the typical features of illness through contact with patients (Schmidt *et al*, 1988). There is movement away from utilising *all* of the basic pathophysiological features which exemplify the first stage, towards higher level representation which is accessed more quickly from memory. There is considerable resonance with Schatzman's opinion upon the inherent powers of 'natural analysis' applied to the process of data analysis (1991).

The third stage exemplifies the formation of *Illness Scripts* as discrete, yet complex packages of information as a cognitive representation of an illness (Feltovich & Barrows, 1984), formed via repeated exposure to cases featuring similar symptoms and signs. In this way, there is further elaboration of the relevant script including issues such as atypical features and context. However, the order in which information is both gathered and organised depends upon the level of expertise, with medical students more reliant upon the serial order of items of information than experienced physicians (Coughlin & Patel, 1986.).

New exposures are now compared to previous instances of the same illness (analogy) and this comparison with previous exemplars illustrates the emergence of pattern recognition. New exposures are *stored as instance scripts* in Stage 4 of the model, each contextualised in slightly different ways, yet merged into one prototypical form (Bordage & Zacks, 1984), which is sometimes characterised by quite overt 'autobiographical memory' for more unusual cases (Hasselbrock & Pretula. 1990; van Rossum & Bender, 1990).

The developmental sequence is inextricably linked with education beginning with the biosciences, explaining physiological then pathological processes, and finally merging this with clinical knowledge acquired from patient contact. However, within these stages there is greater complexity and understanding through the broader and deeper conceptualisation of clinical problems and the discourse involved i.e. *Semantic Theory* which captures the meanings assigned to symptoms and signs (Bordage & Lemeiux, 1991). Cognitive expertise is demonstrated not through a greater knowledge base, rather through better organisation of both biomedical and clinical knowledge linked together as packages of contextualised data, with quicker accessibility and retrieval in working memory (McLaughlin *et al*, 2007; Boshuizen *et al*, 1987).

The next section will discuss the general application of simulation studies in Medicine ranging from high to low fidelity studies, but more particularly the approach adopted by studies such as this one, which seek to explore cognitive attributes and attitudes through the use of techniques replicating clinical practice, rather than those addressing behavioural skills.

2.4 Using simulation to explore cognition

The use of simulation studies is widespread in Medicine with a general emphasis towards practising behavioural and technical skills required in clinical practice e.g. clinical communication and examination, technical competences such as venepuncture, catheterisation, and basic life support (BLS). *Tomorrow's Doctor's* suggests a blended approach to teaching in the curriculum which includes simulation based activities (ibid, paragraph 100). Simulation based teaching in Phase 1 of the curriculum already utilises a spectrum of activities ranging from low tech simulators for resuscitation and examination tasks, to higher fidelity methods using actors working from standardised scripts in communication skills sessions.

In order to explore cognition associated with diagnostic reasoning, a non-behavioural approach is required to correspond with the desired outcome i.e. an attempt to represent cognition associated with the nearest approximation to clinical practice. With this objective in mind the role of 'patients' in simulation will be explored in the following sections. The discussion below starts with a brief typology of various methods ranging from low to high fidelity methods used across various domains of practice, leading to those concerned with analysing cognitive attributes such as decision making during specific encounters with simulated patients (SP). Within this section the educational aspirations of some simulated studies will be explored, including the ethos of constructivism in reconstructing future practice, and the value of extrinsic and intrinsic feedback to the participants (the '*internal conversation'*).

2.4.1 Introduction to simulation studies

Simulation seeks to imitate situational behaviour or processes in real life by creating an equivalent situation for the purpose of training or study (OED, 2006). It creates a safer environment for learning specific skills, assessing competencies, and analysing tasks which may entail any combination of **psychomotor** (task based), **cognitive or attitudinal domains**. Decker provided a broad typology of simulation based education as illustrated in **Table A** (2008), which represents simulation tools as a spectrum of training mechanisms which are suited to separate domains of practice, rather than the more dichotomous perspective of *low* to *high fidelity* tools (originally based on technical sophistication). The key issue is finding the *most appropriate* simulation tool to match the educational needs of the situation/learner and the fidelity of the tool reflects its approximation to reality.

The use of *simulated patients* (also known as *standardised*, abbreviated to SP) are far better suited to explore interactive communications skills such as those aimed to enable coping with an 'angry patient', than a computerised simulation model which would be better equipped to illustrate the management of critical care parameters involved with anaesthesia, shock or significant cardio-respiratory problems. Involvement of SPs in teaching also provide opportunities to invest in training where particular issues require a solution to replicate clinical practice in a safe environment and minimise student anxiety e.g. intimate examinations (Jha *et al*, 2010). For studies trying to probe decision making and cognition the SP provides the closest approximation to consulting with a real patient (RP), and a grounded theory technique is best suited as a methodological approach with which to explore the emergent issues.

Table A: A typology of fidelity elements in simulation based education

Tool	Descriptor
Partial Task Trainers (low tech simulators)	Replica models or manikins used to learn & practice simple procedures
Peer to peer learning	Peer collaboration used to develop skills e.g. physical assessment
Screen based computer simulations	Program to acquire knowledge, assess competency, and provide feedback on knowledge and critical thinking e.g. driving test simulation
Virtual Reality	Computer generated environment with multiple sensory systems via sophisticated training systems promoting authenticity
Haptic Systems	A simulator that combines real world and virtual reality exercises
Standardised Patients (SP and RP)	**Role playing in simulation using actors or students paid to portray a patient in a realistic manner**
Full Scale simulation (medium to high fidelity)	Simulation involving a full body manikin with programmable physiological responses to practitioner actions

Miller provided the first classification of fidelity from the field of aviation to include *psychological* and *physical* fidelity (1953), followed by Rehmann who revised the classification which incorporated *equipment*, *environmental* and *psychological* fidelity (1995). Whilst there is historical evidence that simulation has been used since the eighteenth century with foetal models in obstetric training (De Boursier de Coudary, 1759 in van Meurs, 2006), technological development has created the biggest impact on high fidelity, technical simulators used in the field of Anaesthesia (Tjomsland & Baskett, 2002). The field of Emergency Medicine is probably better known for the more widespread use of manikins such as 'Resusci-Anne' in cardiopulmonary resuscitation, but also the impact of teamwork in acute care (Small *et al*, 1999). More latterly with the advent of minimal access techniques, the field of Surgery has

benefitted from task-based psychomotor skills training in the acquisition of surgical expertise (Kneebone *et al*, 2004).

Preparation and training using various forms of simulation provides not only a safer environment in which to err and learn from feedback, but also overcomes the reduction in opportunities as undergraduate training has moved away from the strict apprenticeship model (Kohn *et al*, 2000; McManus *et al*, 1998). Simulation also provides accurate reproducibility of case material, enables *deliberate practice* for consistent training towards achieving desired competencies (Ericsson, 2004), but can also utilise feedback or debriefing from facilitators/instructors including analysis of filmed events (Issenberg *et al* ; 2005; Hogg *et al*, 2006; Fanning & Gaba, 2007).

In addition to assessing competencies and addressing political accountability, Bradley points to the issue of clinical governance in providing high quality care to patients (2006). This has given extra impetus to the role of simulation in undergraduate and postgraduate training, allowing monitoring of continued professional development (CPD), risk management, and remediation for poor performers. Furthermore, the assessment of skills and competencies in modern medicine through the use of simulation across a variety of domains of practice satisfies the expectation that new doctors have been trained to particular standards (*Tomorrow's Doctors*, 2009).

2.4.2 Standardised Patients in simulation

Barrows & Abrahamson first proposed the concept of *programmed* patients in their study of appraising student performance in diagnostic skills in the sphere of neurology (Barrows, 1993). Their study used what are now called **standardised patients** (SP) i.e. *a person or actor with a particular history and/or signs trained to deliver them in a consistent manner for the purpose of training or teaching* (Ker & Bradley, 2007).

SPs provide *high fidelity* simulation and reflect the closest approximation to real life events during medical consultations, particularly those examining clinical method which include communication and consultation skills (Elstein *et al*, Ch 3, 1978). The SP is usually a trained actor or a patient working from a standardised 'script' containing specific directions, symptoms, and responses to enable consistency and reproducibility when used for assessment such as in OSCEs (Objective Structured Clinical examinations) that are linked to learning outcomes in the curriculum (Schuwirth & van der Vleuten, 2003). Experienced SPs may also become involved in scoring performance alongside examiners.

This study uses a *high fidelity*, *partial task* simulation to explore the cognitive strategies of the participants and find out more about their decision making, judgments and opinions based upon the interaction during the simulation and the *post hoc* reflective discussion. High fidelity refers to the closest approximation to real life scenarios, in this study the medical consultation. *Partial task* simulation alludes to the component of the consultation being analysed, and in this respect, the scope is targeted towards to *gathering information, diagnostic reasoning, the perspective of the participant on those processes,* and the influences that might have a bearing on these activities. For example, the inclusion of treatment and management options in such a scenario would reflect a complete task analysis with high authenticity, but well beyond the expertise level of these participants.

Table B: Qualities of high fidelity simulation

Taken from Isenberg *et al,* 2005.	
1.	Feedback is provided during the learning experience
2.	Learners engage in repetitive practice
3.	The simulation is integrated into the curriculum
4.	Learners practise with increasing levels of difficulty
5.	The simulation captures clinical variation
6.	The simulation is adaptable to multiple learning strategies
7.	The simulation permits individualised learning
8.	Learning outcome are clearly defined and measured
9.	The simulation is a valid (high fidelity) approximation of clinical practice
10.	The simulation is embedded in a controlled environment

Simulation can address and facilitate the learning and rehearsal of basic skills for communication and examination, and aid the practice of complex clinical situations by integrating basic biomedical knowledge and human interactions into clinical practice. These communication sessions illustrate some of the pre-eminent, best evidence from Issenberg's qualitative, systematic review of peer reviewed papers on simulation across 35 years (2005), which include the following key points (**Table B**).This study fulfils some of the parameters above even though it focuses upon one case scenario and therefore does not capture clinical variation. However, it is a good approximation of the interaction that is recognised in clinical practice using an office based setting. The participants in this study have already experienced simulation with experienced actors on three separate occasions in Year 2 using scenarios such as the 'angry', 'depressed', and 'garrulous' patient in which to practice specific communication strategies in a facilitated, controlled environment with feedback using Pendleton's guidelines (Pendleton *et al*, 1984).

2.4.3 Educational strategies in simulation

The broader educational concepts underpinning the typology of simulation encompass *behaviourism, constructivism, reflective practice, situated learning* and *activity learning (*Ker &Bradley, 2007). This study adopts an interpretive, **constructivist** approach in that it seeks to create a central organising theme which reflects the thoughts and perspectives of medical students in a simulated environment. The reflective discussion following on from the simulation will explore beliefs and cognitive structures around the role of making a diagnosis based upon their cumulative experiences to date (assimilated experience which is individually constructed through multiple realities).

It reveals their thinking about how they approach the context of the simulation based upon limited prior experience, how they handle and process a set of symptoms gathered from the SP which illustrates the way they are creating links between various features. Such experiences often provoke challenges to existing ideas through *Transformative learning* (Mezirow, 1991; Byrne, 2002; Parker & Myrick, 2009), affecting both the participants' and researcher's views on the role of the consultation, data gathering, formulating diagnoses and their views on learning and teaching. Video recording of consultations is one such example where both '*reflection in action'* and '*reflection on action'* can both occur to help restructure thought allowing the participant to develop their own learning in a constructive manner for future practice (Schon, 1987).

One of the caveats to learning from simulation arises from the additional cognitive load experienced by the participants which may act as an inhibitor in learning. Cognitive load theory (CLT) was proposed some years ago to explain the interaction between instructional designs and failure to learn (Sweller, 1988; Fraser *et al*, 2012), based upon the idea that working memory may become overloaded during certain instances (Miller, 1956). This effect is determined by a number of factors including

prior learning and the task difficulty (*Intrinsic load*), the excessive load created by the interaction with the task which impairs learning (*extraneous load*), and lastly the amount of working memory that is taken up with the task (*germane load*). Simulations can heighten the emotional components of the interaction and this may impair learning (Alessi, 1988; Rehmann *et al,* 1995). This may cause additional performance anxiety which affects engagement with the task.

The central component of these simulations is the interaction between the actor and the student, including *how* and *why* the participant asks certain questions in the medical history to gather information, and what has influenced their choice of questions and their interpretation of the answers. It specifically addresses one of the concerns about analysing and influencing clinical thinking and decision making through the process of feedback in simulation studies. This *may* reduce the impact of bias and error expressed through the heuristic model of reasoning (Eva & Norman 2005).

Feedback associated with simulation activities can be achieved either extrinsically (from the 'trainer, facilitator, or faculty') and is usually provided after the event in studies based on practising behavioural skills (*post hoc*). It may be also gained through the *intrinsic from the conversation embedded in the experience* i.e. the discussion that the participant has with themselves about what happened, why it happened, and actions or thought can be reconstructed through other perspectives (Laurillade, 1997). This has resonance in the reflective discussion of this study, although not explicitly for feedback per se, rather to construct new meanings of events for future practice (Bradley & Postlethwaite, 2003).

The simulations within this study represent significant themes in medical practice including the central competencies of communication and decision making, but also reflective practice through the post hoc discussion with the researcher. The research method is *qualitative* and focussed on the **cognitive** as well as **communication**

skills within the simulated interview, which are barely discussed in either of the aforementioned papers.

Such ideas encompass much of the argument put forward by Eraut in his book '*Developing professional knowledge and competence*', and specifically his discussion of learning professional processes (1994:107-115) where he pulls together five features of process knowledge, much of which is beyond the skills of the *novice* student as defined by Benner and others (Benner, 1984: Dreyfuss & Dreyfuss, 1986). These skills include '*acquiring information, skilled behaviour, deliberative processes (planning and decision making), giving information, and metaprocesses for directing and controlling one's own behaviour* '. These are complex, cognitive concepts which are more than just common sense, and this view resonates with Ericsson's general suggestion that it may take as long as 10 years of deliberate practice to achieve proficient autonomous practice (1993).

The participants in this study know the rationale behind the use of the traditional medical history (comprehensive, systematic and reproducible), and the basis for gathering information from the patient. Exposure to such experiences is *limited* during phase 1, and therefore will probably demonstrate the features of associative learning in varying degrees. Only deliberate practice will help achieve the goal of fluent history taking which becomes embedded as automatic practice and flexible enough to cope with different contexts.

However, the cognitive stage is more complicated than learning a series of skills or a process as the task based approach suggests above. This linear model presents a *reductionist* approach and underestimates the cognitive processes inherent to decision making, and similar reservations regarding communications skills teaching have been hotly debated (Silverman *et al*, 2011; Salmon & Young, 2011). Critical reviews on the effects of simulation based medical education (SBME) have consistently focussed upon behaviouristic studies with measurable outcomes and methodological rigour in the acquisition of clinical skills, however gaps in

understanding are being highlighted, and this applies to the influences upon cognitive aptitude and professional experience (Issenberg *et al* 2005; McGaghie *et al*, 2010). Significantly fewer studies have used SPs to examine cognition using an interactive reflective discussion to tease out perspectives in decision making (see literature review), but SPs do offer valuable opportunities to study problem solving alongside synthesis of clinical information (Yelland, 1998). In the postgraduate arena there is a growing body of research pointing to the benefits of using unannounced (incognito) SPs in real practice (Rethans *et al*, 2007), although there are inherent issues in data collection. The maximum impact of SPs appears to be in the teaching and assessment of psychomotor and communication skills in the undergraduate curriculum (Hargie *et al*, 1998), and it has been suggested that *vicarious* learning is as effective as learning by doing if accompanied by a script for communication skills (Stegman *et al*, 2012).

High fidelity human patient simulators (HPS) have been utilised to study clinical judgment in acute care nursing scenarios, using qualitative methodologies to explore decision making and judgments (Lasater, 2007). The role of the 'debrief' appeared to be the most important feature to examine clinical judgment but sufficient time needs to be allowed to facilitate critical reflection and integrate cognitive learning from the simulation (Seropian *et al*, 2004).

2.5 The Research Questions

The aim of this thesis is to *develop a substantive theory on how students at this stage in their development view the key skill of* ***diagnostic reasoning*** *(DR)* by asking them to reflect upon their actions and decisions within a simulated consultation. The data derived from the filmed consultations and the reflective discussion will provide material to observe real time decision making and illustrate the sources of knowledge and experience that underpin the diagnostic decisions chosen by the participants during the simulation. In contrast to other research studies, it considers the diagnostic process from the perspective and experience of the student, rooted in the theoretical lens of *Symbolic Interactionism* i.e. acknowledging that views and interpretations of events are influenced by interaction with others, and that data cannot be analysed in isolation from knowledge and prior experience (Schatzman, 1991). The key sub questions within the study are:

1. **What features of a simulated consultation provide most information for the student to assimilate and process towards a tentative diagnosis**? This covers the important area of *data gathering* from the clinical interview and from the provision of examination details pertinent to the scenario (if requested by the participant).

2. **How is the diagnostic process constructed from the perspective of a medical student?**

   Students in the curriculum are encouraged to adopt critical *reflective practice* in their undergraduate portfolio as way of improving professional development. The participants in this study will be given an opportunity to view their own simulated consultation and reflect upon their thoughts and actions, and although such filming can evoke some anxiety about

performance, it remains a powerful investigatory/learning tool which has already been shown in other studies to improve interviewing skills in the postgraduate arena (Edwards *et al,* 1996).

3. **What dimensions drawn from the data might provide a more effective theory through which we can understand diagnostic reasoning at this stage of learning?**

   It is hoped that additional dimensions of thoughts, views, and perceptions will be drawn from the participants' point of view which will enrich the current understanding of DR at this stage of development, and which will facilitate learning and teaching in the future.

4. **How can teaching methods be further developed using theory derived from the student perspective?**

   There is a perceived problem around the 'theory-practice' gap in teaching the cognitive skill of reasoning. Much of what is taught is by definition theoretical and many researchers have tried to bridge the gap using written case based scenarios e.g. Clinical Reasoning problems (CRPs), for use in teaching. Filmed observational studies with a reflexive discussion after wards may provide a more powerful medium through which to approach the teaching of reasoning.

3 Chapter 3: Methodology

3.1 Introduction: Role, Identity, Understanding.

In order to answer the key research questions posed by this study it is necessary to broaden and deepen the discussion to explore some of the fundamental assumptions that underpin the reality of human beings and the meaning of things for them. In turn, this may illuminate the ontological position from which the reality of the medical student can be viewed, which will include their changing role and identity as they pass through the undergraduate programme. Becker's study describes the professional assimilation process, albeit from a very traditional curriculum in the USA (Becker *et al*, 1961), which encompasses a number of phases relating to professional identity from freshman through to intern, and similar transitions are seen in current undergraduate programmes (Diemers, ibid).

Through the reflective discussions in this study, we are given a chance to look into their reality or existence, contextualised through the simulated consultation, and this may shed light upon how they view their *role* and *identity* as students at a particular stage of development (and perhaps the expectations that are placed upon them by transitions in the curriculum). This simulation is but one of many encounters in their careers which will influence their interpretation of what is meant by being a doctor (ultimately), the nature of that existence and the knowledge that surrounds it.

The study will adopt a constructivist and relativist epistemological position in that it attempts to create a picture of the participant's views and thoughts through multiple realities or perspectives (Charmaz in Morse *et al,* 2009: 138). It assumes the active influence with the external world around and a situated participant and researcher, acknowledging other influences. It strives to answer the following questions through emergent conceptual analysis with the possibility of creating new theoretical ideas;

'What is going on? What is happening in the mind of the participant, what is this founded upon, and why?'

Perhaps this can be illustrated by analysing the medical consultation from an ontological perspective i.e. examining roles and identities. In this way, it will also provide epistemological ideas on how the medical student acquires and views knowledge in general and in particular in the consultation gained through interaction with the patient. During a medical consultation particular gestures have great significance, for example asking someone to sit down using a hand gesture implies that a process has begun and is accepted by both parties, one accepting the role of the doctor and another the patient. The relationship started at that point conveys meaning to each individual for a period of time, and their reality changes with a different set of parameters which may be commonly accepted by the society to which that individual belongs. Vocal gesturing is more controllable with greater reflexive control, however non vocal gesturing is more problematic as it is difficult to 'police' our facial responses as we cannot see them (Mead, 1934: 65).

Accepting or embarking upon the role of a patient has several implications from an ontological perspective and necessitates a pluralistic approach where the nature of being fluctuates between *self determination* (the norm) and '*loss of control'* (The Illness Experience, Morse & Johnson, 1991). Control is temporarily assumed by another party, in this case a healthcare practitioner whose altruistic characteristics are sought and expected. In illnesses of short duration, self determination is regained quickly, however with enduring illnesses regaining control may never be fully achieved.

Similarly, the medical student generally accepts that he/she will be expected to adopt a new role or self identity during different activities in the taught curriculum. Each new identity has different role parameters, meanings and expectations. Early clinical interaction in the curriculum often requires the student to adopt a passive role as an observer, watching a more experienced clinician demonstrate various skills. One of

the skills most difficultly to convey to an observer is what you are thinking about as an interview unfolds, and reviewing performance is often contextualised through defined competencies espoused at modular outcomes e.g. using open or closed questioning. Higher cognitive skills are difficult to assimilate and even harder to explain when the emphasis then turns from observation towards active engagement with a patient.

A significant change in role and expectation is often associated with the key transitions in the medical curriculum, the first being between the pre-clinical period (usually the first 2 years in the UK), and the clinical attachments seen in years 3, 4, and 5 (Teunissen & Westerman, 2011). The fluency of this transition however, is learnt gradually by controlled exposure, by trial and error in safe environments such as simulated consultations (Maran & Glavin, 2003). The emergence of thoughts and opinions on diagnostic reasoning is one such transition.

There is an uncomfortable duality to such simulations in that the student recognises a learning situation with educational processes and outcomes ('*please take a history from this patient with a view to gathering information, making a diagnosis, acknowledging a complaint, etc*'). Yet the student is required to adopt a new role or identity in steering a consultation towards the defined outcome whilst trying out their communication skills (?). The individual's response to the new situation is partly enshrined in the idea of *transformative learning*, involving the reconfiguration of ideas, knowledge and professional boundaries (Mezirow, 1991).

The interpretation of the meaning of things and events, such as the symptoms described within a consultation or the interaction between the parties involved will vary for each individual. The reliability of an undergraduate programme relies upon the ability to pull together potentially variable experiences into a series of common themes which could be viewed as dimensions organised by a central theme (see dimensional analysis). The multiplicity of academic and clinical experiences within a five year programme of undergraduate medicine contributes immensely to the

individual's interpretation of meanings, and may vary considerable with some notable experiences e.g. Cardiac arrests, seeing their first death.

This description is written from the perspective of a medical teacher, and not a student, therefore the danger here is that we may not know that the student's perspective may be. This is where the conceptual approach utilising *Symbolic Interactionism* provides the theoretical framework through which the views of the medical student can be analysed. It has been suggested that medical students slowly develop cognitive structures which represent illness or disease by forming links between biomedical information and clinical information from the consultation (Schmidt *et al*, 1990). These features contribute towards the development of a mental concept of the disease in the mind of the student. Progressive exposure to patients with the same illness/disease adds to the complexity of this mental concept and helps create both the typical pattern for this illness and the more atypical features. These are both complex and yet fundamental mechanisms for the student to adopt as part of the diagnostic process however, how do they actually achieve these processes and are they aware of what they are doing and thinking?

3.2 The theoretical framework: Symbolic Interactionism

The theoretical framework on which the study is based in the field of Social Psychology pioneered through the work of a number of prominent theorists including George Mead at the Chicago School of Sociology, who adopted a *naturalistic view of studying human behaviour* (Mead, 1934). Their conceptual approach was based upon ***Symbolic Interactionism*** *(SI).* This term was later interpreted more effectively by Blumer as; *'human beings act toward things based upon the meanings that the things have for them; the meanings of such things is derived from the social interaction that the individual has with his fellows, and meanings are handled in, and modified through an interpretive process and by the person dealing with the things they encounter'* (Blumer, 1969: 2).

The theory of natural analysis was also viewed merely as an extension of a person's natural analytical processes (Schatzman, 1991), and there is a significant parallel between this and clinical reasoning skills. Both listen to a story, consider the attributes or features, how they are described and asks questions of what is not understood. Both also consider the meaning of the event or interaction with the researcher or clinician taking a perspective leading to an explanation or diagnosis. One of the fundamental constructs of SI is the mutual interdependence of the individual and society, and the social forces at play are just as relevant as internal forces within the individual. This incorporates Mead's comment that '*humans are both determined and determiners*' (Mead, 1932: 77) and behaviour resides within the interface between the two. Cooley's view on the role of interaction is best defined by Meltzer who wrote '*the role of interaction is that of a mediating bond between social environments and individuals, and it is this role that must be scrutinized to obtain an understanding of the mutual interdependence of these two entities in human society* '(Meltzer *et al*, 1975: 9).

The social environment for the participants in the study stems from a number of interdependent forces which would include the national and international drivers within undergraduate medical education (e.g. *Tomorrow's Doctors*, ibid). Locally the values and ethos of the medical school as determined by curriculum design for example, and lastly the modular activities within different parts of the programme. Although this provides context at a *macro* and *meso* level in terms of institutional decisions and negotiations with teachers providing group work in CR, many of these conditions will be unknown to the student cohort. Their conceptualisation of clinical reasoning will by necessity be far more basic and centred inwards towards individual cognitive skills and tasks, which place this study in the dimensionalisation process described by Schatzman (1991, ibid).

These interactions at various levels contribute towards the received meaning and interpretation of medicalised behaviour, including the inherent role of diagnostic reasoning. Some of these are *explicit* in social interaction during the curricular activities; others are more *implicit* or even subliminal e.g. The cognitive skills associated with making diagnoses represent one such area of medical expertise *whereby role modelling can implicitly convey a desirable skill without explicit discussion of the intricacies of cognition that ultimately achieve the desired result*. This would include complicated issues such as disease probabilities, weighting of cues in Judgement Theory (Hammond, 1996) and evidence based practice. Strauss & Corbin (1990; 165) described the conditions pertaining to any study in their conditional matrix, with the global factors in the more peripheral circles, the inner circles being relevant to the local conditions and actions. Strauss introduced the concept of negotiations to link negotiated interaction at various levels (Strauss 1978: 77), but felt that many studies merely used these features as descriptive background rather than specific influences on the interaction.

Mead's influence in social psychology (and to a lesser extent Dewey) was to move the psychological emphasis of the development of the mind away from the individual, and relocate it in the social environment. He introduced the term '*reflexiveness*' i.e. 'the turning back of the experience of the individual upon himself' (Mead, 1934: 134). The idea of 'self-concept' was developed by Mead as a continuous interactive communication between the '*I*' and the '*Me*', the '*I'* being the reaction to others or events in an impulsive, spontaneous human form which is then rationalised in internal conversation with the '*Me*'. The '*Me*' evaluates and interprets in the context of interaction with others, before the experience is stored, creating the *social self*- comprised of beliefs, attitudes, expectations and ideas (Mead, 1934; Aldiabat & Navenec, 2011).The cognitive skills of reflexivity and metacognition can be seen clearly as part of this internal dialogue and are reflected in the idea of intrinsic feedback in simulations studies. This concept has particular resonance with the subsequent work on Transformative Learning (Mezirow, 1991).

Mead also viewed the perceptive ability of human beings as part of the evolutionary continuum (phylogenetic) alongside the development of thinking ability, and that perception acted as the mediating process between the individual and the social environment (Meltzer, 1975: 32). Both of these statements have current relevance for the position of reflexivity in research and *reflective practice* espoused in contemporary medical practice (which is also an integral part of the undergraduate portfolio in Phase 1).

He quotes the term 'generalised other(s)' as the component that controls human behaviour, both in terms of the 'Me' as part of the self concept, but 'others' counted as individuals, social groups and sub groups. These others share attitudes as part of a larger community. Altruism could be regarded as one of these attitudes within the caring professions and in the wider population. This point is taken further by Blumer who believed that human behaviour is fashioned by the interaction with others ('*joint action'*, Blumer, 1969: 17), which according to La Rossa promotes self-confirming

lines of action and ensures that personal values are not transgressed (La Rossa & Reitzes, 1993). From this Blumer developed the triadic premises of SI:

1 *Humans act towards things based upon the meanings they have for them*

2 *The meanings of such things is derived from social interaction*

3 *Meanings are handled in and modified through an interpretative process and by the person dealing with the things that they encounter*

These assumptions have been augmented by Blumer and others to include (from Aldiabet & Navenec, 2011):

4 *Humans live in a symbolic world of learned meanings*

5 *Humans and society have a relationship of freedom and constraints (La Rossa & Reitzes, ibid)*

6 *Self concept provides a motive for behaviour*

7 *The self is a social construct developed through social interaction with others.*

These are all useful concepts with which to view our social interactions and meanings of things, however they require some translation and interpretation in the context of the world of the medical student to provide some meaning. For the purpose of this study this entails considering the meanings between medicalised ideas (e.g. what is a symptom?), and the relationship between different ideas (how does risk behaviour relate to diagnostic reasoning)?

3.2.1 Symbolic Interactionism: What does this mean for the student?

The power of reasoning linked to language was proposed by Mead as an integral feature of human behaviour which involves inferences about relationships between things (Mead, 1938: 518). For example, the linkage between a variety of symptoms and signs into a recognisable pattern representing an illness ('Illness script') is a prime example within the sphere of diagnostic reasoning used by experienced clinicians. The participants in this study will have only limited clinical knowledge with which to link symptoms and signs to biomedical knowledge in creating such patterns, and so their tentative ideas may illustrate difficulty in making inferences about the relationships between things at this stage of development.

The language of medicine and its symbolism is another potential constraint to behaviour and thought, particularly in the early stages of development at medical school. One of the central concepts of SI is the idea of 'role taking' which is the behaviour resulting from the conversation between the 'I' and the 'me', primarily imagining oneself as seen by others. This approach has been adopted through the use of reflective practice within the undergraduate portfolio with the goal of encouraging students to step outside of their personal perspective and view events/interactions from other viewpoints, including their own role within consultations. The wider perspective is of course to develop critical reflection and analysis of professional practice (both good and bad) with a view to improving professional development and self-regulation (Sandars, 2009).

The difficulty entering this new world for the novice medical student is emphasised by Charon's comment, 'moving from one symbolic world to another necessitates the learning of new symbols and language' (1979). However, there is a constant flux in the meaning for things because of the constant reconstruction from experience and interaction. Thus goals will change from one situation to the next, for example, the goal of a simulated consultation in the curriculum (faculty aim) maybe to

expose the student to a new problem in a facilitated, safe setting when errors can be rationalised (an example of this is found in the clinical practice programme in year 2 when students are exposed to communication in difficult situations e.g.bereavement). Charon's comments are particularly relevant to the transitions in role and expectations during the medical curriculum which applies to the participants of this study, being at the first stage of one of the three significant transitions suggested by Teunissen & Westerman (2011).

The learning process encompasses gradual changes in thinking, attitudes, language and self concept, and behaviour is gradually shaped through interaction with faculty and peers, and resonates with some of Becker's comments about assimilation into the social organisation within medical school as students find their '*professional self image'* (Becker *et al*, 1961:419).

Both language and reasoning ability are fundamental issues in the diagnostic process whereby the use of particular phraseology almost creates another language through the basis of medical jargon. This can be viewed as an inclusive group activity through which doctors make sense of specialised terms and learn how to convey information in a succinct manner; or it can be viewed as an exclusive group activity which creates a cocoon of identity (joining a club). Immersed in technical terms often derived from other languages (Greek and Latin especially) the language of medicine becomes one of the primary tools in group interaction and conveys meanings for things that the laity have difficulty engaging with or indeed understanding.

Where does that place the novice medical student trying earnestly to engage with new terms and meanings, particularly in clinical practice where human behaviour poses so many contrasting problems? Blumer views group life as a '*process in which people meet in different situations, indicate lines of action to each other and interpret the indications made by others'* (Blumer, 1969: 52). He goes further in suggesting that this process is dependent upon both individual interactions but also between collectivities e.g. medical schools, universities. There may be an overarching

collective approach for example to patient centred care, however how each student interprets this ethos comes from a series of interactions with both teachers and those in professional practice, influenced by contact with various patients. This will never be a uniform experience and diagnostic reasoning ability is one such example.
This interaction is dynamic, as students learn about their new world, develop perspectives and share experiences. Thus, their views on the role of the diagnostic process will change with time through the course and beyond with individual constructing some sense of meaning for ideas and terms, then reconstructing or adjusting those premises based on further interaction i.e. a social constructivist approach (Charon, 1979).

***Reflexive Memo**:*
Individual reasoning ability is said to be very idiosyncratic with poor transference into other domains of practice (Elstein et al, 1978), and Blumer's comment on self indication help substantiate this variability. What meaning of a patient's differential diagnoses does the individual student take away from teaching in the skill suite or at the bedside? It cannot possibly mean the same thing to each member of a teaching ward round unless every intricacy of the history, examination, management and treatment is taken into account. How can prior teaching on the cognitive skills involved in diagnostic reasoning create a more definable group meaning without so much variance??This is the 'raison d'être' of many studies in reasoning-we know human judgment is fallible but how can we make it better?

Human interaction is mediated by both interpretation and symbolism (e.g. cultural norms) and as Blumer also suggests this mediation process sits between the stimulus and response in human behaviour (ibid: 79). This applies not only to interaction between humans but is directed towards the 'self'. There are countless situations which are recognised in everyday life such as arguing with oneself, rationalising and excusing one's actions, making compromises, etc, etc. 'Acting towards oneself' is argued as a central process that gives rise to meanings and actions towards things and is termed *self indication.*

This is part of the '*making sense of the meaning of things'* and its mere description implies a very individualised cognitive process that cannot necessarily be subsumed into broader psychological concepts, however can be aligned into a group action, and this is where teaching can facilitate the group action towards specific subjects such as reasoning.

During the filmed consultations and reflective discussions, *self indication* and interpretation of an event (the simulation) will be uppermost in the mind of each participant as they search for a line of action within the consultation based upon the information that they have gathered. They may not recognise this as taking place however the position of the researcher will be to facilitate opening up the internal dialogue of each student focussed around their views on decision making and the diagnostic role.

Finally, one of the key questions arising from this study is *what is meant by a diagnosis?* In grammatical terms, this word represents a *verdict*, *opinion*, or j*udgement* however the implications of these various terms are significant for both the clinician and patient. What does this term mean for the fledgling medical student grappling with a multifaceted concept sitting in front of a patient for the first time? Any number of alternatives may be suggested from an experienced doctor's perspective (and the researcher), which might include *the solution to a patient's problem, a medicalised term applied to a patient's problem, a 'catch all' pattern representing a disease, or an alternative within a competing list of solutions.* However, all of these alternatives are immersed in the individualised experiences of the doctor/researcher and none of these may mean anything to an inexperienced medical student making the first steps towards autonomous decision making.

The next section discusses the methodological approach adopted by the study i.e. dimensional analysis (DA). This one of the 2nd generation variants derived from 'classical' Grounded Theory Method (GTM) which emerged through slightly different

interpretations of the original theory proposed by Glaser & Strauss in 1967. The link between the interpretive position of symbolic interactionism and GTM is strong, and relates back to the philosophy of the Chicago School of Sociology in that attempts to understand behaviour, interpretation and thinking , thereby making it a natural choice to use for this study.

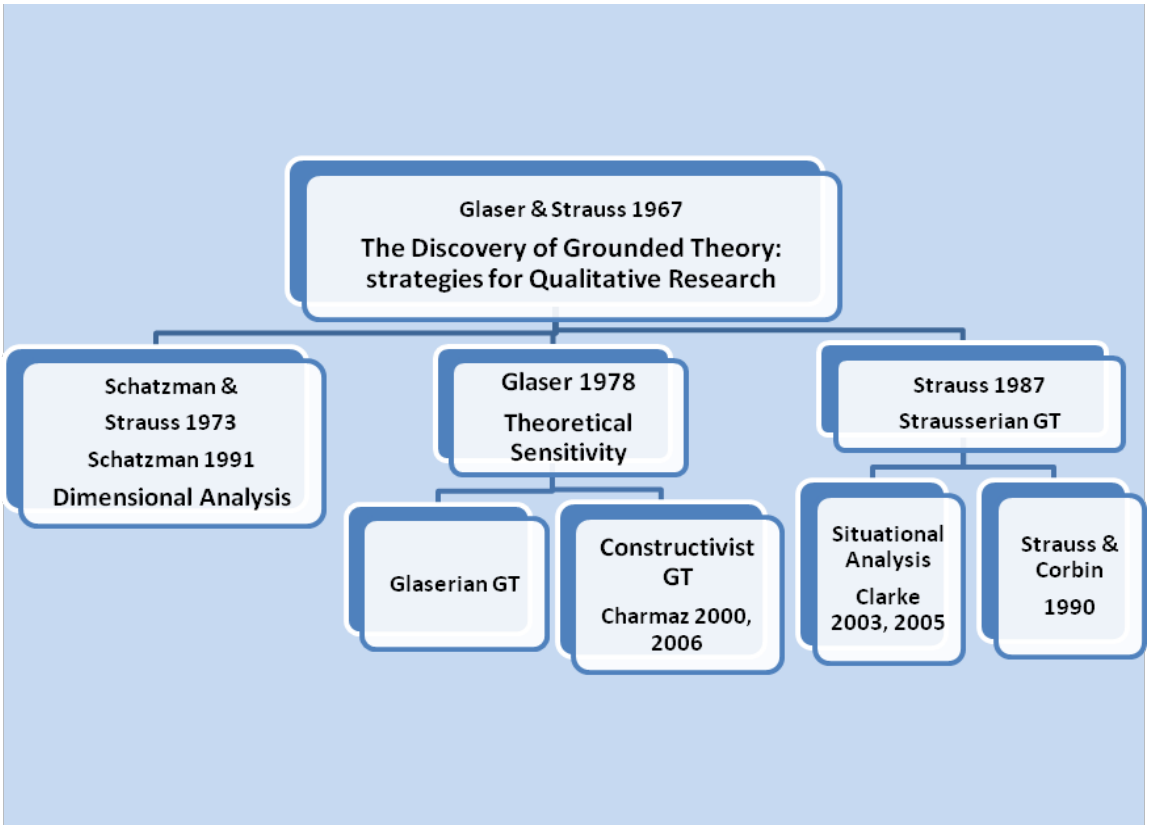
3.3 Grounded Theory Methods

It is clear that the *views, opinion, perspectives and experiences* of the participants in this study are paramount towards the creation of a theory which explains how they perceive the skill of diagnostic reasoning, immersing this study firmly in the qualitative research paradigm. This places the participant's view or standpoint foremost in the research process whereby the researcher's interpretation of their perspective is critical to the analytical process (Denzin, 1978). The dimensions or attributes derived from the data reflect the meanings of *things* for the participants, primarily linked to decision making in the simulated setting in this study.

Grounded Theory was established by Glaser & Strauss in 1967, primarily in response to the recognition that qualitative studies using natural analysis were not systematised or rigorous. Since that time, further interpretations/variations have been developed and these are encapsulated by Morse in **Figure E** (Morse, 2009: 17). The emergence of these variant forms of the original concept (which is now called *classical* grounded theory), have been grouped into four periods by Benoliel (1996); the *discovery decade* (1960-70), the *development decade*, (1970-80), the *diffusion decade* (1980-90) and the *diversification decade* (1990-1996), although further development has emerged since.

Different positions have been adopted by various subsequent researchers in the field who have contributed to the corpus of knowledge and techniques arising from classical Grounded Theory, many of whom had worked under the tutelage of Glaser & Strauss. These enhancements or progeny have created a family of methods under the umbrella of GTM, some preferring to recognise three main forms (Glaserian, Strauss & Corbin school and Constructivist GT) yet others list seven versions (Denzin in Bryant & Charmaz, 2007: Ch 21).

Figure E: Genealogy of Grounded theory (adapted from Morse, 2009)



Dimensional analysis (DA) is one such variant, although it cannot be considered as a standalone approach to analysis without first immersing its beginnings in the emergence of the Grounded Theory technique (GTT) which relies upon the *constant comparative process*. DA is ascribed to the thoughts of Leonard Schatzman who collaborated with Strauss using grounded theory technique before his own ideas gradually emerged (Schatzman in Maines, 1991).

Grounded Theory Method (GTM) utilises a *systematic, inductive and comparative approach to conducting enquiry as a way of developing theory* (Bryant & Charmaz, 2007:1). This means that emergent data arising from a case must be compared with similar properties arising within other cases, and if enough cases exhibit the same properties (theoretical saturation) then this may contribute towards creating new theory.

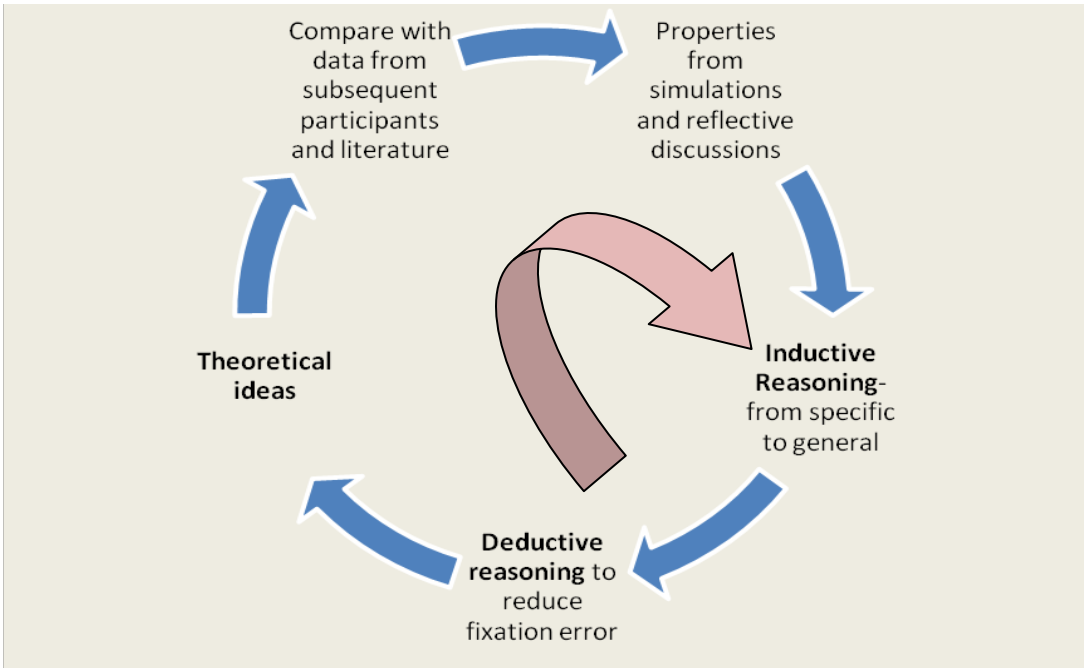
Hood suggests that three features are core to GTM, (1) theoretical sampling, (2) constant comparison of data to theoretical categories, and (3) focus on the development of theory via theoretical saturation of categories (ibid, ch 7). The similarities between GTM and Dimensional Analysis lie primarily in the constant comparative process and the cycles of induction and deduction used within an interactionist view of social psychology. However, there are differences in interpretation as well, illustrated by Glaser's reaction to some of these variants. He concluded that in common with Strauss & Corbin's departure from classical GTM published in 1990, Schatzman's approach by implication was similarly flawed through the '*forcing of data'*, although others would argue that this merely acknowledges the impact of the researcher on the emergent data (Glaser, 1992: 94; Mruck & Mey in Bryant & Charmaz, 2007: 581).

The argument against 'forcing data' was to integrate rigorous memo-ing with sufficient reflexivity and critical reflection to address this issue, thereby forcing the researcher to safeguard their methodological rigour. The issue of reflexivity has become a debate within itself across many disciplines. Opinion varies according to the field of application, however a shared tenet is enshrined by Steier as '*turning back on one's own experience*' with a self critical focus, or in a methodological setting, *'to take account of their own relations to the groups they study'* (Steier, 1991:2; Lynch, 2000). The outcome is to ensure that the researcher does not bias the empirical data with his own perspective or agenda whilst remaining blind to other emergent characteristics.

GTM (and DA) are reliant upon the cognitive skills of cycles of Induction and deduction as part of constant comparative technique, illustrated in **Figure F** (Richardson & Kramer 2006). The original viewpoint in GTM was that theoretical concepts in the mind of the researcher should be set aside. However, as Kelle points out, '*an open mind does not mean an empty head*' (Kelle in Bryant & Charmaz, 1995: Ch 9), and this analysis leads to the position of *abduction* as a form of reasoning in

both grounded theory and dimensional analysis. Abduction can be regarded as the creative insight that generates working hypotheses, and that creative insight or inference does not originate from an empty head, but relies upon ideas and general concepts that might be adapted to suit the context (Coffey & Atkinson, 1996). The analogy between this premise and the role of Scheme Inductive Reasoning in complicated medical cases is quite apparent, whereby general schemes or frameworks of approaching problem-solving can be applied to different scenarios to act as a catalyst for ideas.

Figure F: Constant Comparative Process: Iterative cycles



Using specific, singular forms of data from interviews for example, *induction* moves from the specific to extrapolate the conceptual category or dimension. *Deductive* reasoning moves from the general concept back to specific instances and is used for iteration to reduce *fixation error risk* (focussing on one particular solution or concept when further new data suggests competing ideas). There is a clear analogy between this process in research and the discussion of diagnostic errors in probability, including anchoring or conservatism, the anchor being the *subjective* starting point of

diagnostic probability before the features of a case are presented (Edwards, 1968). Similarly, the tendency to seek more and more tests that confirm a hypothesis, rather than using discriminatory tests that rule out alternatives is called confirmation bias (Wolf *et al* in Dowie & Elstein, 1988: Ch 17).

Abduction comprises both the rational and imaginative form of inference (insight) required to develop theory, and is the step beyond simple induction and deduction required to create new knowledge/ideas. The first description of abduction can be found in the writings of Charles Peirce on logical inference as he tried to capture the final step when making sense of material that does not fit with pre-established categories i.e. insightful creation (Peirce, 1878; Strubing in Bryant & Charmaz, 2007: 589). This skill is developed through natural analysis and problem solving learned through social interaction in early life (Schatzman in Maines, 1991: 305). By this, he meant that scientific enquiry was a natural extension of an individual's natural analytical processes, and this reflects the natural (and variable) ability in clinical reasoning attributes seen in expert clinicians. It seems entirely logical to assume that researchers' facility in using GTM applied to their data express the same variance in scientific ability. With progressive experience in both spheres, analysis should become more sophisticated.

Natural analysis is akin in many ways to the linked skills *narrative reasoning* and *interactive reasoning* which constitute the pervasive human activity to make sense of their world as a form of meaning-making (Bruner, 1986; Benner *et al*, 1992; Fleming, 1991), of particular importance in clinical medicine when listening to patients' stories/histories. Bruner described this as the capacity to 'read other minds' and includes the interpretation of actions, speech, motives and the inferences drawn from such experiences. However, such reasoning is prone to considerable misjudgement and error particularly with unfamiliar social environments where the meaning of action may not be immediately apparent.

3.3.1 Dimensional Analysis

The foundations of Schatzman's ideas in developing DA can be seen in a book written with Strauss called '*Field Research, Strategies for a Natural Sociology'* (Schatzman & Strauss, 1973), although the preface makes it clear that Schatzman was the primary source. At this time, research based upon naturalistic enquiry was perceived by some as a less rigorous method of scientific analysis with theoretical explanations of events under scrutiny that lacked an explicit approach in the analytical process (Bernstein, 1985). Such criticism is acknowledged by the authors of one of the most notable studies on student culture in medical school '*Boys in White*', relying upon observations from field work pulled together under the guise of '*what is ordinarily vaguely referred to as qualitative analysis'* (Becker *et al*, 1961: 30). The authors go on to say, '*the methods of arriving at conclusions have not been systematised and such research has often been charged with being based on insight and intuition and thus not communicable or capable of replication'*.

One of the authors of this book, Anselm Strauss recognised the challenge to develop a more robust analytical approach to such sociological theory and joined forces with Barney Glaser, culminating in the publication of their grounded theory method (ibid), based upon constant comparative analysis used in a structured and robust manner towards developing theory. Strauss came from the Chicago School of Sociology and was influenced by Blumer and Symbolic Interactionism (SI). Strauss invited Glaser to become involved in a study called '*Awareness of dying'* at UCSF where he was working at the School of Nursing to develop the first doctoral programme for nurses, and this paper become their first collaboration (1965).

Robrecht suggests, *'grounded theory method stresses that the theory must come from the data, not prior knowledge, and that the operations leading to theoretical conceptualisations must be revealed*' (1995). One of the key terms describing this methodological process is the insistence that *prior knowledge* or *preconceptions are*

laid aside during data analysis and the formation of codes. Data is derived from the phenomenon being studied and through rigorous analysis and interpretive procedures a theory may emerge –the emphasis being *trusting in emergent theory* rather than the imposition of received theories (Strauss & Corbin, 1990: 20-23).This assumes that the researcher can conduct data analysis and subsequent categorisations independent from prior learning, experiences and social construction of ideas.

The received impression of grounded theory is sometimes at odds with the discussion in Chapter X1 from Glaser & Strauss' original book which expands upon *Insight and Theory Development*. Insight is what we would commonly refer to as reflexivity and reflection upon prior experiences, and feeds into the important issue of *memoing* to maintain a clear perspective of the influence of personal beliefs about the area of research being studied. To paraphrase the writing and apply it to the researcher's domain (clinical teaching), the principle insights came from personal experiences as a teacher and doctor, but some are based upon subsequent theorising, and reflection upon earlier experiences (ibid, 252). A further comment suggests that Glaser & Strauss were already leaning towards a broader concept of grounded theory, '*a third corollary pertains to how fruitful insights can be gotten from existing theory*' (ibid, 253). Yet they also sound a warning that adhering to existing theory will often stifle emergent ideas.

Merriam (2001) suggests that all research is linked either implicitly or explicitly to the researcher's view of the phenomenon being investigated, and theories relate to academic discipline or professional application (Passmore, 1997). As Schatzman clearly articulates, *'Rarely if ever do we abandon prior theoretical or methodological anchorage'* (in Maines, 1991: Ch 17). Theoretical anchorage cannot be merely jettisoned for the purpose of any study and is an ever present feature of professional experience. **Table C** (section 3.4, p80) on memos and reflexivity illustrates the recognition of the various influences upon my position during the early phases of data

analysis, enabling me to understand my theoretical anchorage and how this was reflected in my interrogation of the data. This is illustrated in parts of the reflexive memo below:

Schatzman's comment about anchorage relates specifically to his experience of working with nursing students at the University of California (UCSF) using comparative analysis. '*Their comparisons proceeded on the basis of prior assumptions and understandings about the nature and variable importance of these considerations'* (in Morse et al, 2009: 92). What Schatzman recognised was the impact that these assumptions made on the analytical process but had not been identified by the comparative analysis associated with grounded theory and the dimension of experience was what was missing from the whole process (Schatzman, 1991). His contribution was therefore to acknowledge that anchorage or relative position in terms of the researcher and making adjustments for the individual's perceptual filter was an implicit part of the analytical process.

Schatzman went beyond the parameters of classical grounded theory and expanded the range of analytical skills to include

- Forming dimensions or characteristics using comparative analysis
- Assigning value to these dimensions-those that have significance beyond others
- Recognising the embedded beliefs of the researcher through professional experience i.e. the interaction with the researcher or the '*dimension of experience* ... .*perspective both limits and directs analysis and also .....directs organisation of relationships'* (Schatzman in Morse, 2009: 93). This makes the tacit processes involved in grounded theory more explicit.
- Making inference about dimensions and the relationships between them to develop theory

In contrast to Strauss, he also suggested that comparative analysis be delayed until enough data had been collected to generate enough dimensions so that theoretical/premature closure was avoided. In effect, he was saying keep an open

mind for long enough to understand '*what is all involved*' alongside the emergence of a *central organising dimension* or key linkage as it was first described (Schatzman & Strauss, 1973: 111).

In scientific natural enquiry such as DA the tendency to fixation error can be minimised through theoretical saturation of the data, re-challenging and verifying the dimensionalising process through iteration and constant memo-ing through which ideas are hypothesised and extrapolated. DA relies upon cycles of induction and deduction using the constant comparative process to realign dimensions or themes (**Figure F,** p72). Theory in DA is constructed from a pragmatic, *relativist* position in that emergent ideas are then compared with subsequent data through several iterations and compared with the current literature base and theoretical concepts in the field. This separates it from classical GTM which adopts a positivist or objectivist stance where the observer is apparently neutral, free from context and any pre-conceptions (Charmaz, 2006, 130-132).

The researcher using dimensional analysis is not neutral and is situated with pre-existing knowledge and perspectives where truth is conditional. Several interpretations of action may arise from the data which remains fluid in the early stages until the cycles of induction and deduction can create the beginnings of the explanatory matrix. Through each iteration the perspective on the data may shift as theoretical sensitisation refines the relevance (or not) of each dimension within the explanatory matrix. Perspective determines both the selection of dimensions and the relationship between them, either from the researcher's viewpoint or the participant's representation of the issue being studied.

The researcher extracts and labels data which gradually builds a picture comprised of large chunks of similar data that represent a specific characteristic or attribute, called a dimension. Tabulated data is built up across participants to line up these characteristics and subsequent data analysis may conflate or confound such properties. Such cross referenced comparators eventually start to build a larger

picture based on working hypotheses which are proven or realigned by amalgamating the data sets from each participant. As Robrecht suggests the researcher adopts a perspective or viewpoint from an *interpretavist* position on the information (Robrecht, 1995: 169-177). She goes on to describe the process of examining the dimensions arising from the data, accepting some and rejecting others until the most prominent dimensions begin to take precedence to provide a more effective theoretical position with a central organising dimension at the core.

These working hypotheses become less literal and more theoretically mapped through differentiation and analytical abstraction. The 'final' phase is integration of dimensions into an *explanatory matrix* which should be justified by revisiting the data again (deduction) to maximise theoretical rigour through reflexive analysis. This will be discussed in Chapter 5 using themes from the data.

Reflexive Memo:

Yet again, the remarkable similarities between the theories of reasoning and natural analysis resonate in my mind. I had not anticipated this as my understanding of the field of both natural analysis and dimensional analysis up to this point was incomplete. The parallels between the domains are making the comparisons easy to draw out and are beginning to underpin the deeper knowledge and understanding that I have for the study overall. I realise that my expertise is growing slowly and the domain appears to suit the analytical side of my personality, but there are occasions I need the help of conceptual levers to propagate the analysis.

Two experiences recently have provided some evidence of progression. Last week I met up with one of my fellow doctoral students who will probably use GTM in her study, but couldn't analyse which theoretical framework would provide the foundations for her study. We talked about SI and the similarities between our two studies, however the significance was in my (new) confidence & ability to analyse her approach and give constructive advice. Later on one of my work colleagues asked me about what I was doing at this stage of my writing. The answer (I felt) was concise and clear, couched in terms that I think she understood for someone not accustomed to this domain of research. Is this merely a case of 'See one, do one, teach one' or evidence of deeper understanding.

3.4 Reflexivity and Memos

Schatzman recognised the potential impact of the embedded beliefs of the researcher through professional experience i.e. the interaction with the researcher or the '*dimension of experience ... .perspective both limits and directs analysis and also .....directs organisation of relationships'* (Schatzman in Morse, 2009: 93). With this statement he was reiterating a clear message originating in Glaser's warning about 'forcing data' inferring a cause of potential bias (Glaser, 1992), yet he also appeared to acknowledge the potential benefit. His statement is immersed in Mead and Blumer's work on symbolic interactionism i.e. 'the researcher must be aware of their own meaning for things derived from years of both professional and educational experience impressed by various cultural norms' with groups such as teachers and patients. It is a warning for the researcher to acknowledge their self concept and the internal conversations which may influence ideas and perspectives, including the interpretation of data within the study. This 'reflexive stance' is explicitly recommended in constructivist GTM which would consider the position of the researcher as core with memos as a key function (Charmaz, 2006: 189).

Schatzman's comment reflects the duality of this argument in that embedded beliefs can both **limit** and **direct** research. This view is shared by Strauss & Corbin who equally adopted a more positive stance on reflection and reflexivity than Glaser who regarded the researcher as the 'neutral knower', recognizing that researchers can build upon their personal and professional perspectives and to become aware of the impact it may have on data interpretation (Corbin in Cisineros-Peubla, 2004). This again emphasises the counterbalance required between reflexivity and abductive thought that define dimensional analysis compared with classical GTT.

There exist a number of interpretative stances for reflexivity however they all share the underlying idea of recursive 'turning back on one's own experience' (Steier, 1991:2), which include Lynch's methodological reflexivity underlining the concept that

research students '*take account of their own relationships to the groups they study*', and this has great resonance for this study (Lynch, 2000:29).

Table C: Early prompts and memos reflecting issues of reflexivity

Researcher question	Memo-mixed types
(Discussing the examination findings) *"...starting with **the key material** (PA).*	Original *analytical* memo: Procedural elements of examination without being able to target expected findings exemplifies lack of clinical experience. **Subsequent *analytical and reflexive* memo; Key features approach and weighting ideas-this reflects my stance in teaching-that there are key features in a clinical case that become apparent-this may not be the case for the novice student who will not be able to differentiate between strong features and weak one in the history or examination.**
"Go through your ideas of what was wrong with this lady? So what was top of your mind, your leading diagnosis?" (PC)	Original *analytical and reflexive* memo: Assumption that they have made a diagnosis. There are some personal beliefs that I clearly hold which I have to set aside sometimes, almost akin to Husserl's idea of 'bracketing' (suspending prior assumptions and beliefs). **Subsequent *reflexive* memo; my inference that there are also competing diagnoses and that the participant has formulated ideas from the simulation on a diagnosis**
*"How does that **help** you with what you were thinking earlier? (PC)* (Asking about how examination data influences prior thinking from the history).	Original *analytical* memo: Leading question towards the examination clarifying the diagnosis: the term **help** may not apply! **Subsequent *reflexive* memo: Assumption that extra information from the examination actually helps refine the diagnosis based upon the history alone**

Reflexivity is viewed by some as enhancing objectivity in the methodological process (Lynch 2000: 26), and **Table C** illustrates how this was used during the data analysis to highlight some of my theoretical preconceptions which acted as a blocking mechanism whilst trying to develop the preliminary dimensions from the simulation material.

To acknowledge this perspective early in the data analysis process became a pivotal point to maintain objectivity and rigour in the subsequent analytical process, particularly during deductive iterations of the data to substantiate some of the inductive dimensions (Kennedy & Lingard, 2006). This was amply illustrated by the lack of saturation concerning the 'theoretical coat' of knowledge deficits mentioned by only two participants during their reflective discussions.

During the early stages of the data analysis when inductive ideas were at a premium, and pedagogical anchorage appeared to be acting as a blocking mechanism, it was suggested that I should examine the way in which my prompting questions were phrased. I looked at what the relevant memos were saying at the time, and how my perspective might have shifted (using data from the first five participants).

At this point it was useful to remind myself of Patton's comments: '*good questions in qualitative interviews should be open ended, neutral, sensitive, and clear to the interviewee'*, and not present one's own perspective, thus potentially biasing the findings (Patton, 1987; 2002). This became a salutary reminder of my views on clinical reasoning and demonstrated the need for greater reflexivity.

This prompted a theoretical shift towards issues such as knowledge organisation in the subsequent data analysis, and away from my subjectivity immersed in consultation behaviour and the reasoning literature. The memos associated with this shift illustrate movement from speculative and apparently unconnected comments towards a greater coherence as some of the properties were conflated into significant dimensions. They also reflect the change in researcher position and the internal dialogue of a researcher's mind as raw data is labelled with conceptual labels whilst exploring and theorising about emergent patterns (Strauss & Corbin, 1990: Ch 12; Lempert in Bryant & Charmaz, 2007: 245-247).

Memos are both part of methodological practice but also are the cornerstone of developing theory from data using increasing levels of abstraction (Charmaz, 2006).

They are the distillation process towards developing theory and conceptualise data in narrative form (Lempert, ibid). Glaser was quite clear about the impact of memos and described them as the '*bedrock of theory generation'* (1978: Ch 5), and he described five goals of memos:

1. Raising data to a conceptualisation level.
2. Developing the properties of each category which begins to define it operationally
3. Presenting hypotheses about connections between categories and/or their properties
4. Beginning to integrate these connections with clusters of other categories to generate theory
5. Beginning to locate emergent theory with other theories with potentially more or less relevance*.

(**This last goal aligns Glaser's ideas with those of Schatzman on dimensional analysis, although this chapter of the book Glaser adds a footnote to say 'he indebted to Odis Bigus for many ideas', begging the question whose thoughts are these? However, in Chapter 3 of Theoretical Sensitivity firmly rejects Schatzman's views on selective sampling).*

Retrospective analysis of my memos illustrate a journey of increasing complexity in commentary from the initial, naive analytical memos immersed in consultation theory, towards memos scripted over a year later where the central dimensions are embedded in the central organising theme. Earlier memos were more descriptive, lacked depth and analytical complexity. The subject matter was often overtly medicalised as if a teacher was looking over a pupil's performance. However, some memos on the 'first pass' through the data started to explore some of the concepts that would ultimately emerge from the data analysis e.g. participant A's comments about gathering information:

"I suppose there is so much information coming at you at once you want to organise it a little and take it one at a time instead of trying to do everything at once, and forgetting important details and also you want to cover all the posts and I find it helps with structure, just to have it there" (PA).

Research Memo: Organisation of information and mind-see 'structural theory' and revisit ideas on 'Working memory'-organising function?

This is probably one of the first significant comments from the first simulation that both reflects the respondent's voice illustrating the complexity of the task from her perspective (the very essence of this study), but also the researcher's voice formulating an idea about knowledge organisation through an analytical memo, rather than focussing on the teacher's voice concerned with consultation theory.
The *theoretical memo* from July 2012 exemplifies two aspects of the use of memos, firstly as a form of inductive thought in that conflation of the cognitive attributes of the data analysis was moving theory forward, and secondly that there was a feeling of 'coming together' that provided a reflexive and positive emotional component(there was a '*eureka*' moment):

Theoretical Memo (July 2012)

*'**Conflation of the cognitive attributes became a fundamental stepping stone in the DA process at this stage of the analytical journey. There was a feeling of 'coming together' between the various properties in the data and the relationships between various smaller properties started to line up more effectively. I found myself returning to the same theme time and time again, that of knowledge organisation and adaptation which appeared to provide a suitable umbrella term for the properties in the data. Could this be the central organising concept?'***

Secondly, it acted as an *operational note* in terms of jogging the memory to revisit the data to assess whether was enough saturation about knowledge deficits in the participants' simulations (Strauss & Corbin, 1990: ibid). This was a key move in that

the theoretical idea of epistemological insecurity was not saturated by data, and therefore remained an abductive, theoretical thought without significant instantiation in the raw data.

Operational Component to Memo (July 2012)

'Equally this was also a period of revisiting the data in deductive mode to substantiate the ideas of ontological security and its epistemological foundations. There were only two participants who made explicit comments about the role of knowledge in the simulation, which although clearly relevant, did not sufficiently saturate this idea. Accordingly revisions in the data analysis chapter were made regarding the impact of knowledge deficits.'

If memos act as the cornerstones for developing theory, extrapolation of these ideas found true expression in diagrams and figures, and reflects a tendency to resort to visuo-spatial representations of data. Pulling together data into diagrammatic representations often acted as a catalyst for conflating properties in the data, particularly the cognitive properties that appeared so diverse to begin with. However, the major caveat to the use of flow diagrams is the linearity in the representation of parts of the data analysis which were often far from linear, particularly the inductive-deductive cycles involved in the constant comparative process.

4 Chapter 4: Methods

The conceptual focus of this study is to build theory from the 'perspective of the medical student' using Dimensional Analysis as the methodological approach, with Symbolic Interactionism as the theoretical lens. Data was analysed from filmed, simulated consultations between 3rd year medical students and a standardised patient (SP) using a case scenario of dyspepsia i.e. something seen commonly in practice and covered already in the curriculum (see 4.1). The case scenario was created to provide a fairly typical picture of dyspepsia encompassing at least four risk factors with enough ambiguity in the case to encourage competing diagnoses.
The participants were attending the introductory module for year 3 ahead of clinical rotations on the wards. This module provides a brief recap on core skills learnt in Phase 1, with augmented teaching on skills useful in the hospital environment. At this stage of the curriculum, there is a key transition between facilitated practice in Phase 1, and more stand alone exposure to patient contact in Phase 2. A rehearsal study took place in April 2011 to prepare procedural elements for the study and to improve sensitisation to some of the methodological issues associated with DA, including familiarisation with the generic prompts. It also acted as an introduction to writing memos which became a significant learning point. Filming took place in the Media Laboratory in The Checkland Building, University of Brighton.

The formal study took place from September –November 2012, and was comprised of **four stages** (all filmed);

1) Filmed simulation between participants and SP (the researcher was present but was physically separate from the process quietly writing memos). Once the participant has acknowledged that they had spent enough time taking the history the SP departed.

2) The researcher sat down with the participant to ask about the diagnostic opinions based upon the history alone.

3) Once the participants had completed their diagnostic discussion, they were allowed to ask for further information based upon physical signs from the case descriptor; information was released *only* in response to their specific questions. Once given this information they were asked to revise their diagnostic thoughts based upon the history *and* examination.

4) Stages 1-3 were then recorded onto a DVD (2-3 minute gap) and the simulation was played back. The participants were allowed to stop the recording to reflect upon their thought processes and decision making at various points in the process. The researcher could also stop the simulation to ask generic prompts in the same manner to encourage discussion. The prompts were focussed upon the participant's perspective unless the participant opened up the discussion to talk about specific issues, allowing the researcher to ask questions that are more specific e.g. if the participants mentioned mnemonics specifically then this area was explored further.

The filmed account of the reflective discussion was inset with the original simulation DVD to allow timings/events to be cross referenced. Data analysis was subsequently drawn from the simulation (Stage1) and the reflective discussion between the participant and the researcher (Stages 2, 3, and 4). Filmed material was kept under lock and key with only the researcher and the two supervisors allowed to observe the simulations for analytical purposes.

4.1 Standardised Case Scenario

Standardised patients (SP) provide *high fidelity* simulation and reflect the closest approximation to real life events during medical consultations, particularly those examining clinical method which include communication and consultation skills (Elstein *et al*, Ch 3, 1978). They were first introduced by Barrows & Abrahamson in the secondary care setting, and have subsequently been used in undergraduate teaching as well as in the assessment of general practice consultation skills including those arriving as unannounced patients in real practice (Rethans *et al*, 2007; Jha *et al,* 2009).

An expert panel approach was used to create a scenario that would reflect a medical condition that would have been covered in the curriculum and that was common in practice. Expert panels are used in setting the standards for both face and content validity in several contexts, particularly in high stakes certification (Hutchinson *et al*, 2002). Standard setting was achieved through an expert-judgement approach involving four expert GPs each with over 20 years of clinical experience in primary care and who were actively involved in teaching students at this stage of professional development, including the researcher. This expert group peer reviewed the actor's role descriptor and changes were made by consensus opinion.

The scenario involved a case of episodic upper abdominal pain which would represent a typical dyspeptic picture. It contains a number of predisposing and aggravating factors in the medical history such as anti-inflammatory drug use for a chronically painful knee (ibuprofen or 'Nurofen' ™), smoking, excessive alcohol intake, work relate stress, and overindulgence in certain food types (**Appendix 4**). The descriptor was suitable for either gender with minimal adaptation (there were no urinary or gynaecological symptoms), and two actors were involved in the filming (one male and one female of the appropriate age group). Both actors worked from the '*Playout*©' group who have contributed to undergraduate simulation for over 8

years. They were sufficiently experienced in role play and using standardised scenarios to provide an accurate portrayal of the case even though potential exists of variation in practice-this was not seen in any of the simulations (Tamblyn, 1991). Instructions in the descriptor indicated that '*they should remain polite, interactive but not to provide too much information too quickly*' i.e. driven by the participant's questioning (who would be able to piece together the information from the questions evolving from a full medical history). It was added that they should appear to be in pain occasionally through the simulation. The presenting complaint i.e. starting complaint would be '*severe pain in the stomach'*. The case includes an overall concern that although this pain is thought to be indigestion, it appears far worse than the actor would expect, and this coupled with a family history of ischaemic heart disease (father has had a 'bypass') has prompted more concern. Such components are based upon teaching to elicit underlying 'ideas, concerns, and expectations in sharing and understanding of problems (Pendleton *et al*, 1984).

The SPs were instructed not to reveal concerns unless directly asked by the student in order to maintain some consistency in responses. There was enough ambiguity in some of the aggravating factors to challenge history taking skills, particularly clarification of symptoms and risk factors. It was hoped that such ambiguity would open up the possible differential diagnoses that exist with a case of epigastric pain, particularly for gall stone disease (fatty food component) and pancreatitis (alcohol intake), whilst still remaining relevant to prior teaching and biomedical knowledge in the curriculum.

4.2 Ethical considerations

The central tenets of ethically responsible research concern *informed consent* (exercising autonomy, voluntary participation and knowledge of the risks and benefits), These tenets include *protecting people from harm* (non-malificence), *confidentiality,* and *mutual trust* between the researcher and volunteers (adapted from Silverman, 2006: 315-323; *Good Clinical Practice in Clinical Trials*, Medical Research Council, 1998). Ethical clearance was granted through the Research Governance and Ethics Committee of the medical school; ref 11/040/SCO (see Appendix 6).

One of the primary issues with a study of this type is the impact of insider research upon the relationship between the participants and the researcher, considered as the potential 'power dynamic' in the study. This brings into play both mutual trust and the voluntary nature of participation in the research process, rather than any perceived pressure to become involved to please a member of faculty. Inside knowledge of organisations and the members thereof confers a '*status set'* including a sense of authority, social status within the hierarchy, and access to privileged knowledge e.g. examination results (Merton, 1972: 11-22).

Merton discusses the two competing doctrines of '*insider*' and '*outsider*' research comparing different views contextualised by issues such as gender, race and position. Using an extreme example from research into racial groups, one commentator states that outsider research is not credible using the statement, '*whites are basically incapable of grasping black realities'* (Wilson, 1974: 324). This assertion may have some truth in it; however, it is generally not that simple and would ignore the powerful impact that some ethnographic studies might have in creating differing perspectives which contribute to creating negotiated views.

Shah argues that social insiders are better positioned '*because of their better knowledge of social patterns of interaction required for gaining access and making*

meaning' (2004: 556). Access is generally more easily gained to specific groups, however awareness of theoretical and social anchoring are paramount in counterbalancing the insider position through greater reflexivity.

There are some delicate dilemmas that pervade insider research. Conversely, some would argue that *Informant bias* may contextualise responses with this caveat, '*known or expected alignments or loyalties are crucial to the way in which an interviewer is perceived'* (Powney & Watts, 1987:40). In other words although this study does not explicitly use an interview process, the diagnostic discussion may be framed by prior knowledge and interaction between a teacher and a participant i.e. '*they are influenced by who they think you are'* (Drever, 1995: 31). This premise is at the heart of symbolic interactionism. This can only be mitigated in part through adequate signposting at the start of the study.

Griffiths suggested the insider as '*someone whose biography gives them a lived familiarity with the group being researched'* (1998; 361), and this would partly include the prior relationship as a module leader with the participants. Any familiarity must be set aside in the research process thereby attempting to exclude one component of the 'status set' described above. The recruitment process was modified to take account of this during the initial contact period and the Participant Information Sheet included a statement to create distance between the researcher from any prior function or interaction in the curriculum. Indeed the premise that participation in this research might inform future teaching and contribute to development of the curriculum could appeal to more altruistic tendencies (and move it away from assessment processes).

It was important at the consent stage for this study that the relationship between the researcher and the potential participants was redefined explicitly, and that there was no component of assessment taking place within these simulations. The primary focus was to find out *what they were thinking* and for them to explain this wherever possible, and not to express what they *might think I would like to hear* (as a teacher

previously involved with their education). Equally, it was important to remind them that knowing more about their views on the diagnostic reasoning process would have potential benefits, not least for themselves in a reflexive manner but also from the perspective of consultations skills (Edwards, 1996; Mezirow, 1991; Bradley, 2007).

Ethical considerations for any research study means creating conditions that are right for the research participants, based upon values from within the research community and school (Illing in Swanick, 2010: 295). In a filmed study such as this informed consent, confidentiality and anonymity are paramount. It is imperative that volunteers are reassured that their identity is protected, and what will be entailed in volunteering for the study. This includes advice about the benefits of filmed simulations for the individual and their development, but also issues regarding performance or withdrawal from the study (see excerpt from PIS in **Appendix 2**).

Excerpt from Participant Information Sheet:

'What are the potential benefits in taking part?
Similar studies using simulated consultations have shown that participants improve in their consultations skills as result of their involvement, and a deeper insight into decision making improves diagnostic skills.

What if I have any concerns over my performance?
*There will be an opportunity to undergo a debrief session with the researcher should you wish to address any concerns over your performance. Your involvement is **not** being assessed and is not part of your degree at BSMS.*

What if I want to pull out of the study?
If you consent to being part of the research, you nevertheless retain the right to withdraw at any stage should you so wish. This will not affect your progress in the undergraduate programme.

The problem of *performance anxiety* or distress over perceived mistakes in consultation technique or diagnostic ideas will be addressed within the debriefing period, if requested by the participant. This is fundamental to the feedback process from an ethical perspective in mitigating negativity from a bad experience. It has been reported that the increased intrinsic cognitive load associated with complexity created

through any simulation may compromise learning, but also that high extrinsic emotional load (e.g. decreased tranquillity in diagnosing a heart murmur) may also have the same impact (Basu Roy & McMahon, 2012; Fraser, 2012).

The simulation in this study will have a high intrinsic cognitive load but the emotional load was minimised in a tranquil setting. It was also stressed beforehand that achieving the correct diagnosis was not the aim, and no assessment of this process was considered. It was all about '*how their mind was thinking'* and how this impinged upon creating viable diagnoses. The whole experience was introduced and constructed as a positive experience for the participants (which implicitly promote the valuable internal and external dialogue about the simulation). This includes the ability to diagnose issues of performance for themselves when filming is involved (Laurillard, 1997; Festa *et al*, ibid).

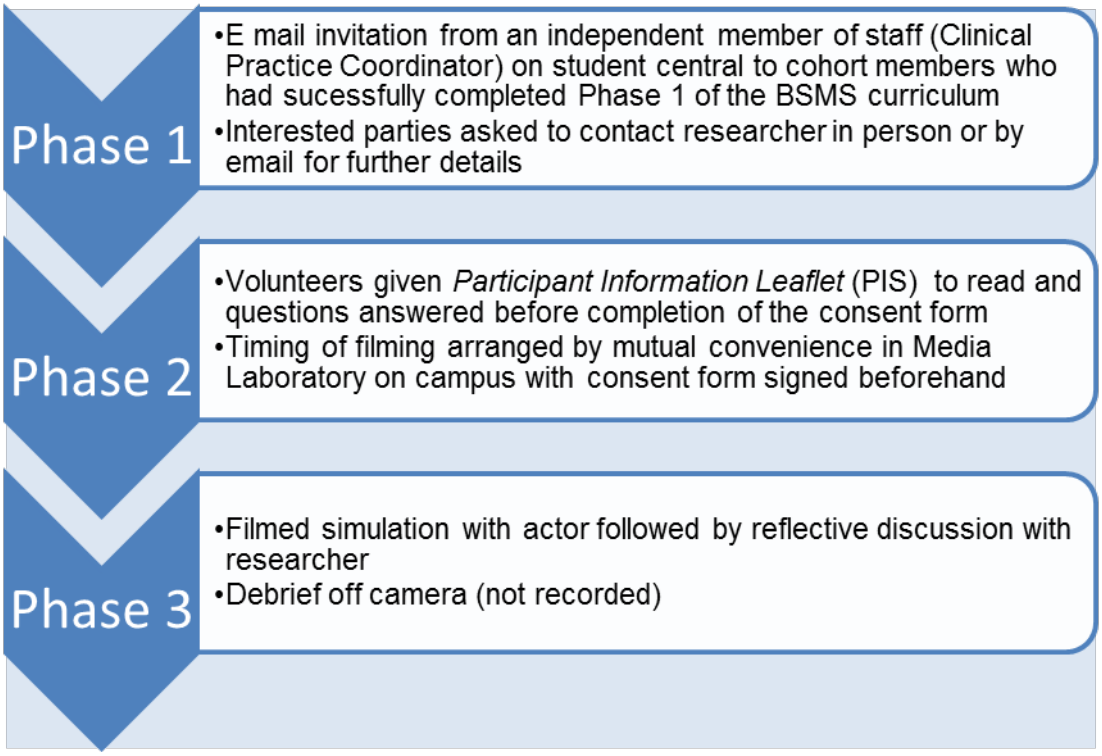
4.3 Recruitment of participants

Recruitment of volunteers for the study took place during the summer in 2011 after the examination results from Phase 1 were released in July (**Figure G**). Timing was influenced by two key factors. Firstly, a natural transition point in the undergraduate curriculum during a summer recess following completion of the full eight modules that comprise Phase 1(Years 1 and 2). Secondly, it was imperative that students whom might volunteer for the study perceived no relationship between this study and subsequent progression or indeed assessment in Phase 2 of the course (Years 2 & 3) commencing in September 2011.

My position in the medical school as Module Leader for the Clinical Practice Modules in Phase 1 means that I am juxtaposed between a role as a researcher and an assessor in the curriculum, therefore the recruitment process took place as the students embarked upon year 3 of the curriculum, where I have no involvement in assessment. A reflexive dynamic may still exist during the reflective discussion in terms of a perceived 'power relationship', however every effort was made to distance the research study from progress within the undergraduate programme. An explicit statement in the Participant Information Sheet (PIS) reassured participants that withdrawal from the study was permissible without sanction.

Initial contact was made through an email to the relevant student cohort who had successfully completed Phase 1 studies from a member of the faculty administration who had no direct involvement with the study. This email suggested that interested parties should contact the researcher directly by email if they were interested in volunteering for the study. In this way there was no perceived pressure to agree to participate in the study from the researcher as a member of faculty, in order to circumnavigate some of the potential ethical and methodological issues involved in insider research (Labaree, 2002).

Figure G: The Recruitment process



The ethical principles developed by the MRC recommending Good Clinical Practice in Research were followed (MRC, 1998). These included the issues of confidentiality and anonymity within the medical school and the university at large. The Participant Information Sheet (PIS) was sent electronically to the volunteers ahead of the simulation, allowing time for prepared questions on the process. The volunteers of were explicitly reassured about both of these issues and that the filmed simulations would be viewed only by the researcher and one supervisor, who is not a member of the medical school faculty, and would not be used for teaching purposes in the future. 12 volunteers agreed to take part in the study and filming took place during September, October and early November in 2011 using the media laboratory. Three volunteers subsequently failed to turn up for the simulation.

Following completion of the simulated consultation every participant was offered a '*debrief*' after the reflective discussion, in line with the findings from systematic reviews of best practice in simulation studies (Isenberg *et al*, 2005). These endorse

the importance of feedback within simulation and the conversations embedded within the interaction that stimulates construction of new ideas (Laurillade, 1997; Parker & Myrick, 2009). Extrinsic feedback from the researcher was provided after filming had stopped if requested by the participant (2 cases), and serves to temporise fears over performance anxiety and making errors. It is recognised that reflection upon performance may occur either a) at the time of filming (*reflection in action*), or b) by watching the recording back (*reflection on action*) immediately after the discussion, or c) sometime after the event (Festa *et al*, 2000). Therefore participants were asked to contact the researcher if they wanted to review the simulation at a later stage (none used this offer).

4.4 Rehearsal Study

The rehearsal study took place in April 2011 using two volunteers with two explicit aims in mind: Firstly, as a novice researcher using a form of grounded theory it was important to sensitise myself within dimensional analysis including memo writing and ideas of conceptualisation. This issue formed the focus of some of Schatzman's deliberations about what was involved in analysis, what the researcher actually did, and how researchers learn to do analysis (Bowers & Schatzman in Morse, 2009: 87-88)? This was most pertinent to a researcher coming from a different discipline. Secondly, to formalise, practise and work out the optimal timing schedule the recording of the simulated consultations in the media laboratory. This included familiarisation with the facilities in the media laboratory and to plan the film schedule with the media technician. Both of these outcomes were realised with significant benefits to the final study later that summer.

Three participants volunteered for the rehearsal, two students from the 2nd year undergraduate cohort and a transient member of the academic staff acting as a reserve -an F2 (Foundation year 2) attached to the department of Primary Care. The volunteers were taken through the Participant Information Sheet (PIS) and consented to being involved in the rehearsal, with the knowledge that involvement in the rehearsal would *have no impact on current studies or progression* in the programme, and would of course mean that they *could not participate in the final study* later in the summer. All agreed to this process and found the participant instructions clear and unambiguous.

Benefits and outcomes of the rehearsal:

1. *Participant scheduling*

One student volunteer withdrew one week before the filming so the reserve was utilised (F2). Two participants completed the rehearsal simulation and subsequent reflective discussion with the researcher on film. Each simulation and discussion took approximately 60-70 minutes to complete including time to record onto DVD, suggesting that the final study would require several days of filming to complete. The value of the feedback during the 'debrief' off camera was also endorsed by discussion with the two participants, particularly with the undergraduate volunteer who was keen to be reassured about her consultation skills during the simulation.

2. Memos and notes

One of the earliest lessons derived from the rehearsal study was the difficulty of making '*first pass'* memos during the simulated consultation. Memos are the distillation process towards developing theory and conceptualise data in narrative form (Lempert, ibid), however it was quite apparent that early attempts at analytical memos during the rehearsal were extensively immersed in consultation behaviour and technique which subdued abduction. Bowling suggests that the analysis of observational studies should begin after a time has elapsed when the 'reactive effect' has worn off, thus reducing the real chance of for bias in the interpretation of events (Bowling, 1997:321). A time delay between recording and transcription allowed enough reflection upon events, and in particular, the realisation that first pass memos were of limited value. There was also acknowledgment of the impact of my presence upon the participants' behaviour during filming of the simulation, known as The 'Hawthorne effect', although this is known to erode with time (Roethlisberger & Dickson, 1939; Clark & Bowling, 1990).

Glaser was quite clear about the impact of memos and described them as the '*bedrock of theory generation'* (1978: Ch 5), but research naivety was a fundamental issue at this stage of the study. Resolution of this problem became an evolutionary process during the following 12 months as ideas of reflexivity and acknowledgement of pedagogical influences were recognised.

3. Filmed simulations and discussion.

Using the visual medium for analysing simulated consultations employs a mixed methods approach of both observational analysis, and semi-structured prompts which stimulate discussion about how and why the simulation evolved in a particular way. This reflects the potential complexity within these social interactions in terms of verbal and non verbal cues. It also enables the reflexive analysis of communication practice and decision making from different perspectives, including the risk prone dimensions of thoughts and actions associated with clinical practice (MacDougall, 2006; Carroll *et al*, 2008). Video has been utilised in studies of social communication within healthcare as an *instructional* and *reflexive* medium (Jeffers & Guthrie, 1988: Latvala *et al*, 2000). It provides visual feedback derived from interviewing patients and performing clinical skills, including the cues associated with dynamic negotiation in teams which are not available in text based studies (Coiera, 2000). Video feedback has been used successfully as a communication teaching intervention in postgraduate settings focussing upon core skills such as listening, questioning, responding to patients' emotions, and building rapport (Roter *et al*, 2004).

The psychological fidelity of this type of simulation requires both preparation and feedback to facilitate learning and subsequent discussion. It is acknowledged that the participants go into role during simulation in a situation of '*suspended disbelief'* (Ker & Bradley, ibid), in addition to the anxiety associated with performance on camera when it is known that the emotional load created by simulation may inhibit learning and performance (Fraser *et al*, ibid). Coming out of role is usually

recommended for the purpose of feedback, particularly if the SP is being used to provide feedback. The decision making role created within this study will be breaking new ground for the participants, who up to this point in the curriculum have been asked to gather data and/or examine only. This creates an added burden of responsibility with the attendant performance anxiety and affective learning recognised in all experiential activities such as simulation (De Maria *et al*, 2010; Yardley, 2011).

This places more emphasis upon the feedback process in simulation, and in this case the debrief mechanism should the participants need it. Moreover, it means that the generic prompts used in the reflective discussion are flexible enough to bring out areas of discussion or concern, whilst not appearing to force any issues. In this way the integrity of the data collection process is maintained, the dialogue is open and transparent to external review, and rigour is evident (Benner *et al*, 1996: 351-358).

One of the learning points from the rehearsal study was to become more accustomed to the use of open questions/prompts, and so for the final study care was taken in setting the tone of the diagnostic discussion without leading questions or appearing to justify their diagnostic choices. In this way, the explanations about what was going on in their minds at various stages in the simulation were encouraged in their own language. Technical or theoretical language was avoided unless introduced first by the participants, and then the researcher was allowed to ask for an explanation of their meaning.

4. Learning about data analysis

Perhaps one of the most significant issues which became apparent during the rehearsal and subsequent analysis was the subject of *researcher position* and the use of the term '*neutral knower'* (Bryant & Charmaz, 2007: 247), which illustrates the tensions between classical GTT and some of the subsequent interpretations of

grounded theory, particularly Dimensional Analysis. The original work of Glaser and Strauss (1967) gave little consideration to the role, position, and experiences of the researcher within the data collection and analysis. This very point became an obvious issue during the rehearsal as I became aware that my analysis and interpretations were clearly *not neutral* (and also *not knowing* as a novice in this domain) and heavily influences by pedagogical perspectives and my role at the medical school.

Early memo writing during the simulation focussed heavily on consultations skills, merely commenting upon the use of a generic framework for subjective complaints like pain (SOCRATES mnemonic) and the degree of flexibility to depart from the traditional medical history format demonstrated by the 2nd participant (F2 Doctor). There was a memo to Benner's work on the novice '*being reliant on guidelines'* (1984), which confirms the lack of neutrality in my position in adopting a grounded theory techniques approach, however Schatzman would no doubt regard this the inevitable retention of prior theoretical anchorage (inMaines,1991:306).Subsequently this *reflexive memo* was added with the insight of retrospection:

Reflexive Memo:

May 2011.

There was no depth in the analysis of the rehearsal compared with subsequent memos in the final study (unrealistic expectations?). The lens of symbolic interactionism was entirely clouded at this point in time. The frustrations experienced by novice researchers in early data collection became all too obvious. Emergent theory was waiting to jump out at me (or so I thought), and the individual chunks of data stood splendidly alone in isolation without any links to start piecing together towards some semblance of thematic analysis.

The second attempt at analysis of the rehearsal began with a template using four perspective prompts adapted from Strauss and Corbin's work on axial coding (1998), those of *Interaction*, *Meaning*, *Action towards*, and lastly *Language and Reasoning*. The idea of the template was to develop more avenues of thought using themes within Symbolic Interactionism, however this manoeuvre can be seen retrospectively as trying to 'force the data' (Glaser, 1992), or by others as a conceptual lever. Clearly

the insecurity created by the lack of coherent analysis forced the adoption of a coding mechanism aimed at linking initial coding (specifying the properties and dimensions of a category) when constant comparative analysis had not occurred with enough cases, or indeed enough depth of analysis. Supervision repositioned this process and analysis from the rehearsal study took on far more meaning. The memos below reflect my thoughts at the time.

Reflexive Memo (June 2011)
'Shifting Perspectives'
There are no doubt salient moments in any research project and in the development of a skill set, in this case my tentative foray into data analysis for the first time. It might be entitled 'a sudden realisation' as it happened in the space of 45 minutes of supervision looking at the rehearsal study in May 2011.
I am fortunate that the 'Be Prepared' motto is a mantra that somehow stuck with me into adult life. Without organisational foresight it would be impossible to deliver the modular learning throughout the academic year. I recognize it as a strong feature in my character which in general yields positive ramifications, and this certainly applies to academic study. There are draw backs of which I am aware-occasional inflexibility in the face of sudden changes and the sense that too many changes create subdued panic at times!
However, back to the positives as it is much easier to reflect upon changes with a positive outlook. At the time of the RPA and Ethics approval I was planning the rehearsal study to immerse myself in some data collection and iron out any issues in the method (filming).A technical hitch during the first rehearsal fully justified this decision and the second rehearsal using a F2 doctor went to plan thereafter. This data was used in supervision. During the first stand alone analysis, I realised that my perspective was purely pedagogical, appeared very superficial and wondered how I was ever going to develop some substantive material to utilise for the project.
Analytical memo:
Avoid leading questions during the reflective discussion-stick to more open ended prompts unless the participant has opened up the subject matter for discussion. There is too much of a diagnostic slant, and a tendency to interpret actions of the participant rather than let them explain.
In future: Must ask 'why' more. Ask participant to explain and defend decisions.

4.5 Theoretical Sampling of the literature

Novice researchers using grounded theory for the first time has often been advised to leave sampling of the literature until the very end of the analytical process, trusting to emergent themes only arising within the data and not allowing preconceptions to be limited by engaging the literature in advance (Bryant & Charmaz, 2007: 176). The idea of 'naïve empiricism' *('entering the research process with an empty head'*) has largely been discounted as it is impossible for researchers to jettison professional and experiential anchorage (Pelle in Bryant & Charmaz, 2007:194; Schatzman in Maine, ibid). Early theoretical sampling runs the risk of premature closure on properties in the data (the same as premature closure in diagnostic reasoning), both in terms of sampling the data collected but also in sampling from the literature base (Charmaz, 2006: 106-7).

Yet being familiar to some degree with the relevant literature may provide orientation i.e. guide analysis rather than limit it. Being aware of pre-existing concepts may heighten theoretical sensitivity i.e. the ability to generate ideas and theorise, however preconceptions may interfere with interpretation and the confirmatory evidence may be poorly scrutinised as a result (Dey in Bryant & Charmaz, 2007: 175). Reflexivity has been vitally important to recognise the potential impact of pedagogical and professional anchorage during the early stages of data analysis, yet theory has acted also as a conceptual lever on some occasions, moving conceptualisation forward e.g. Glaser's coding families (Glaser, 1978: 81; Strauss & Corbin, 1987).

It was important to sample the literature for comparable studies in the field of simulation and to find out whether any of these studies were employing *qualitative analys*is, either as classical grounded theory or versions thereof (such as dimensional analysis). As a result sampling for similar simulation studies was performed ahead of the study. The yield of comparable studies was very low (**Table D**), except for one

very illuminating study on using DA amongst nurses dealing with acute confusion in the elderly (McCarthy, 2003). This study provided a broader idea of the type of conceptual vision that would be required to move my own study away from pedagogical immersion, and thus acted as a conceptual lever, opening up the avenues for theorising. However, most simulation studies utilise a quantitative design method with a focus upon measurable competencies and skills, with passing reference to cognitive skills and transformative learning in the theoretical sense. Such papers acted as background material to Decker's typology (ibid).

In the domain of CR where much of the literature was already familiar, an explicit decision was made to maintain awareness of the newest publications in case they provided a different perspective with which to interrogate the data. Several review papers were useful in providing the historical aspect to research with the inherent shift from information processing models through to the knowledge organisation paradigm, and subsequently dual process theory. Conceptual links immersed in studies linking the potential benefits of reflective practice and the accuracy of medical diagnoses in complex cases were uncovered after the data analysis had been completed, but nevertheless provided a useful avenue for theorising (Mamede *et al,* 2008). The sampling of research papers on the experiences of the key transitions in medicine was performed after the data analysis after the substantive theory had already emerged. These papers were subsequently valuable in providing some resonance with some of the findings on creating context and the data gathering role.

Table D: Theoretical Sampling

Theoretical Sampling of the literature Review and Search Strategies					
Search Engine	**Databases searched**	**Search Terms**	**Results**	**Filters**	**Results (2)**
Proquest (Dialog Datastar)	Australian Education Index, British Education Index, ERIC	Medical Decision Making AND Grounded Theory (S15)	8	Peer reviewed	
Proquest	"	Diagnostic Reasoning AND Dimensional Analysis (S10)	0	Peer reviewed	
"	"	Decision making AND Dimensional Analysis (S11)	25	Peer reviewed	
"	"	Clinical Reasoning AND Grounded Theory (S7)	4	Peer reviewed	
"	"	Diagnostic Reasoning AND Grounded Theory (S6)	1	Peer reviewed	
"	"	Decision making AND Grounded Theory	224	Peer reviewed	
"		Reasoning or decision making AND Simulation		[Medicine or Nursing]	3
EBSCO	PsycINFO	Reasoning or decision making AND Simulation Studies		[Healthcare or Medicine] Full Text and Peer reviewed	8 (2 relevant)

Search Engine	Databases searched	Search Terms	Results	Filters	Results (2)
“	British Nursing Index	Simulation	44	Full text and Peer reviewed	
Proquest	British Nursing Index	Simulation studies AND PUB.exact [Journal of Nursing Education’] AND decision making	144	Full Text and Peer reviewed	
“	AEI, BEI, ERIC	High Fidelity patient simulation AND [medicine or nursing or physiotherapy]		Full Text and Peer reviewed	18
Proquest	AEI, BRI, ERIC	Standardised patients AND [medicine, nursing or physiotherapy]	20	Peer reviewed	
“	“	Standardised patients AND [cognition OR reasoning OR decision making]	3	Peer reviewed	
“	“	Inference AND reasoning OR decision making		[Medicine and Nursing]	6
EBSCO host	CINAHL plus with full text, PsycINFO, and e journals	Standardised patients AND diagnostic reasoning	3	Peer reviewed	One relevant
“	“	Standardised patients AND cognition		[Medicine and Nursing] Full Text	1
	Medical Education	Simulation studies with actors AND medical education	129	Full text and Peer reviewed	

5 Chapter 5: Data Analysis

The following section illustrates the methodological process of Dimensional Analysis using the key components of labelling, collating properties of the data across participants, sorting these into concepts or dimensions, and the formation of a central organising perspective which generates the theory that explains the phenomenon being explored.

An example will be taken from the data analysis concerning the *cognitive strategies* used by participants to illustrate both the individual components of the process, and the journey involved as a researcher as the process evolved and different properties emerged. Cognitive strategies emerged as one of the significant dimensions in the analytical journey and subsequent explanatory matrix; however, the same data analysis process was equally applied to the other properties that will feature in the case findings in Chapter 6. The various representations of the data analysis and ideas in this chapter are not necessarily the final perspective and more often are examples of 'work in progress', expressing cycles of induction and deduction in the constant comparative process.

Within this chapter there is an acknowledgment of my professional anchorage expressed through a growing sense of reflexivity as a novice researcher using dimensional analysis for the first time. In addition, the valuable contribution of conceptual levers will be discussed e.g. coding families (Glaser, 1978), and how they created different perspectives with which to interrogate the transcript data. The influence of these concepts will illuminate the data analysis process and the gradual emergence of ideas.

5.1 Key Stages in the process of data analysis

Schatzman identified the processes within Dimensional Analysis that can be represented by the points paraphrased below (in Maines, 1991; 303-313):

1) *Labelling* bits of data that contribute to the whole process (multiple components), akin to functional coding these are the *parts*, *attributes*, or *headings* which may ultimately give 'critical mass' to various dimensions within the data.

2) Comparing this data across cases and expanding into various attributes which are *abstract concepts* called *dimensions* through an iterative cycle of induction and deduction involving a constant comparative process. These dimensions have various properties which coexist in a relationship aligned by the dimension itself.

3) Collating multiple dimensions which ultimately explain the social process under scrutiny and provide the explanatory matrix with themes which explain *context, conditions, processes* and *consequences.*

4) Determine what the central perspective is and analyse this with respect to context, conditions, processes and consequences (ordering the data).

5) Revisit data to achieve theoretical saturation until a central organising perspective emerges which explains the relationship between the key dimensions (Integration).

Differentiation involves expanding or conflating dimensions of the data and defining the relationship between them, and in this study perhaps the most significant findings have emerged in the area of cognitive strategies.

In order to reach an explanation of the *whole process* bits of data are labelled or given designations, which will be illustrated below by utilising the example from the data analysis (**Table E** in 5.2). As the simulations were being transcribed short

analytical memos were added to the relevant sections and highlighted for subsequent analysis. These start life as the multiple components of the process but are expanded into various attributes of the whole process by the researcher's interaction with the data, which ultimately create the increasingly abstract concepts or dimensions (Kools *et al*, 1996). In parallel the labelling process helps illuminate the decision making processes as the data was collected and ordered under various headings.

As Schatzman comments the interaction between the data and the researcher borrows from the researcher's experiences and theoretical anchorage, compared to classical grounded theory which trusts ideas to emerge purely from the data (Schatzman in Maines, ibid: Robrecht, 1995). As discussed in the previous chapter this is where DA is *assumed* to depart from classical GTT espoused by Glaser, however during the process of data analysis there were occasions where Glaser's ideas helped considerably with theoretical sensitivity, specifically the use of his coding families as conceptual levers (Glaser, 1978). The process of DA is therefore reliant upon the fundamental concept of reflexivity which acts to remind the researcher as to their perspectives, personal beliefs and experience. Reflexivity will be discussed later in this chapter.

Reflective Memo (March-April 2012)

The descriptions in this chapter provide some illumination to the evolutionary processes involved in the successive iterations of the data, starting with a perspective which was heavily influenced by professional anchorage, the literature base, and pedagogic fixation. Initially the data sets from the simulations swallowed up any power of natural analysis and I felt only inertia in the research process without any energy to respond to encouragement from my supervisors. 'Find another perspective, another angle or view point, with which to interrogate the data', were their words. Schatzman's comments about complexity in the analytical process diverting the researcher away from generating theory were apposite. Some of the dimensions were in front to my face but I couldn't make sense of them, never mind fit them into some overarching explanatory matrix.

The change came about trying to engage with the concept of theoretical sensitivity and in a sense, challenging my professional and pedagogic foundations. What I had previously written about in the methodology section now began to make sense and had clear relevance to the data and emerging dimensions. Creating some distance between me and the data began to provide clearer, more globalised theoretical concepts in my mind and explaining this to fellow research students and work colleagues allowed me to clarify those conceptual ideas which will be explained in the next section.

5.2 Labelling and differentiation within the data analysis.

The most significant dimension of the data which arose from exploring and analysing features of the transcripts was concerned with the *cognitive mechanisms*, and this became the first composite term to describe a number of strategies employed in the simulation by the participants during the early iterations of the data*.* **Table E** provides an example of the opening section of one simulation illustrating the how the data was labelled and how it reflects my interaction with the data at that point in time.

Each simulated consultation and reflective discussion was transcribed verbatim by me, watching for non-verbal cues to support what was said on film. Notes and some analytical memos were written during the initial transcription (*first pass*), but the more effective interaction with the data sets occurred during a more reflective review of the simulations which provided better objectivity and a salutary reminder of how anchoring in the clinical reasoning domain could influence the analysis.

It also helped to acknowledge the potential influence of the generic prompts in the reflective discussion on the participant responses. In fact, memos and field notes written during data collection (i.e. whilst watching the simulation) were heavily influenced by focussing upon consultation features and pedagogical anchoring *('watching my ex pupils grappling with the simulation and seeing how they performed'*), to the point where notes became counterproductive and in retrospect they restricted abductive thought.

Table E: Illustration of the labelling process

Conversation between Participant F and Actor (A) (after the actor had given his opening description of the problem)	**Labelling Process**
P; Can you tell me a little bit more about the pain?	Label; *open question* about pain
A; I guess it started out as a deep seated ache and now it's getting a lot worse, gradually over the last few days and nothing seems to shift it.	Label**; onset** of pain and **character**
P: (nods) Ok and you say it's just around here (motions to lower chest/abdomen)?	Label; *Clarifying question* about **site** of pain. *Acknowledgement* through nod.
A; Yeah just around here (motions again to upper stomach)	Label; **Site** of pain
P; And you said it's come on the last few days, how many days exactly?	Label; *Clarifying question* about **duration** of pain
A; This is day 5 (P writes down this)	
P; How did it come on, slowly or quite quick?	Label; **Onset** of pain
A ; Erm, we were at a wedding that's when I noticed it, we were eating, drinking, usual sorts of things you do at a wedding reception, and it was shortly after the meal that I noticed it.	Label; **Onset** and **context** with **associated features** e.g. food and drink
P;* (nods*) And it's gradually got worse....and can you describe the character of it? What sort of word would you use?	Label; return to **character** of pain and **temporal** nature. *Acknowledgement* and further *clarification.*
A; I would describe it as dull, deep seated ache	Label; **Character**

The excerpt in Table E is taken verbatim from PF's transcript 53 seconds into the simulation, after a simple introduction and the opening statement from the actor about the problem he is experiencing. The labelling process at this early stage reflects my pedagogical interaction with the data as a simple interpretation of the process unfolding from the simulation.

The *labelling process* appeared to give rise to two properties in the data; firstly on the individual features of the *SOCRATES mnemonic* (highlighted in bold type), which were well demarcated in the transcript i.e. Site, Onset, Character, Radiation, Associated features, Timing, Exacerbating features and Severity. Secondly,

alongside these features were data associated with *consultation skills* used by PF (*italics*). Consultation skills included the use of *clarifying comments*, *acknowledgements* or facilitation of the actor's complaint (e.g. non verbal cues such as nods), and *looping* back to revisit subjects previously discussed either to elicit further information or to confirm understanding (looping could be viewed as *cycling* in Glaser's terms?). The latter skills are all described in terms of developing rapport which is taught behaviour within the curriculum (Kurtz *et al*, 2005: 47).

This stage of the analysis illustrated Schatzman's comments upon research students '*being naturally inclined to work from substantive metaphors and paradigms drawn from their own experience or prior knowledge'* and the resonance in my memos and comments is evident (Schatzman in Maines,1991: 305). My interaction with the data at this early stage illustrates two themes heavily reliant upon pedagogical foundations, and subsequent development required significant leverage using other conceptual ideas.

At this juncture, there was little abstraction involved in describing these properties of the data and the analytical process appeared uncomplicated. Theoretical sampling across cases revealed that these two properties of the data populated every single case providing theoretical saturation. Comparison across cases confirmed that all the participants used the features of the mnemonic strategy to collect information about the problem, and indeed they were using this within the structure of the traditional medical history i.e. theoretical saturation.

What did this labelling process tell me and was there anything else in the data that corroborated why this was happening? The problem at this point was the restrictive influence of pedagogical anchoring (consultation parameters) which impaired my ability to think inductively about the broader meaning of the two mechanisms. I had to step back from the data at this point and think about what these two properties in the data actually represented. The analytical memos associated with this stage

reveal that the use of the TMH format was viewed as a separate property from the mnemonic in the first iteration of the data (and was labelled thus). It slowly became evident that both were clearly being used as heuristic devices for working memory. Changing the perspective of how I viewed these properties began cementing the relationship between the TMH format and the mnemonic strategy acting as *sequencing* mechanisms. This became one the key analytical steps towards identifying the strongest dimension within the analysis.

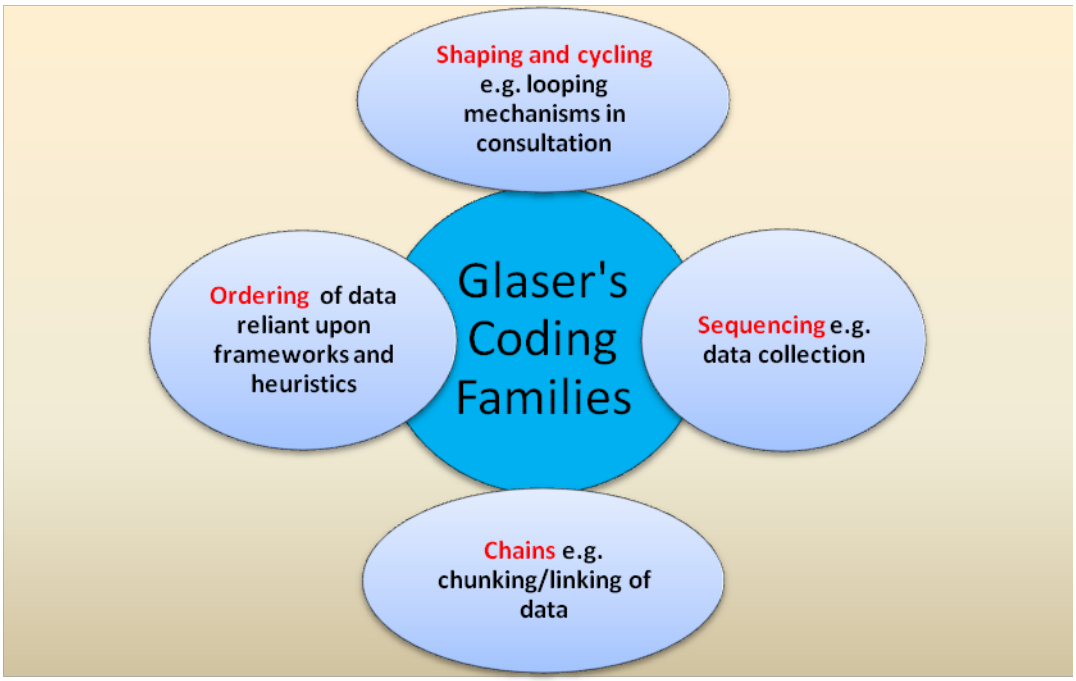
Memo:

Whilst struggling with the data analysis and watching the reflective discussions with each participant I was drawn to the recurring nature of my prompts. Alongside a tendency to ask leading questions in some of the early discussions and the subsequent adjustment in the way that questions were versed (critical reflection?) was the realisation in the gulf in perception between the participants' views on the role of history taking and my own.
It became apparent that some of their views focussed purely on the history as merely gathering data as a perfunctory process to complete without making any mistakes, but with little thought to forward diagnostic thought. This realisation re-centred my understanding of their developmental position and my expectations of their decision making capabilities (=transformative learning). In addition, it changed the presentation of my introductory lecture on clinical reasoning for the year 2 cohort which took place during the data analysis. Some of the more theoretical ideas were dropped from the presentation, focussing more on the basic interaction and thought processes illustrated by a filmed consultation.
The data analysis had informed my perspective on where they were situated in terms of early diagnostic reasoning which should be one of the prime outcomes for a professional doctorate.

The first conceptual lever was to view them as *memory devices* rather than as separate consultation mechanisms (trying to move away from my professional anchorage). The second lever that shaped this process was to view the data using Glaser's coding families (1978: 74-82), particularly those of *process*, *ordering*, *chains, shaping and cycling* **(Figure H)**. The combination of these two analytical

viewpoints initiated the conflation between the first and second iterations, with the idea that both contributed towards organising the data arising from the simulation. By adopting some of these coding families with which to interpret the data provided a stepping stone towards greater abstraction and conceptualisation in the dimension of cognitive mechanisms (the term used at that early stage).

Figure H: Cognitive mechanisms shaping theory



There was a strong sense that by employing the two mechanisms provided order in the collection of data from the simulation, and indeed a *sequence* that could be relied upon i.e. a 'fall back' or 'fail safe' mechanism, and this was borne out by quotations from the participants during the reflective discussion i.e. grounded in evidence from the transcripts. By using these mechanisms to help sequence the collation of the data emerging from the simulation it follows that 'chunking' should be enhanced i.e. the connections between individual pieces of data.

The following quotations illustrate how two of the participants viewed the use of cognitive mechanisms and further examples will be shown in the case findings chapter.

"How useful it is to have the structure of the history because sometimes when I lose my train of thought.....so I just went back to the traditional structure" (PI)

*(*Talking about written aide memoires):

"Organise my mind a bit, hopefully not miss things out! I suppose there is so much information coming at you at once you want to organise it a little and take it one at a time... cover all the posts and I find it helps with structure" (PA)

The next stage was to *look for other properties in the data which could explain this phenomenon*, or might be associated with it (the 2nd stage of Schatzman's explanation). This is very similar to clinical reasoning in practice when similarities are sought in either the patient history or the examination features, where patterns emerge to fulfil an Illness script representing a disease.

However, before that position was reached it was suggested that I tried to identify how my pedagogical perspective was influencing the way in which I viewed the data amidst the labelling process, by looking at my analytical memos. Although I had to recognise my theoretical anchorage as Schatzman has suggested, this exercise proved effective in highlighting my starting position in the data analysis process, and providing the impetus to look for conceptual levers that would free the analysis into other directions of thought. The left hand side of the **Table F** accurately reflects the position immersed in both pedagogy and the CR literature base, with the reflective memos highlighted in bold alluding to a position evolving in the analytical process yet to be uncovered.

My notes from the time illustrate questions which no doubt many researchers have asked at similar stages of the data analysis: *Could I abandon my prior theoretical*

knowledge and allow properties of the data to emerge without forcing preconceived ideas? (Kelle in Charmaz & Bryant, 2007: 191-2). It brought about a greater appreciation of the concept of theoretical sensitivity, broadened my insight into the area of research and allowed different perspectives to be considered.

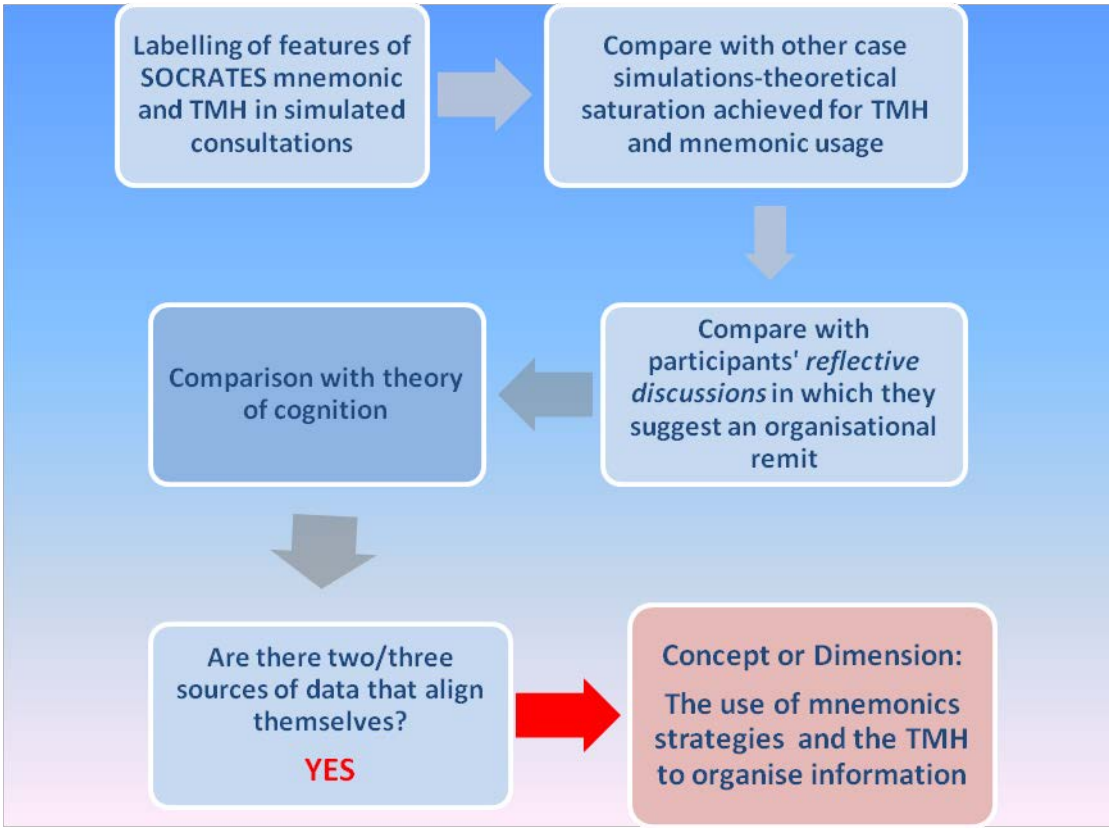
Table F: Acknowledgment of pedagogical position during early data analysis

Early Conceptual Ideas (Expectations of the data and what my memos/notes say about my perspective)	→ **Reflective and Analytical Memos**
Timeline (time spent on key areas of the consultation)	How did they use SOCRATES? (Time spent on each component). **No global perspective of frameworks emerged at this stage**
'Key features' approach	Weighting of risk behaviour as prominent features e.g. smoking and drinking
Deduction, induction, and looping mechanisms	Sparse examples but overshadowed by focus upon consultation skills initially. **Required several visits back to data to conflate ideas**
Consultation skills demonstrated by the participants	**Analysed from basic communications skills perspective as observer of simulation which blinded initial abduction**
Propositional linkage (from the four stage theory), causal, temporal, spatial, part, whole, family type.	Basic biomedical features used a causative linkage e.g. what organ is near to the pain?

By comparing what was actually seen in the simulation (*my interaction with the data as visualised*) with the reflective discussions thereafter (*the participants' perspective*) provided a more complete view of the whole process, rather than the apparently disparate components. Thus began the differentiation process where abstract concepts (dimensions) are considered to represent the processes under

scrutiny, and where the relationships between such concepts are defined. The data from the participants' perspective indicated a very clear and decisive message about knowledge management and organisation provided through the use of the mnemonic and the structure of the TMH.

Figure I: Process map of early dimensional analysis for cognitive strategies



This became the point where two data sets were conflated under an important property, that of knowledge organisation as a cognitive mechanism or strategy (see memo from July 2012 below and **Figure I**). However, this process did not emerge in a linear fashion. Knowledge organisation emerged as a significant property of the main dimension, but at this stage did not accommodate the features enabling the participants to cope with the transition, or indeed the cognitive 'outliers' which included the 'leaps of faith' whereby the participants appeared to be making

decisions based upon flimsy evidence. Such features would ultimately be assimilated into the explanatory matrix at a later stage.

Conflation of the mnemonic and the TMH guideline as cognitive mechanisms (heuristics) to facilitate knowledge organisation and structuring information (in the data analysis), bears significant resemblance to how the participants collate the features of the history during the simulation, and helps explain their relationship to each other. The decision making processes in both are similar and resemble scheme inductive reasoning where by the participants utilise an outline structure to define and guide their cognitive strategy in gathering information from the simulation Within this process there is a strong *perspective shift* from the baseline analysis of using consultation theory as labels, towards the abstract conceptualisation of using sequencing mechanisms through Glaser's codes as a conceptual lever, and ultimately in the creation of a significant dimension. The shift in perspective is amply illustrated by the theoretical memo at the time (July 2012 below). This memo demonstrated the nascent ideas in my mind (theoretical and inductive) with a salutatory reminder about the iterative function of DA in checking saturation (reflexive and operational).

Theoretical and Reflexive Memo (July 2012)

Conflation of the cognitive attributes became a fundamental stepping stone in the DA process at this stage of the analytical journey. There was a feeling of 'coming together' between the various properties in the data and the relationships between various smaller properties started to line up more effectively. I found myself returning to the same theme time and time again, that of knowledge organisation and adaptation which appeared to provide a suitable umbrella term for the properties in the data. Could this be the central organising concept? This was the second time that I had suggested such a similar concept and there is a growing conviction in this process as data analysis continues.

Recently this work was presented at the association of medical educators (ASME) with some good feedback and interest (my perception) from those who attended. I was reminded of Bounded Rationality (Simon, 1972) by a colleague at Keele with an interest in this area and this very much fits with the context setting that I have found

in the data. There was a greater emphasis on this in the presentation than I now believe it justifies. The cognitive organisation and adaptation seems more inclusive as an ongoing concept and this has freed up my thinking.

Equally, this was also a period of revisiting the data in deductive mode to substantiate the ideas of ontological insecurity and its epistemological foundations. In essence this might have suggested that the participants were unsure of their role during this simulation, and at this particular point in the curriculum i.e. the transition between facilitated practice and stand alone contact with patients. However, there were only two participants who made explicit comments about the role of knowledge in the simulation, which although clearly relevant, did not sufficiently saturate this idea. Only one participant commented upon role identity (PB) and the impact it had upon her view of their role at this stage of professional development i.e. data gathering rather than decision making.
Revisions in the data analysis chapter were made regarding the impact of knowledge deficits and roles. This is a lesson not to jump ahead of the data and resonates with the concept of premature diagnostic closure demonstrated in some of the simulations.

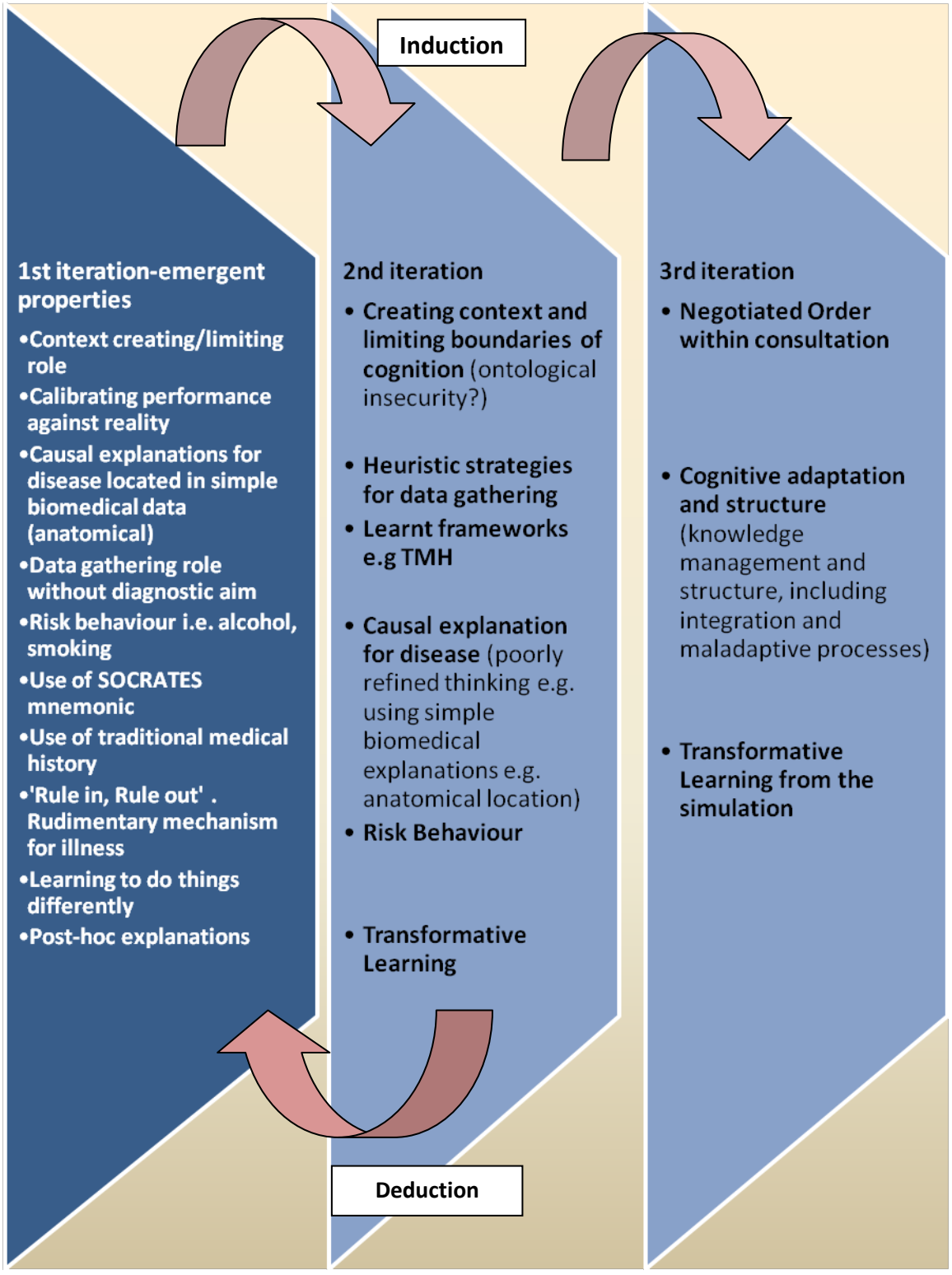
5.3 The Constant Comparative process using cycles of induction and deduction

The iterative processes illustrated in the first draft of this process reflect the initial labelling process using a limited perspective for the first iteration. However, a maturing position slowly emerged in my application of what is described as *dimensionality* (Kools *et al*, ibid), in that it incorporates natural analytical ability (‘*to derive meaning from interpretation or analysis of the component parts*’). This process took several months and required several visits back to the data (deduction) to verify some of the inductive ideas growing through my analysis (**Figure J**).

Schatzman’s own description of dimensionality includes the ability to address the ‘complexity of the phenomenon by noting attributes, context, processes and meaning’ (1991). Attributes reflected in the first iteration of the data employ relatively concrete terms, immersed in biomedical terminology, consultation theory, anchorage as a clinician and pedagogical leanings, borrowing heavily from the relevant literature base.

Those in the third iteration reflect a transition towards a perspective which is exemplified by more inclusive, overarching dimensions which explain the ‘*whole process’*, influenced by other ideas such as negotiated order which acts by shifting the perspective towards social processes, and away from pedagogy. (Strauss, 1987). This draws together the component properties towards a cohesive explanation of what is going on in the participants’ minds during the simulation. Amidst the early stages of the data analysis there was a clear tendency to look for *linear relationships* i.e. ‘cause and effect’, rather than the more dynamic process described by Kools *et al* (1996).

Figure J: Constant Comparative Process (first iterations)



Schatzman warns of the difficulties incurred by departing from the safety of 'linear, analytical work' and describes the parallel and interactive processing as challenging

(Schatzman in Maines, ibid). This includes the properties developed from the raw data but also in the stages of dimensionalisation that apply to the process of DA. In short the inductive ideas in my mind were (generally) not being replicated by what was emerging from the data and the mismatch created a blocking mechanism. My tendency to look for linearity in rules and procedures was also a hindrance to start with.

Significant movement beyond this point became difficult until other perspectives were adopted, through the application of conceptual levers derived from Glaser's coding families (ibid), and suppression of my views as a teacher.

However, this early phase did amply illustrate theoretical saturation for the use of *frameworks* and *heuristics* in very simulation, and therefore it could be argued that this represents the views of Strauss on allowing the role of theory to facilitate the development of conceptual ideas i.e. his '*forcing variant'* of GTT (Strauss, 1987).

One of the main problems with the diverse properties arising from the first iteration is summed up by Schatzman's comment, '*What is all involved here?*' (Schatzman in Maines, 310; ibid)

Others have described a cluster of properties which appeared to have a 'critical mass' across a number of properties which have also achieved theoretical saturation as standalone ideas (Kools *et al*, 1996), however there appeared to be some 'outliers' arising from the data which could not immediately be assimilated into one overarching idea. Included in this group were the properties labelled '*leaps of faith'*, '*rule in, rule out'* mechanism, and '*worst case scenario'*, which displayed some incompatibility with the emergent idea of knowledge organisation through the use of cognitive mechanisms such as heuristics.

Table G: Analytical Memos exploring ideas about cognition

Cognitive attributes arising from the data		
Heuristics and **Frameworks** which help organise knowledge *Question: Are these the same?* Answer: Yes-they both help collate and organise data from the simulation	**Knowledge Organisation and management** Simplistic biomedical explanations for disease Use of Risk Behaviour Approach to data gathering which limits reasoning Context creation by the participants to limit role	**Learning from the experience** **Post hoc rationalisation** (These features were developed later in the analytical journey)
Question: How do these apparent outliers fit with other data? Worst Case Scenario Leaps of Faith Rule in, rule out mechanism	*Question:* *There are properties here that are working to facilitate knowledge in some way, but How?* *Is there something about compensatory mechanisms?* *Answer? this appears to be compensation for a lack of clinical knowledge during a particular transition in the curriculum.*	**The first ideas around adaptation**
Memo: **these appear to be faulty inferences based upon flimsy evidence in the simulation.** ***Question: How and why does this happen?***	**Memo**: **The participants demonstrate adaptive processes to compensate for particular deficits in knowledge e.g. they rely upon hard data described by risk behaviour rather than softer data about the pain.**	

A synopsis of where ideas were being formulated at this stage is contained in the tabulated memo and musings in **Table G,** illustrating the fact that whilst frameworks and heuristics had been assimilated, features such as *simplistic causal explanations* for disease and *risk behaviour* had not yet found their place in the evolving data analysis. Also emerging at this stage were properties in the data focussing on *context creation* by participants (creating a slightly different context to the simulation

where none had been given) which appeared to limit their role to pure data gathering and restrict any subsequent diagnostic reasoning. Exploration of this property occurred in parallel to cognitive mechanisms at this point in the data analysis; however, as will be seen later features of this ultimately created a sense that an adaptive process was influencing a number of themes arising from the data. The questions posed in the table define how the data analysis and interpretation shifted in emphasis from what appeared to be poorly refined thought, towards an explanation immersed in the stage of development or evolution as trainee doctors (reflecting the importance of SI).

There was a tendency at this stage for analytical notes to emphasise the *abnormal* mechanisms that were being demonstrated, rather than seeking an explanation immersed in context appropriate for the stage of development. At this point, ideas on conditional reasoning and the impact of anchoring on judgement were important levers on developing the analysis. The memo in Table G alludes to faulty inferences leading to 'leaps of faith' (e.g. 'there is no abdominal mass, therefore it cannot be cancer'). Two examples below show the issues with conditional reasoning illustrated from quotations from the transcripts:

Example 1

When asked about how thinking has been changed by the fact that the actor does not have an abdominal mass, the participant replies,

"Definitely not any cancer but it solidifies the thought of a hiatus hernia, the location there, maybe gastric region 'cos that's just above the stomach".(PI)

Example 2

"The most obvious things to me are whether there's a mass or a blockage, a hernia or ulcer, but as none of that seems as likely as gastritis due to alcohol I guess I've narrowed down in my mind too quickly, but it's all pointing that way now". (PB)

Example 1 would appear to be a simple misinterpretation involving conditional reasoning where premise 1 has been interpreted as 'all or nothing', rather than focussing on the key word *sometimes* (likelihood);

Premise 1: Patients with abdominal masses (*sometimes*) have cancer.

Premise 2: This patient does not have an abdominal mass.

Conclusion: This patient does not have cancer.

This is an example of the error rate of 30% using the form of reasoning called '*modus tollens'*, and considered a major rule of inference (Evans, 1989). If the term '*sometimes'* is taken out of the first premise it becomes evident that premise 1 is false (Eysenck, 2001: 351-59). However, in the case of the participants some are clearly interpreting this as true with the subsequent error incurred in reasoning strategy. *Example 2* shows a tendency towards similar thinking regarding masses with further rationalisation and insight into her reasoning strategies concerning the eventual (correct) diagnosis.

Interpretation of the 'leaps of faith' mechanism demonstrates an interim period in the data analysis where the cycles of induction and deduction gradually shaped the emergent properties, and the questions above illustrate the '*probing*' or '*mining'* of the data through induction, with significant help from conceptual levers such as Glaser's coding families. Further illustrations will be covered in the Case Findings (Chapter 5) alongside examples of the other dimensions that helped shaped the explanatory matrix.

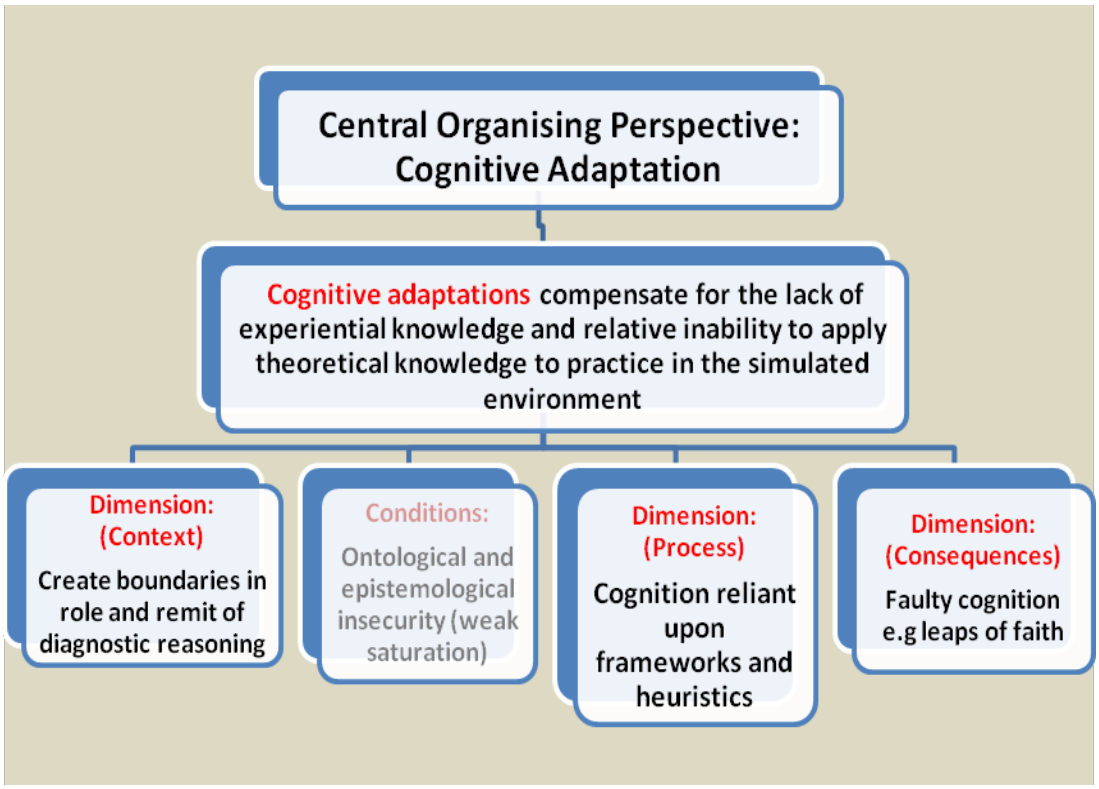
5.4 The Emergence of the Explanatory Matrix

Two conceptual ideas/levers propagated the analysis at this point towards a more effective interpretation: cognitive **adaptation** and (to a lesser extent) transition**.** Between the 2nd and 3rd iterations, there was pause in the conceptualisation of the data as a whole until the data was viewed through these new conceptual perspectives which gave rise to the beginnings of the explanatory matrix. Adaptation became the keyword through which the participants tried to achieve a way forward set by the demands of simulation, the limitations of their clinical knowledge and the lack of integration with biomedical knowledge, but also at this stage of the curriculum characterised by a transition in expectations of their role.

This stage of the analysis had considerable resonance with Robrecht's comment that a story/problem is revealed to the researcher by taking an interpretative stance or view point on the data with a degree of objectivity (1995).

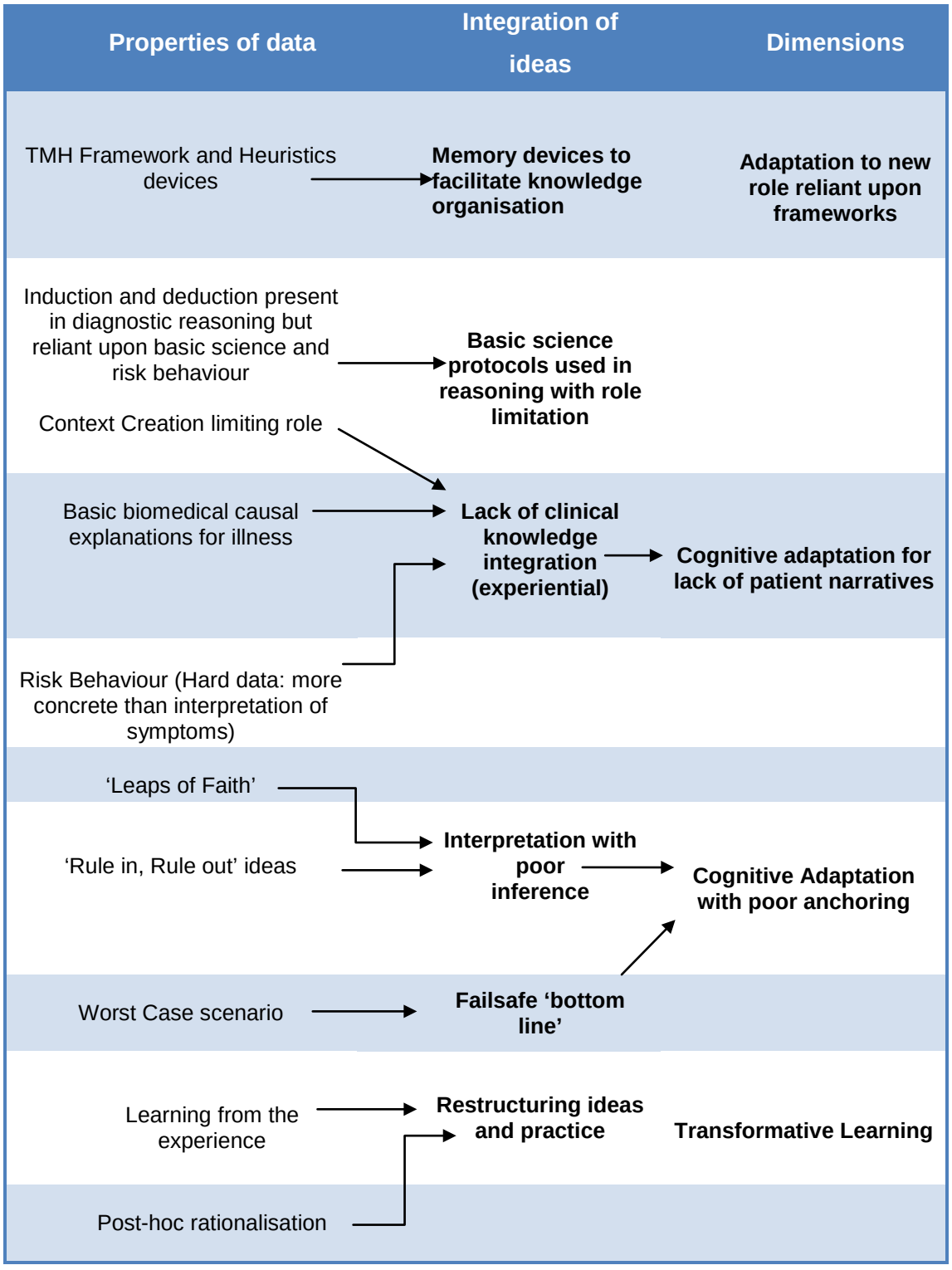
This was the point in the data analysis that provided the conceptual position that explained the multiple perspectives illustrated in **Figure K**, and from which took shape the explanatory matrix and central organising theme (adapted from Kools *et al*, 1996). Other dimensions arising from the data are considered here alongside the cognitive mechanisms as they augment the explanatory power of the emergent pathway towards a central perspective. Applying the four central themes of *context, conditions, process and consequences* to the complexity of the initial properties arising from the data acted as an organisational lever, encouraging greater conceptualisation in a broader sense and into the realm of explanation of the 'whole process'. The interaction between different properties in the data became more evident by adopting this framework, particularly the role of context which will be discussed in the case findings.

Figure K: The emergence of the Explanatory Matrix and Central Organising Perspective



Transcripts showed examples of context *creation* by the participants at the start of the simulations (adding their own parameters or boundaries to limit their role to data gathering in some cases), which acts by limiting the extent of reasoning and the boundaries of the inquiry. Role limitation has foundations in the lack of clinical knowledge at this transition in the curriculum when greater standalone practice is expected to replace the *facilitated* practice featured in Phase 1. Within this statement is the central concept of coping through adaptation, and even though the conditional aspects of ontological and epistemological insecurity suggested in my abduction did not reach theoretical saturation in the transcripts (and became an almost irrelevant dimension), cognitive adaptation is clearly evident in many of the quotations from the simulations.

Figure L: Constructing the central dimensions



Cognitive adaptation became the central dimension or perspective which holds the key position in the explanatory matrix and gives the most effective interpretation of the various dimensions arising from the study. **Figure L** outlines the conflation of ideas with respect to the various dimensions involved in creating the organising perspective. The premise behind this perspective suggests that in order to cope effectively with the demands of the simulation (and any equivalent exposure to standalone practice at this transitional stage), the participants have to adapt to the demands of the new situation. They achieve this by relying upon *learnt cognitive strategies*, *modifying context slightly*, and by using more *concrete biomedical values* in their judgements (risk behaviour for example). However, the process of adaptation comes with some *pitfalls exemplified by faulty inferences* in conditional reasoning and anchoring judgements.

It also helps explain the '*reflection upon action'* that was evident in the reflective discussions (Schon, 1987), and the process of reconstructing ideas for better practice from viewing performance in the reflective discussions after the simulation. These will be discussed in greater depth in Chapters 5 & 6.The seeds of this idea can be seen in *theoretical memo* from February 2012 which developed into something more substantive by July 2012.

Theoretical Memo (Feb 2012): 'The Central Organising Perspective'?

The participants work from a position of ontological and epistemological insecurity, being relatively unable to apply or combine experience from a limited number of exposures to clinical medicine thus far in the curriculum. Being uncertain how to use limited knowledge and experience to overcome this insecurity they rely upon a number of cognitive mechanisms such as mental heuristics and guidelines. They appear to be reticent to extend skill to diagnostic reasoning in some cases.

Theoretical Memo (July 2012)

Figure J became a fundamental stepping stone in the DA process at this stage of the analytical journey. There was a feeling of 'coming together' between the various properties in the data and the relationships between various smaller properties started to line up more effectively. I found myself returning to the same theme time and time again, that of knowledge organisation and adaptation which appeared to provide a suitable umbrella term for the properties in the data. Could this be the central organising concept? This was the second time that I had suggested such a similar concept and there is a growing conviction in this process as data analysis continues.

Equally, this was also a period of revisiting the data in deductive mode to substantiate the ideas of ontological security and its epistemological foundations. There were only two participants who made explicit comments about the role of knowledge in the simulation, which although clearly relevant, did not sufficiently saturate this idea. Accordingly revisions in the data analysis chapter were made regarding the impact of knowledge deficits. This is a lesson not to jump ahead of the data and resonates with the concept of premature diagnostic closure demonstrated in some of the simulations.

6 Chapter 6: Case Findings

The findings which achieved theoretical saturation from the data analysis of the simulations and transcripts will be discussed in this chapter. Quotations from the transcriptions will illustrate the respective properties of the dimensions and provide examples into the mindset of the participants, and how these comments informed and shaped my interaction with the data, including inductive ideas leading to the formation of the key dimensions.

The saturated properties which created the most significant and overarching dimensions in the study were those describing the *cognitive mechanisms or strategies which enabled adaptation* to the new role of diagnostic reasoning, and the *intrinsic learning* that took place. In general, the reflexive discussions with the participants provided the most effective critical mass towards creating the dimensions which ultimately created the substantive theory.

The dimension of cognitive mechanisms started life as a global idea with little differentiation to begin with, encapsulating most of the properties in the data but not all. There was a feeling that some of the properties within this dimension were being used to adapt to a new role created within the simulation i.e. a diagnostic role. In some properties of the data (e.g. use of risk behaviour) there was more certainty in handling 'hard' data, but in others (e.g. the physical examination) there was far less comfort in integrating date with the clinical history. Some of the 'outlying' properties were difficult to assimilate initially into an overarching theme until viewed through a different conceptual focus (e.g. 'leaps of faith').

However, the emergence of this dimension cannot be viewed in isolation as the properties arising from the data analysis draw upon interactions with the other significant dimension which is *Transformative Learning*. It is quite clear from the reflexive discussions that the participants are able to reconstruct ways of looking at

their thoughts and performance which includes ideas that arise in the properties contributing to cognitive adaptation e.g. views on premature closure. The emergent themes encompass the following ideas which are interlinked in various ways through the pathways suggested in **Figure J** earlier.

1. *Causal attribution as explanations for disease.*
2. *Using risk behaviour as key feature.*
3. *Use of learnt frameworks and heuristics.*
4. *'Naive Cognition'.*
5. *Premature diagnostic closure.*
6. *Context creation.*
7. *The 'contribution' of the physical examination.*
8. *Diagnostic Ideas: Emergent semantic thinking.*
9. *Learning from the experience.*

Sections 1-3 describe the evolving causal linkage of data gathered in the simulation that contribute towards diagnostic ideas, with the reliance upon cognitive frameworks to underpin data collection. 'Naive cognition' introduces the apparent 'outliers' in the data that have particular resonance towards how diagnostic errors may evolve alongside the prime issue of premature closure. Section 7 elaborates on the apparent '*black hole'* in the data describing the utilisation of the physical examination material compared to the narrative features of the simulation. Counterbalancing some of these maladaptive influences are the sections that illustrate the emergence of higher cognitive function amongst the participants e.g. the appreciation of semantics and the value of transformative learning in the reflexive discussions.

6.1 Thematic Analysis

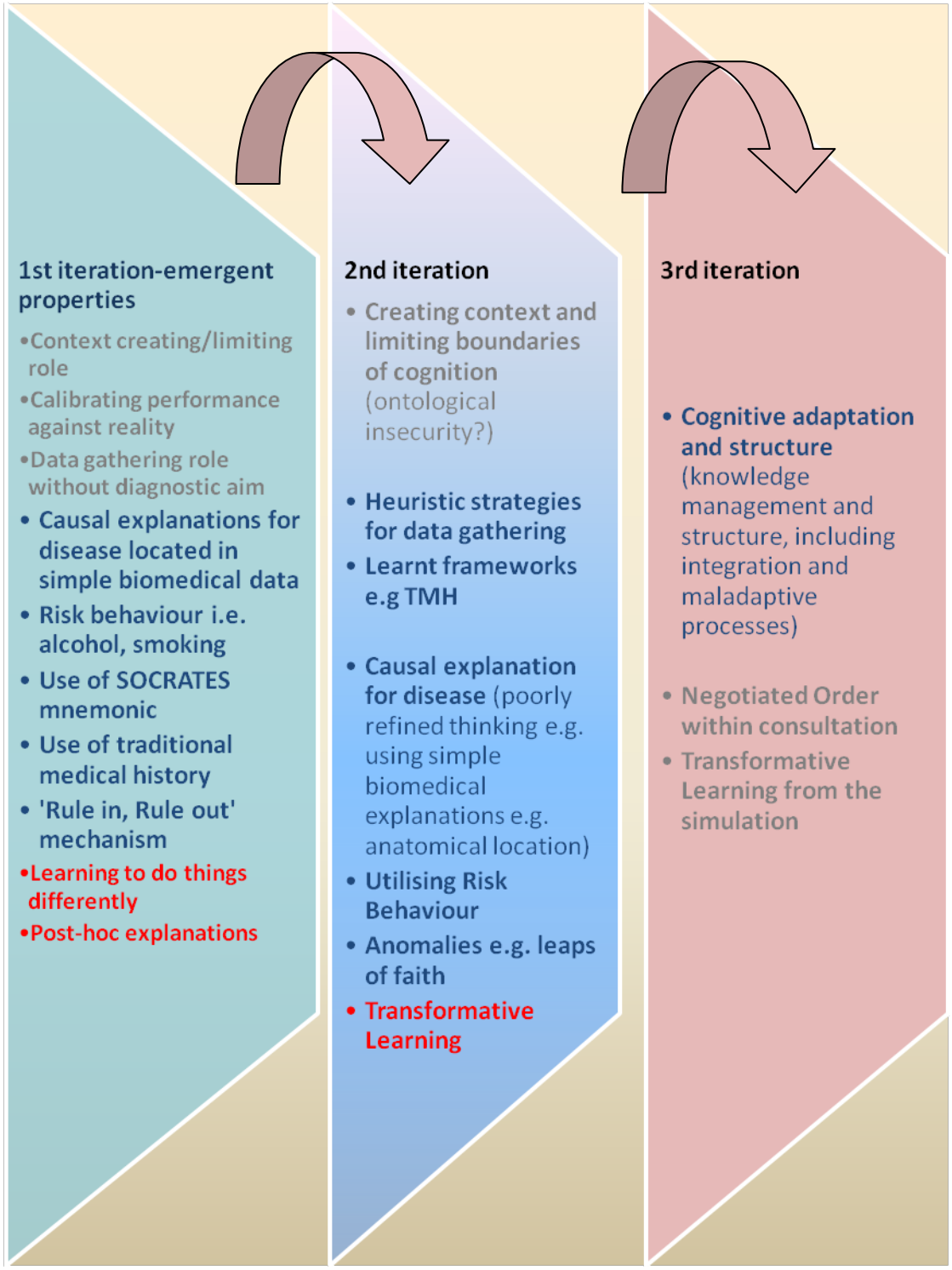
The first three iterations of the data already discussed in Chapter 4 show the gradual evolution of the theoretical ideas on cognition in general, and how the subsequent iterations of the data moved the conceptual stance towards an the adoption of *intermediary* cognitive strategies which reflected this stage of professional development in the broadest sense (**Figure M**). The cognitive mechanisms in this figure have been emphasised to illustrate how the inductive cycles moved the analysis forward and started to provide an dimension that created an 'umbrella' for various properties.

Rudimentary properties which arose from the first iteration included *Simplistic biomedical explanations for disease, utilising risk behaviour as a key feature, the use of learnt frameworks and heuristics,* and subsequently the section which has been labelled as *'naive' cognition* for the purpose of this chapter. This includes three apparent anomalies in cognition such as the apparently misguided interpretation of the *'rule in, rule out'* mechanism. These anomalies will be discussed together as they represent features of errors in clinical reasoning with significant ramifications for teaching in the curriculum.

The first section examines the participants' explanations for illness derived from the simulation, including some of the elementary biomedical terms applied to the abdominal pain, and the features of the case scenario where the participants discuss possible *causal attribution* i.e. the primary causes of the actor's problem. Within many of these sections, the role of *semantic theory* has been valuable in reaching an appreciation of the layers in some of the participant's comments i.e. teasing out what the participants actually think is the meaning attributed to each symptom (Bordage & Lemieux, 1991). This has acted as a conceptual lever with which to view the data, adding to the analysis rather than being viewed as a 'forcing'

mechanism. In this way, it resonates with Schatzman's ideas on borrowing from theory and sometimes being useful in *directing* research ideas, rather than limiting it.

Figure M: Iterative cycles of data analysis focussing on cognition



6.1.1 Causal attribution for explanations of illness

There is a mixture of statements from the participants which relate to causality of the symptoms arising from the simulation derived from using the SOCRATES mnemonic (**Table H**). It can be seen from the quotations that fairly simple ideas and language were being suggested to explain potential causes for illness in the simulation, often relating to non specific anatomical locations and basic disease processes (e.g. inflammation). Basic patho-physiological language or protocols are used to explain disease with non specific anatomical descriptors in general, and these appear to relate to the site and character of the pain descriptor.

Causal explanations of this type might be regarded as a *poorly refined* cognitive mechanism by an expert (my original term for this property of the data), however their quotations reflect the interpretation of symptoms described in often very broad, basic biomedical terms in tune with their teaching thus far. There is little differentiation occurring in the quotations *until* risk behaviour is combined with these vague anatomical relationships. The mnemonic components of SOCRATES which cover associated and exacerbating features give more credence to risk behaviour, and appear to provide more scope in terms of exploring diagnostics ideas compared to other features collected in the simulation e.g. features of the pain.

For example, compare the depth and complexity of these two quotations:

"I'm thinking stomach or oesophagus, definitely irritated. It's quite central" (PA).

“He mentioned he had a problem with fatty foods, and drinking, so I’m wondering if it’s something to do with gall stones” and later “the area of pain that he had, his diet and alcohol consumption, being a heavy smoker leads to a picture....” (PH)

The anatomical location of the pain provides a relatively basic cue towards diagnostic ideas until it is combined with the causative risk factors of drink, food,

smoking, etc. Some of the quotations are even more ambiguous in terms of the contribution that anatomical location provides to the diagnostic formulation, but when associated with other features a more defined structure in thought processes begins to emerge.

Table H: Causal Explanations for the clinical problem

Data excerpts: ***Vague descriptors***
*"I was thinking appendicitis or **something with the abdomen**..." (PE)*   *"Some sort of significant **problem had happened within her abdomen**" (PD)*   *"I'm thinking more bowel than bladder of gynaecological " (PE)*- when asked about initial diagnostic thoughts (actor was a woman on this occasion)   *"I'm thinking stomach or oesophagus, definitely irritated. It's quite central" (PA)*   *"Trying to determine whether we're on about a pain or an ache" (PB)*   *"....and then working out the differentials based on where it is anatomically, and the fact that there's no referred pain".(PF)*   *"One of the first things that I wanted to do was to identify where the pain was, just to anatomically close down the kind of thing I was thinking, cos 'he was in his **upper abdomen, that kind of area**. I was thinking what is in that area that could be causing him that pain? " (PH)*   *"It did make me think it was more to do with **inflammation,** and in my head I was already jumping to what things could cause inflammation, or what other things could be inflamed in that **area of the abdomen** in general"?(PE)*

As PH states these '*lead to a picture'* or pattern of a possible diagnosis for the abdominal pain with features that are linked together i.e. encapsulation of the features of an illness/disease. When viewed through the lens of Symbolic Interactionism, this relates to *their meanings* for some of the features of this scenario and ultimately provides a partial explanation of the illness involved.

It also illustrates the interaction between different properties in the data, and how they begin to shape emergent ideas throughout the initial iterations of the data. However, interspersed with the basic patho-physiological protocols there emerges a picture of growing semantic understanding demonstrated by some of the participants which will be discussed later in this chapter.

In general, comments lack the depth which is derived from clinical contact with patients, thereby helping to explain the links between symptoms and signs. The simplistic explanations for symptoms within the simulated case are indeed realistic explanations immersed in the 'essentialist' model of illness (Campbell *et al*, 1979: Norman, 2000), reflecting the use of biomedical knowledge to validate symptoms of illness. This is exemplified in the excerpt below as PD relates diagnostic thinking to vague biomedical descriptors such as a body system or a disease process;

"I'm thinking more bowel than bladder or gynae', cos gynae' hasn't change at all. I haven't asked her about her urinary tract, so it could be that. Whereas in gastro' she hasn't had any change in bowels either, i didn't really go in deep with that, so it could be inflammation maybe of that or some form of infection, could be cystitis or some form of bladder inflammation or infection." (PD)

What appears to be missing is the rich tapestry of description generally associated with experiential knowledge acquired through hearing other patients describe this sort of problem i.e. integrated clinical knowledge providing the causal networks between different sets of data. As Benner suggests teaching covers objective attributes of illness at this stage of professional development and students lack the situational experience to complement this knowledge (Benner, 1984: 20).

When viewed analytically this idea provides only one perspective with which to view the data -that of the meaning and insight into the cognitive strategies used by the

participants i.e. they appear significantly restricted, lack subtlety and conceptual denseness (cf. Strauss & Corbin's comments on theoretical sensitivity, 1990; 41-47). In order to develop this property further, the participants' use of 'risk behaviour' needs to be brought into the equation alongside the basic patho-physiological protocols. When these ideas are encapsulated into the diagnostic ideas arising from the simulations, more evidence of deeper thought and connection between individual features (causal pathways) emerges in the protocols discussed in the reflexive discussions. Specific disease labels are seen in the explanations for the actor's problem.

6.1.2 Using 'risk behaviour' as a key feature

Alongside the clinical features of the scenario there are at least four risk factors deliberately built into to the actor's descriptor (excessive drinking, smoking, use of anti-inflammatory medication, and over indulgence in some foods), which should promote diagnostic ideas of gastrointestinal disease and infer predisposing factors towards peptic ulceration. These factors would be encompassed by prototypical theory to represent the typical features of a peptic ulcer (Bordage & Zacks, 1984; Bordage, 2007).Here we see far more differentiation in diagnostic ideas through the expression of cognition that links more than one feature i.e. patterns. Some quotations lack complexity creating tenuous links to illness e.g.

"It could be related to food because she eats a lot of curries" (PC).

"About the alcohol? That could be a potential irritant for his pain. Yeah, it could have had some causal factor" (PI).

However in general, greater complexity is illustrated by the quotations which afford clear examples of effective linkage of causative ideas (**Table H**), and this can be seen in the comments below from PA which exemplifies the emergence of pattern recognition in causal attribution.

'I'm thinking it's related to the drinking, potentially the Nurofen, and the smoking can irritate the stomach, and combined with food, spicy food & lots of food. What he called indigestion I might agree with that.'

(PA's opening comments as to what she thinks is wrong with the patient)

PA has made an explicit link between various risk factors implanted in the case scenario in her diagnostic conceptualisation of the actor's problem. Two competing diagnostic solutions are suggested, firstly liver disease postulated through the combined risks of alcohol and fatty food; secondly, the three risks factors predisposing the diagnosis towards irritation of the stomach lining, rather than liver disease.

Table I: Causal Attribution related to risk behaviour

Data excerpts from participants
*"He mentioned he had a problem **with fatty foods**, and **drinking,** so I'm wondering if it's something to do with **gall stones**" and later "the **area of pain** that he had, his **diet** and **alcohol consumption**, being a **heavy smoker** leads to a picture...."* (PH)
*"Just what it could be in relation to what he did, **drank too much** which immediately pointed me to a GI problem....I was thinking maybe indigestion or because he said he was at a party it was because of **alcohol**, with an **acidic or fatty foods** can, are likely to cause a stomach pain thing".(PI)*
*"So **Peptic Ulcer or Hiatus Hernia** can be aggravated by various **foods** at the party and also he was drinking **alcohol,** both of them can be aggravated by it, aggravated by **acidic food or drink**. So also the **milk** was a neutralising effect and the location was the stomach, so all those three things come together".(PI)*
*"Ruling in **gastritis** more and more with his alcohol, it's not reflux its irritation, **something's irritated his stomach**, what is it and then asking more about **alcohol".** (PB)*
*"She seems to suggest that she's taking quite a lot of **Nurofen** for her knees, and that cause **gastric ulcers** and things like that, in the stomach, in the abdomen..." (PD)*
*"But then at the same time he's taking **Nurofen,** pretty often for this knee, so I know with Nurofen you have a predisposition to **ulceration or increased bleeding** in the stomach and the need for **antacids** and things like that".(PF)*

Causal Links in bold

Whether the participants accurately interpret these clinical features within the history (assuming that they have correctly elicited them in the first place) largely depends upon their individual perception of causal attribution and the relative importance (weighting) of these features within the complete history. Both the structure of the TMH and the individual features of the SOCRATES mnemonic create the conditions for collecting this data e.g. exacerbating factors for the pain. Here is the cross

linkage between individual properties in the data, in this case between the use of memory frameworks and chunking of causative features.

"We went through his eating and drinking and the fact that his pain started with this fatty meal at a wedding, with a lot of alcohol consumption. That made me think about a few things, firstly what sort of diet he's having. Is this something that's been precipitated by alcohol consumption, perhaps a long term alcohol problem, or possibly due to a fatty intake, and I was trying to narrow myself down to along a gastro sort of line, the fatty intake and alcohol might indicate problems in that area" (PH).

PH's comment demonstrated thought beyond simple pattern linkage, including inductive ideas about diet, the contribution and temporal nature of the alcohol problem (acute or chronic) and how this impacted upon his diagnostic reasoning by narrowing down (the alternatives) towards a gastric solution. In effect, he is forming abstract ideas by formulating his thinking using at least two broad ideas. Firstly, through the linkage between cues i.e. pattern recognition, and secondly, using the comparative relationship of '*acute*' versus '*chronic'* in the way he views its contribution towards the diagnosis (semantics). The temporal aspect was also picked up in this comment from PD inferring that a further trigger had caused the relapse in pain:

"That told me it might not have been a new issue, it might have present within her for a while and suddenly become a lot worse, something had ignited it again".

PI takes the mnemonic features further by specifically stating the linkage between two competing diagnostic alternatives or labels (named as distinct diagnostic terms rather than just 'inflammation of the stomach lining'), and the exacerbating/relieving features collected through using the mnemonic strategy. The pain descriptor is also included in contributing to the diagnostic alternatives.

"So Peptic Ulcer or Hiatus Hernia can be aggravated by various foods at the party and also he was drinking alcohol, both of them can be aggravated by it, aggravated

by acidic food or drink. So also the milk was a neutralising effect and the location was the stomach, so all those three things come together" (PI).

The level of cognitive linkage in this quotation reflects a well developed causal network for this particular clinical problem and how it is represented in thought. This decision making process is governed by the participants' knowledge of the connections between risk behaviour and disease (causal links or behaviour that predisposes patients to types of illness) .There is a sense that from the quotations that the features of risk behaviour are used *more effectively* in the diagnostic process than the clinical features of the pain. When combined with one or two of the comments about clinical knowledge deficits, the reliance upon more concrete data items may reflect a more factual, literal view suggested by Bordage which lacks semantic depth (2007).

It is possible that collecting more concrete data within the history in terms of drinking, smoking, drug use, etc, provides tangible information which can be utilised more effectively. In contrast, the subjective, elaborated features of abdominal pain are harder to interpret for our participants, and these are more reliant upon effective history taking, subsequent interpretation, thought and experience i.e. what Mead might call *natural analysis*. Indeed studies suggest that diagnosticians that are more effective employ deeper and varied representations of complaints (Chang *et al*, 1998; Bordage *et al*, 1997).

The reliance upon concrete terms can be explained by two possible mechanisms: firstly, that these terms compensate for the lack of clinical knowledge integration accrued from face to face contact and the difficulty of applying it effectively. Secondly, the *soft data* from the actor's history is harder to assimilate using the *cognitive editing process* which allows clinicians to differentiate key material from verbal 'chaff' during data gathering (Bruner, 1986). The term 'soft text descriptors' was coined by Elieson & Papa in their study on the impact of different knowledge

formats upon developing mental associations for illness (1994). However their findings recommending (hard text) quantitative, mathematical probabilities was later questioned by suggestions that students provided with biomedical causal pathways for illness retain that information more effectively (Woods *et al*, 2005). The quotations from PG and PD provide a sense that pain is easier to compute when associated with a rating scale (NRS) which provides a hard text descriptor:

"I wanted to get a gauge, uhm, with just using pain it feels quite ambiguous when someone's talking about it. If you get a scale there you can work out the severity of it" (PG.)

"Later I asked how bad it was on a scale of 1 to 10 and she said 7, which is pretty high as well, so it was obvious that it was causing a lot of distress. It was obvious that it was a serious issue" (PD).

When the participants started using cues across different component of the history the inferences became strengthened in the way they discuss the case details, and this moves interpretation away from the vague terms which related to anatomical location only. So PD goes on to discuss the lack of relief from analgesia combined with the pain severity:

"Yeah it made me realise that she was a serious case that had come in, it was something that needed to be addressed straight away, that was the impression that I got more and more as it went on. Because even when I was talking to her she was grimacing and grabbing her tummy as if she were in pain as we were speaking. So this and other things before confirmed that it was something that it was something that needed addressing sooner rather than later"(PD).

Although some comments reflect a continued reliance upon consultation tools such as the NRS which are illustrated by the novice stage of expertise, there are excerpts which suggest richer patterns of cue interpretation when considered together in chunks or groupings.

The properties of utilising *simple biomedical interpretation* alongside *risk behaviour* as causal explanations for illness at first appeared to suggest a limited view of diagnostic explanations. These are *concrete* terms immersed in biological fact or unfettered data on risk activities such as smoking and drinking. They are not ambiguous or uncertain, unlike the *abstract associations* inferred by the other features of the history (pain) that may appear more difficult to assimilate with restricted prior exposure to such descriptions. This is inevitable with the various descriptions of pain requiring significant case based experience for adequate interpretation.

But when cues are used in combination, there is clear evidence of propositional networks which are beginning to link relationships between the individual features of the history, making order from the chaos of incoming data. Here the various properties in the first two iterations began to coalesce and connections became apparent. The use of the structured frameworks facilitated the delivery and organisation of the data from the simulation, which then enabled links to become more obvious through the chunking of individual features as explained above.

From this information the participants will build upon the elements of disease that instantiate *Syntactic Theory* i.e. the rules of inclusion of symptoms into a diagnostic entity (Bordage & Lemieux, ibid). In this case, the features of smoking, excess alcohol, medication using an anti-inflammatory drug (Nurofen), and possibly dietary indiscretion have all contributed to the diagnostic rules pertaining to peptic ulceration.

Theoretical Memo (May 2012)

It is not surprising that novices resort to basic pathological processes familiar to their early teaching, and experts utilise a more pragmatic approach to disease which allows them to operate in the real world where answers are not always forthcoming. The novice approach is very much demonstrated in the causative explanation invoked by the participants in this study.

Looking back at previous assignments has also been beneficial, rather than being a reminder of my sometimes trenchant starting position. There are two views on disease which in many ways perhaps demonstrate the difference between my views and those of the participants It arises from the views espoused by Campbell et al on the concept of disease(1979, and Norman(2000).
They compared the 'Essentialist' view adopted by novices that signs and symptoms arise from a pathological process that can be identified and rectified, and the 'nominalist' perspective that experts usually hold which is that disease is a collection of abnormalities that arise together. This equates to the use of syndromes even when basic biomedical explanations are not immediately apparent e.g. chronic fatigue syndrome, the description of 'dropsy' (heart failure) well before the physiological process underpinning it was developed.

Reflexive Memo:
I have recognised an uncomfortable yet illuminating analogy between the difficulties in the data analysis process, and some of the comments from the paper on 'Cognitive perspectives on Medical Expertise', from Schmidt et al (1990).
It has reminded me that data collection is idiosyncratic, and that the amount of data is not directly proportional to the expertise level of the collector (cf. 'the intermediate effect'). It is how that information is managed and sorted which becomes the important feature, and this comment reflects where I currently stand in DA as a novice researcher using this methodology for the first time.

6.1.3 Use of learnt frameworks and heuristics

There are two main consultations 'frameworks' that are taught during Phase 1 of the curriculum, and all of the participants used both of these explicitly during the simulation. Although these conveyed a strong sense of ordering data collection to use one of Glaser's coding families, the more interesting comments came from the reflexive discussions as to how the participants viewed their usefulness. The frameworks demonstrated throughout the simulations are a) the *Traditional Medical History format* (TMH), and b) the *'SOCRATES'* mnemonic for the features of pain. One participant used the CAGE questionnaire for problematic alcohol consumption which also features in the teaching programme (Bush *et al*, 1987). Through my interrogation of the data it was clear that all of the participants demonstrated the use of at least one mental framework or schema which they subsequently described through an organisational perspective. Some used these as mental 'aide memoires' and others by writing down a structured approach on paper at the start of the simulation. In the latter case, they were asked to discuss what they had written down to explore the reasons for use.

The quotations in **Table J** exemplify a number of ideas where participants are using learnt frameworks as the foundation or template for collecting data from the simulation, providing a reliable structure to fall back upon if they lose track of collating information i.e. a 'failsafe' mechanism (Grant & Marsden, 1984).

'I had to follow a logical order',
'Useful it is to have the structure of the history',
'Organise my mind a bit',
'Find it helps with structure' (mixed quotes)

"How useful it is to have the structure of the history because sometimes when I lose my train of thought.....so I just went back to the traditional structure" (PI).

These quotations evoke a feeling of dependence, certainty, organisation and structure which facilitate the collection of data from the simulation, and conversely without it the participants would find collation of the different components more difficult. Not only are the participants using the frameworks for processing information in a logical format, they rely upon it when faced with a loss of sequencing in the presentation of the history.

Some adhere to the mnemonic format literally, illustrated by these comments, which reveals a feeling of '*musturbatory*' thought i.e. I *must* do it in this way or I will miss out important data.

"*I had to follow a logical order" (PC)*,

"I'd got my SOCRATES all mixed up, I was thinking my way through the letters and got muddled" (PF).

This has some resonance with other studies which suggest that storage and retrieval of case based data is reflected in the serial order in which this is reproduced (Claessen & Boshuizen, 1985). It is suggested that novices are more affected by the random order of presentation in symptoms compared with experts (Groen & Patel, 1988: Coughlin & Patel, 1986), and this would explain why our participants feel the need for such mechanisms to organise the chaotic influx of data that sometimes occurs in history taking. This is inevitable in the real world as patients will not reveal cues in the sequence that the student would hope for. The analogy with the novice stage of expertise in the skills acquisition model is clear i.e. the participants are still reliant upon guidelines and rigid adherence to taught plans such as the Socrates mnemonic and structure of the TMH (Dreyfus & Dreyfus, 1986).

Table J: Use of Frameworks and Heuristic Mechanisms

Data excerpts from participants
*" I was attempting to use **SOCRATES** anything to do with pain' (PA)*
*"I was **thinking SOCRATES**.....presenting complaint because I knew I had to follow a **logical order** by following that. I think it's a really useful mnemonic" (PC)*
*"How useful it is to have the **structure of the history** because sometimes when I lose my train of thought.....so I **just went back to the traditional structure**" (PI)*
"I went through a vague recollection of SOCRATES, going through the site, onset, character, etc." (PH)
*Talking about written **aide memoires**, "**organise my mind a bit**, hopefully not miss things out! I suppose there is so much information coming at you at once you want to **organise it** a little and take it one at a time... cover all the posts and I find it helps with **structure**'(PA)*
PH discussing using Socrates: *"Not explicitly as in definitively, it was certainly in my head and there were tick boxes of what I needed to cover, where the pain was, when it started, what type of pain. I think I covered most of the points and I find a useful thing to have in my head, but you have to **be a bit flexible using a tool like that** not to exclude other symptoms, not completely disregard what the patient's saying to you. I try to use things like that in a more flexible manner but having them in my head to know what to ask".(PH)*

In these participants, the use of a written framework creates a tension in the simulation which is apparent from their varied views. Some have learnt to use a framework from memory implying their expertise level is moving out of the novice stage in terms of taking a history; others still feel the need to write down an outline to act as a fall-back position but don't add anything further, and some jot down salient comments (e.g. the NRS). The excerpts below provide an insight into some of their thoughts:

"I felt that I should be thorough and write everything down using the paper made me as I was alienating the patient for seconds as I scribbled things down causing an uncomfortable silence, and then lost my train of thought as well.....
The only thing I wrote down was name, age, nausea, 5days, but I remembered that anyway; and 10 packet history which reminded me" (PF).

"Yeah I feel it can out the patient off if you're writing stuff about them. I think if someone was writing what I was saying I would think very carefully about the words I was saying, and would rather that patient was relaxed and saying everything that came into their head. I don't find writing it down very helpful; if I summarise it afterwards hopefully I'm not going to miss too much of what he said" (PB).

When asked about the two aide memoires she had written on paper at the start of the simulation (both TMH and Socrates), PG replies:

"I personally use a lot of abbreviations, I always remember in exams because it helps me to remember certain things, to ask things, so when I'm studying I make up my own little rhymes just to help me remember things. I like to use them only when I'm under pressure. I know how to take a history but they're something to fall back upon just to check for myself" (PG).

"Keep it open as we've been taught, he's taking about the pain, and I wanted to use that 'golden minute rule' to see how much I could get out of him without getting into the structured history" (PF).

Clearly the organisational function of the mnemonic and TMH framework feature heavily in this group, however *flexibility of thought* did not achieve the same saturation in their comments. There is a sense from one or two remarks that they are becoming more flexible in adapting to the demands of history taking, but rely upon a fall back mechanism at this stage of development.

Mnemonic strategies have been shown to have a direct effect and beneficial impact upon the ability to remember a number of diverse areas, including recall of factual information by facilitating two aspects of memory. This is achieved by limiting potential cognitive overload on short term memory, but also by facilitating encoding

and retrieval from memory (McCormick & Levin 1987: Levin 1993; Bellezza 1996: Cowan 2001). They provide a basic framework for memory which can be easily built upon; they help create associations between individual components by grouping information (chunking) and allow easy repetition for learning. It is interesting to note that certain parts of the mnemonic structure deliver information that is used more effectively i.e. viewing the risk behaviour as *associated* and *exacerbating* features. This contrasts quite starkly with the relative paucity within the reflexive discussion about how the features of pain create a picture of the illness, as delivered through the initial components of SOCRATES.

Repetition of the use of SOCRATES in serial patient contacts helps link the various components until they become automated through deliberate practice (Ericcson *et al*, 1993). In this way it is acting as a *schema* which helps organise the different features of a defined problem and reduce cognitive overload (Schmidt & Rikers, 2007; Sweller *et al*, 2011).

6.1.4 'Naïve' Cognition

During the data analysis It became clear that participants were adopting risk laden cognition which took inference a stage beyond their knowledge and into areas of unsafe practice in terms of general reasoning. Such examples were labelled under the composite term of *naïve* cognition during early iterations of the data, however subsequent integration of ideas eventually suggested an alternative perspective once the central dimension was established. There were three strategies which appeared to fall under this category;

1) 'Leaps of faith'
2) 'Worst Case' scenario
3) 'Rule in, rule out' mechanism

These strategies at first appeared quite separate, but further analysis and interpretation provided a better perspective which describes these misguided inferences. Some comments reflect a lack of knowledge e.g. PB talking about her diagnostic reasoning;

He didn't have a change in bowel habit which made me kind of rule out the IBS (irritable bowel syndrome) aches and pains",

Followed quickly by an example of one of the salient statements illustrating 'leaps of faith':

"If there's no mass that takes away quite a lot of things".

Perhaps the most obvious mistaken application in this group is the implicit link between the examination feature provided to the participants within the scenario, stating that there is 'no abdominal mass present in the abdominal examination', and the subsequent inference that the patient therefore doesn't have cancer (**Table K**). The participants also appear to have adopted a phrase (*rule in, rule out*) without truly understanding the underlying implications or indeed the disease probability implied by that rule. Inductive processes generally arise from a set of characteristics

leading to a diagnosis or solution which encompasses all of those characteristics; however, some of the participants are making a quantum leap in judgement based often on one characteristic alone. PA's comment below sums up the mixed messages in her mind although her analysis is closer to being accurate than any of the other participants.

She mentions '***ruling out or ruling in things'*** during the *systems review* towards the end of her history, and when asked where she has come across that, she replies;

"Good question. I suppose it's like a safety net. You don't necessarily know what to look out for so you just ask general questions and hope that something comes up or something gets ruled out, something makes one option more likely or less likely than it was before".

The 'safety net' refers to the systems review mechanism within the structure of the TMH, but implied in her comment is a 'hit and miss' approach rather than someone who understands the true benefit of the process. Her interpretation of increasing likelihood is correct; however, in most instances the participants are using this rule *quite literally*, often based on one symptom or sign alone, which sets a dangerous precedent, representing an abnormal heuristic strategy based upon a weak premise. This was set against the backdrop of a '*worst case scenario'* stance which appears to be adopted by some participants, in that the worst possible scenario would be cancer and that premise became 'the bottom line' in terms of reasoning i.e. cancer is the most significant cause that must be excluded from the possible diagnosis e.g.

"I was trying to think through what it could be and I'm really not sure (Pause) some sort of problem with her GI tract I suppose. Worst case scenario she could have developed something cancerous perhaps, within her stomach, her intestines, GI tract?" (PD)

Table K: Examples of 'Naive' Cognition

Examples of 'Leaps of Faith'
"If there's no mass it takes away quite a lot of things. The most obvious thing to me are whether he has a mass or a blockage" (PB) *When told there is no mass on abdominal examination,* ***"Definitely not any cancer but it solidifies the thought of a hiatus hernia, the location there, maybe gastric region 'cos that's just above the stomach" (PI)*** ***"Yeah. If there's no mass, just tenderness"*** *(PG explaining her reasoning when asked about her provisional diagnosis of peptic ulceration after being provided with the features of abdominal examination)* *"**I'd ruled out food poisoning as that is normally over in 24hrs"** (nervous laugh) PB.*
Examples of 'Rule in, Rule out'
"When he said it was like indigestion, I was starting to rule out other chest or abdominal pains, some people confuse chest and abdomen so I was ruling out going down the any kind or cardio respiratory route". (PB). ***"I'm just ruling out the very important symptoms, I can't miss blood in the stool or vomiting blood, things that might signify a bleeding ulcer or something like that". (PA)*** ***"I'm getting background information. I'm' trying to figure whether this is about the drinking/eating episodes or if there's something I've missed out or there's something I need to consider".*** Researcher: What do you use that for in your mind? ***"Ruling out or ruling in things".*** *"**You don't necessarily know what to look out for so you just ask general questions and hope that something comes up or something gets ruled out, something makes one option more likely or less likely than it was before". (PA)*** ***"I was thinking about all the 'red flag' type things as it had gone on for so long I was wondering whether it radiated, and what this pain was like, co you know abdominal aneurysm or anything like that, bit of a red flag....." (PG)***

There are a number of possible explanations for making these 'leaps of faith'. It may reflect their interpretation of teaching in the curriculum in that disease presentation are often taught by secondary care staff whose representation of disease probability reflects the domain which they work, rather than the premise adopted in primary care where 'common things are common' (probabilistic reasoning), and cancer does

not sit top of the agenda. The 'rule in, rule out' strategy has been naively adopted from Murtagh's process of *restricted rule outs* (1990), which guides the clinician to exclude the most serious causes of illness, thereby reducing clinical errors (Croskerry, 2003).

This includes the domain of *red flag markers* for disease which are significant symptoms or signs which *increase the likelihood of serious disease*. Nevertheless these are *not absolute markers* that rule out or rule in specific diseases e.g. neck stiffness and photophobia are significant signs seen in Meningococcal septicaemia, but are not *exclusive* to this serious illness (Thompson *et al*, 2006). In this simulation, the presence of an abdominal mass would be a red flag maker for possible cancer, however it is not an *exclusive* finding e.g. it may reflect benign enlargement of intra-abdominal organs.

Equally it may represent extraordinary anecdotes of faulty diagnoses illustrated in the press in patients with cancer; perhaps it may represent faulty belief in simple *conditional reasoning* which can be illustrated by the following example;

Premise 1: All doctors are good people.
Premise 2: Harold Shipman was a doctor.
Reasoning: Shipman was a good doctor.

In adopting this type of reasoning, it is likely that the absence of an abdominal mass has prompted the 'bottom line' in the reasoning process (cancer) to be ruled out. The premise is the issue of a faulty belief mechanism or bias in that the participants may believe that all cancers present with an abdominal mass, whereas the premise is not *universal, but partial in its affirmative nature* i.e. some cancers may present with a mass (Eysenck, 2001 :Ch 10).

The participants' quotations cover different issues with a common thread, which is '*inference based upon a paucity of evidence'*. The first two quotations in Table L provide examples on inference on examination features, '*no mass'* effectively ruling

out cancer in their thinking, a dangerous heuristic for clinical practice. The fourth comment appears to illustrate a basic assumption that food poisoning always resolves within a specific time period, and reflects insufficient knowledge about the variations of food poisoning that may cause gastrointestinal upset.

These comments reflect a rather tenuous adoption of a principle of practice in *some* situations of ruling out the most serious conditions for illness, without an understanding of the prevalence of disease in general. The denominator in this case is to exclude cancer or something similarly serious, before considering other (more common) causes. Within these quotations there appears to be a cognitive process which has not been sufficiently explained by teaching and hence this became one of the significant pointers into the participants' perspective which provoked a changing in the curriculum during the data collection i.e. the explanation of 'red flag' markers, likelihood ratios and the interpretation of key symptoms.

However there did not appear to be an all-encompassing explanation for the sub properties of '*worst case scenario, rule in rule out, and leaps of faith*', which were labelled as examples of maladaptive or naive cognition to begin with, and were viewed as 'outliers' in the data analysis associated with the first iteration. The emergence of an overarching adaptive process drew various ideas together, and eventually the issues of abnormal inference seen in mechanisms such as 'leaps of faith' found an explanation.

In this case the participants were compensating for a poor clinical knowledge base by applying a rule of probabilistic reasoning with little understanding of the clinical domain i.e. their interpretation was simplistic without depth of context which would normally be underpinned by experiential knowledge, but entirely appropriate to their (limited) stage of clinical expertise. This idea also provides the foundation for the use of basic biomedical explanations of symptoms gathered from the simulation.

6.1.5 Premature Closure

Cognitive errors in diagnosis are correlated with incomplete history taking and examination, bias towards one diagnosis, and failure to consider the correct diagnosis (Graber, 2005; Norman & Eva, 2010). Inaccurate diagnoses often have significant consequences especially in the domains of Internal medicine, emergency medicine and general practice, accounting for almost half of the claims in US Emergency Departments (Croskerry, 2003). Premature closure on one diagnosis too early in the data gathering process to the exclusion of other possible hypotheses is based upon faulty history taking, and so it is reassuring that some of the participants in the study are already recognising such errors and faulty heuristics as illustrated by the quotations in **Table L**.

Graber divided 100 diagnostic errors from three medical centres into three domains; '*systems-related'* (organisational: identified in 65 cases), '*no-fault'* errors (e.g. atypical presentation: 44 cases), and *cognitive errors* e.g. faulty knowledge and data gathering found in 74 cases (Graber, ibid), with errors occurring often occurring in parallel. Premature closure is one of the main cognitive biases whereby the clinician is trying to force a hypothesis using incomplete data, without considering other possibilities and searching for data to confirm or refute the alternatives. Such errors are difficult to pick up without accurate self-descriptions and endorse the value of the reflective discussion in which the features of early metacognition emerge. Such features include a greater awareness of the broader picture, ambiguity in the history, and atypical presentations of illness. During the analysis of the simulations, examples of premature closure were indeed difficult to isolate from my interaction with the data. Even in those participants that failed to recognise the potential diagnosis of peptic ulceration, however the *reflective discussion* opened up avenues of reconstructive thought in some of the participants.

Table L: Examples of Premature Closure

Quotations	*Analytical memo*
"*To be honest with you **I make my mind up too quickly** and not focus on the broader scheme of things....."(PE)*	Premature Closure on diagnosis
*'I think it was better than I had expected in terms of the way I linked things together but I think what I've got to do try not to do..... **there are three things here which lead to this diagnosis, I'm going to go guns blazing into this diagnosis,** I need to really broaden and be encompassing, try and get my differentials together in a bag, and when I've got some time pick away at it, in light of his previous history which I'd have in front of me**. So not rushing into any decisions**."(PF)*	Reflecting on how to organise information and allow time and space for decisions i.e. avoid premature closure
*"I think it's really important to keep an open mind. When you're doing things you need to have ideas rolling around but sometimes **you run with one idea and it prevents you from weighing up other options**, and it's important to keep a broad mind and weigh the options up properly " (PH)*	Premature Closure and consider other competing diagnoses
PH goes on to provide an example from practice where she recognised the issues of premature closure as a significant turning point:	
"I think I have, would you like me to expand? (yes)*. There was one lady in a clinic and I was certain that she had heart failure because she has SOB, had to sleep with lots of pillows, pitting oedema in both legs. **For me it sounded like three big ticks for heart failure, and I was quite surprised that she didn't, even though she has these symptoms and things were a lot more complicated.** As she got older she developed dodgy valves in her knees which had caused this swelling and because she had a knee op' she had put on a lot of weight and a bit less fit and that had caused her SOB". **	**Chasing Cardiac Failure rather than considering the alternatives**, but has recognised her error in doing so, with (hopefully) a change in subsequent practice i.e. transformative learning

The quotations show some evidence that 'rushing into things' with a fixed mind will result in premature closure and close down the bigger picture. It is impossible to determine whether this is just purely a processing issue i.e. the diagnosis was not considered (an error in reasoning), or may be linked to knowledge deficits as has been suggested (Graber, ibid). The example from real practice expressed through

the word of participant H in Table M (*) illustrates a current debate about the impact of reflective practice and the accuracy of the reasoning process.

"There was one lady in a clinic and I was certain that she had heart failure because she has SOB, had to sleep with lots of pillows, pitting oedema in both legs. For me it sounded like three big ticks for heart failure, and I was quite surprised that she didn't, even though she has these symptoms and things were a lot more complicated. As she got older she developed dodgy valves in her knees which had caused this swelling and because she had a knee op' she had put on a lot of weight and a bit less fit and that had caused her SOB". (PH)

Little empirical evidence exists so far to confirm such a link, however some sources suggest a multidimensional structure to reflective practice which would preclude the urge towards premature closure. Through deliberately searching for alternative explanations /hypotheses when faced with complex problems i.e. *deliberate induction*, reflective practice facilitates exploration of the consequences of these alternatives tested against new data i.e. *deliberate deduction* (Mamede & Schmidt, 2004). An attitude and willingness to test ideas alongside critical reflection of personal decisions has been found to have a positive effect upon diagnosing complex case (Mamede *et al*, 2008).

Given enough time to '*pick away at ideas'*, it would appear that the statement from PF above has some resonance with these suggestions. When considered alongside some of the emergent cognitive strategies which will be discussed later in this chapter, there is ample evidence from this relatively limited sample of participants that the reflective discussion is opening avenues of thought beneficial in subsequent practice.

6.1.6 Context Creation

Performance across cases in differing domains of practice is referred to as context specificity, and is an important feature influencing diagnostic reasoning ability in action (Eva *et al*, 1998). Two theories represent contemporary thought on the influence of context; *Situated Cognition* and *Ecological Psychology* (Lave & Wenger, ibid; Durning *et al*, 2011). Situated cognition immerses learning, reasoning and clinical outcomes within the parameters of the experience nominating the interactive variables into *clinician, patient, and setting*. Ecological psychology proposes an agent (participant)-environment interaction which can provide affordances (what the environment can give), and effectivities (what the participant can do) which are interdependent.

During the simulations it was noticed that the participants were adopting a verbal 'bookending' mechanism to the simulation i.e. using qualified opening and closing statements (**Table M**). By creating their own context to the simulation which diverged slightly from the *context explicitly provided* prior to the simulation (a case from a clinical domain of teaching already covered in the curriculum based in the media laboratory) they have changed the parameters or conditions pertaining to the simulation. The instructions for the simulation stated that the consultation should merely be approached using the traditional medical history format, rather than a focussed consultation. The participants tried to confer their own context to the simulation by introducing themselves from the setting of a ward or clinic, and furthermore in some cases to infer a relationship with another clinician to whom they would report to e.g. *"I'll just go and tell the doctor everything that you have told me....."*. This implied a transfer of data gathering and furthermore when aligned to other comments, suggested role limitation

Table M: Context creation

Excerpts from data
Context Limitation ***What brings you to the hospital today? (PD)*** ***'Hi Sam, I'm ***** a third year medical student, is it alright if I see you before the doctor today?' (PE)*** ***'I am a medical student in a clinic and the doctor has asked me to ....' (PB)*** ***'I'll just relay that to the consultant and we'll help the best we can' (PD)*** ***'I'll just tell the doctor everything that you've told me and he'll get back to you' (PC)*** ***'I guess my questions were geared to something less than life threatening; once my thoughts were geared towards the problem it wasn't such an issue because I felt I was on the right track' (PB)**** ***"The thing that I could have done is to reassure her that she will see the doctor next, he knows a lot more than I do instead of nodding and asking more questions, 'cos that comes over as trying to tick the box" (PE).*** ***Role Limitation*** When asked 'what do you think is the aim of the consultation?' ***"Just to ask questions that are relevant to the information being given and try to tailor the questions along the way to the information that I'm getting throughout the interview, whilst at the same time trying to stick to some structure.(PI)*** ***"Yeah. I've not got experience of thinking of problems whilst taking the history. I'm just used to 'rhyming' off the history and not thinking about what could be going on along the way".(PI)*** Researcher: What do you feel is the aim of the consultation in the first place? ***PI replies..."Just to ask questions that are relevant to the information being given and try to tailor the questions along the way to the information that I'm getting throughout the interview, whilst at the same time trying to stick to some structure".***

In some respects opening and closing statements reflect the introductory and closing functions of the Cambridge Calgary guidelines which form part of their communication skills teaching (Kurtz *et al*, 2005: 17; *the basic framework*). These

are generally regarded as social, process skills integral to the initiation of communication demonstrating interest and attentive listening, however the participants appeared to be creating limits to their role in this particular scenario illustrated by the excerpts.

There are caveats to this suggestion which may influence the participants' perspective; firstly, that priming for the context may arise from the setting of the simulation (the media laboratory in the university teachings buildings-implicit context?). By using an office setting more akin to a GP's surgery or an outpatient clinic, with an absence of emergency equipment, this creates anticipation of the type of clinical problem about to be encountered (see participant B's comment **). Secondly, the participants were all starting clinical attachments in year 3 in hospital settings indicating that the introductory and closing statement are adapted accordingly to the context in which they are currently studying. Lastly, both simulated role play and clinical examinations in the first two years of the curriculum are usually contextualised to the students' learning level using terms such as '*you are in a GP surgery and have been asked to see the patient before the doctor'.*

Clearly the participants are creating *boundaries* (Glaser's '*degree family'*) to the simulation by bookending comments which set *conditions*, namely whatever information is elicited from the consultation it will be imparted to the doctor, with the implication that decision making is deferred to them (*consequence* of this action). This implies that the participant is creating a *role boundary* which limits responsibilities to data collection during the simulation, without any recourse to significant diagnostic reasoning. Paraphrased in Blumer's language, the meaning of the consultation is to '*collect information and pass it on to more learned authority'* which begs the question, when does this behaviour stop and allow full exposition of the diagnostic reasoning process?

Within this comment there is considerable resonance with *Reporter-Interpreter-Manager-Educator* (RIME) vocabulary proposed as a feedback framework for students (De Witt *et al*, 2008), in that the study demonstrates students limiting themselves (mostly) to a reporter mode rather than going a stage further into interpretation which might elicit more diagnostic thought. This conduct also illustrates the theory of *Bounded Rationality* which sets behaviour with certain constraints and goal achievements, both in terms of individual behaviour, but also that of the organisation, and therefore the curriculum created by the institution in this case (Simon & Newell, 1972).

Condition setting was amply illustrated by another perceptive participant who had worked out the extent of the case scenario ahead of being involved in the simulation:

'I guess my questions were geared to something less than life threatening; once my thoughts were geared towards the problem it wasn't such an issue because I felt I was on the right track' -PB.

PB has anticipated the *means-goal family* relating to the remit of the simulation, correctly assuming that the case scenario would be something which would encompass prior knowledge. However, the context of the simulation was still in doubt (*definitions of the situation*). Equally the mechanism of setting limitations could be viewed as a *strategy* or way of *managing* the simulation (*Type family*) which ultimately leads to a more significant dimension, that of *negotiated order* which borrows from recognized sociological theory (Strauss, 1978), and which Glaser included in his *mainline family* of social order and interaction.

Alongside *context setting* two other properties emerged transiently in the initial stages of data analysis, but ultimately never became fully saturated from subsequent transcript analysis; these were the concepts of

(i) '*Calibrating performance against reality*' (which emerged from participant B's eloquent anticipation of gauging what sort of problem would form the focus of the simulation);

'My anxiety lay with would I gauge the correct severity of the problem. I am going to underestimate it because I know it is a problem that you would expect me to diagnose or you wouldn't give it to use; it can't be anything too serious or complicated but I don't want to underestimate the severity of this condition-he's talking and breathing and we're not in emergency ward '(PB).

(ii) '*Consultation viewed as data gathering without a diagnostic aim*' which also took root in PB's comments below;

'My aim is to gather information, because we're not supposed to make diagnoses, knowing that we don't know everything yet. I might think it's most likely to be one thing but there's a whole of other things that I haven't heard of that it could be, so I'm approaching it as the information gatherer and I've got to be more like a detective in that respect rather than giving a verdict, coming up with different options, my list is probably only a third of what it will be in years to come, so I'm trying to get as much information as is relevant to a tummy problem' (PB).

Both of these quotations from the same participant became peripheral to the property of context setting, but nevertheless gave an illuminating insight into one person's view of the interaction. The sub-properties in the data arising from context setting gave expression to the emergence of the transient property of *ontological insecurity*, giving rise to the idea that the participants create context for themselves which limits boundaries in role, thereby impinging on cognition and role parameters. They are in effect saying, '*my role as a medical student at this stage of the course means that I have defined parameters, both in behaviour and thought*'.

Ontological insecurity encapsulates Mead's view of 'self-concept' in that it questions how we come to view personal identity and role, and how that is influenced by interaction with others, and how we subsequently create the 'social self' (1934). The view of oneself is determined by a number of interactions and understanding of what is required by the institution and others (peers, teachers, etc) at any particular stage of professional development.

The ontological view would be underpinned in most circumstances by *epistemological limitations* i.e. the boundaries of biomedical knowledge at this stage of professional development, and the restricted experience of the clinical application of knowledge with patients, described by Eraut as 'professional knowledge and competence' (1994). This comment incorporates the theories of skill acquisition within professional expertise put forward by Benner (1984), the Dreyfus brothers (1986) and the normative process of cognitive expertise described by Schmidt's group (1990).

However, the epistemological ideas in **Table N** were poorly saturated from the data analysis and encompassed few comments about clinical knowledge deficits arising from limited patient contact and this resonates with Graber's findings that knowledge deficits represent only 3.4 % of errors in diagnostic reasoning (Graber, 2005).

Within the ontological perspective lies the central role of reasoning which encompasses inferences about relationships between things, events, and people (Mead, 1938). The constant reconstruction of meanings from experience described by Charon means that the participants have developed a role limiting mechanism at this stage of their development consistent with their limited exposure in practice (1979).

Table N: Limited reflections upon an epistemological base

Excerpts from data	*Analytical Memo*
"You don't necessarily know what to look out for *so you just ask general questions and hope that something comes up or something gets ruled out, sometimes makes one option more likely or less likely than it was before". (PA discussing 'ruling out mechanism' illustrating an epistemological deficit)*	Scattergun approach to collecting data due to knowledge issues
"Not exactly, no. I ***got a general idea since gastro is one of my weak points, I don't exactly know what I'm looking for or where I'm going*** *so I just go through the structure and see what comes up....it sets off a pattern recognition receptor". (PA)*	Participant defining weak knowledge base
*"****I'm not sure with GORD whether it improves after you've just eaten*** *or the timescale of it getting better or worse, and the fact that it's not gone away". (PF)*	Basic deficit in symptoms description for GORD
"This brother thing, this is ***where if I had better knowledge, knowledge of epidemiology and the hereditary link of stomach acid problems***	Epidemiological knowledge deficit
"To the extent that some pancreatitis which might be causing some pain, but because my ***knowledge isn't vast about how pancreatitis presents****, and I've not had a chance to see patients with pancreatitis". (PF)*	Poor clinical knowledge of pancreatitis based upon limited patient exposure

In order to compensate for epistemological and ontological insecurity they have used a contextualising mechanism to create negotiated, social order within the simulation which to some degree has been learnt from exposure to similar events in the curriculum (e.g. simulated consultation with actors in year 2).

However, the concept of negotiated order arose more from abduction than any significant saturation in the data in terms of explicit comments from the participants.

The memo below distils some of my thoughts during this part of the data analysis, before the key idea of compensation or adaptation was firmly adopted as a central dimension. Ontological and epistemological insecurity are very much features of a tenuous abductive idea without any theoretical saturation in the data.

Theoretical Memo
(March 2012)

Medical students at this stage of professional development work from a position of ontological and epistemological insecurity, being relatively unable to apply or combine theoretical knowledge with limited clinical exposure in Medicine. To compensate for this deficit they adopt a number of cognitive mechanisms such as learnt frameworks and heuristics (e.g. SOCRATES), and context setting. This provides some boundaries for action and thought including the role of diagnostic reasoning and the goal for history taking in the simulation. Negotiated order is required of the interaction with the actor and this provides a structured framework alongside the use of the traditional medical history format (TMH). Some of the mechanisms employed reflect a naive interpretation of key clinical rules e.g. 'rule in, rule out' strategy, cancer being the case limiting condition.

6.1.7 The 'contribution' of the physical examination

In conflating the ideas described in the previous subsections there was an awareness of the relative absence of one feature, coined a '*black hole'* in one memo; with the growing sense of reflexivity that emerged gradually throughout the data analysis, one property emerged as '*the elephant in the room'*. I became aware that during discussions with fellow research colleagues using GTT, my description of the findings *never included* how the participants utilised the examination features given to them after their initial diagnostic ideas were formulated, based upon the history alone. This prompted a further deductive cycle of analysis to determine whether this change in theoretical sensitivity was validated in the data, or as Charmaz suggests 'to illuminate variation and identify gaps that require elaboration' (2006).

Returning to the data on diagnostic opinions towards the end of the simulation (before the reflective discussions) might unearth data around the provision of the examination details. However, if theoretical sensitivity means awareness of subtleties in the meanings of the data, including insight and the capacity to understand features of the data (Strauss & Corbin, 1990: 41-47), then can this be extrapolated or abducted to data that implies a deficit? The potential risk in doing so was to force the data.

The first sub question from the research proposal (1.2) states: *To establish what features of a simulated consultation provide most information for the student to assimilate and process towards a tentative diagnosis.* Reflexive insight was enhanced by returning to this statement by challenging the implicit assumption in this statement written almost 2 years prior to the data analysis i.e. there was an expectation that examination features *would* play a part in the diagnostic process for the participants (as would be expected for an experienced clinician).

Table O: Perspectives on the examination features

Excerpts from data:
PB in response to researcher suggesting that she can ask about attendant examination features: *"**Physical exam not diagnostic tests? I'd want to know if his abdomen was distended".*** *(Researcher: 'He has epigastric tenderness, normal bowel sounds and no mass')* ***"Tender? General appearance and whether there is sort of guarding or things when you're touching....?*** *"**We talked about Bowel sounds and they're normal so we haven't got any obstruction going on.....** (pause) **....the most obvious things to me are whether there's a mass or a blockage, a hernia or ulcer, but as none of that seems as likely as gastritis due to alcohol I guess I've narrowed down in my mind too quickly , but it's all pointing that way now". (PB)***
When give examination details of the abdomen; ***"Definitely not any cancer but it solidifies the thought of a hiatus hernia, the location there, maybe gastric region 'cos that's just above the stomach".*** *(PI)*
"I guess I'd want to do a GI exam on her, I'd quite like to know how she'd respond to palpitation *(clear error in pronunciation)* ***of the stomach".*** *Researcher: 'I can tell you her examination shows epigastric tenderness on light palpation but no mass, and the bowel sounds are normal".* ***"Doesn't tell me a huge amount more does it? It tells me that there is tenderness in that area.....".(PD)***
"I'd like to examine her abdomen just to feel if there's any tenderness, a general feel of it, and her appearance, and maybe ask for a urine dipstix test if that's possible?." Researcher: 'Ok on abdominal examination, she has epigastric tenderness with no mass on light palpation, and her bowel sounds are normal." ***"Well that fact that he has epigastric tenderness on light palpation, that fits in with his story of having a pain in that area. Also the fact that he's not jaundiced at all would suggest if you were thinking some gall stone blockage or biliary colic, you may expect to have jaundice in that sort of area, so although it doesn't rule it out, it changes how kind of acute..... gall stones might be"***(fades away) *(PH)*

Although no clear properties emerged initially, when analysed further it appeared as if the data gathering process became *uncoupled* for most of the participants i.e. the relative comfort of the history taking process was high jacked by asking them for projected examinations details (**Table O**). This is rather starkly illustrated by the excerpt below. When prompted about what examination features would she like to ask for, PC responds (Pause for 9 seconds with sighs):

"I guess take a urine sample, a blood sample, but I'm not sure how you would test for peptic ulcers."

(Researcher reiterates that examination features can be supplied only)

"To confirm the area of pain, see if there's any swelling, or inflammation, rash". *(And goes on with Sigh)*

"Erm..... Well it isn't cancer, because that would be *(holding stomach; pause again)****.....there's no mass there.....possibly a build up of gas if it's there on light palpation". (PC)***

This particular example was notable for the long pauses whilst the participant considered what she wanted to gain from the examination features. It stood at one end of a spectrum of comments with the feeling that this participant was a loss to explore the physical examination features. All the discussions except one revealed a lack of systematic thought in approaching the examination as if the linking of sequences was disturbed by the changed contingency i.e. unexpected events bringing about a change in conditions (Strauss & Corbin, ibid, 143; Glaser, 1978).

This idea emerged from *my interaction* with the data yet my interpretation has been qualified by considering my reflexivity, leading to the premise that there is relatively less integration occurring when the parameters of the physical examination are being considered. By comparison with the diagnostic discussion *based upon the history alone*, the subsequent section discussing how diagnostic thought had been

influenced by the extra examination features was characterised by indecision and poor knowledge organisation (almost a ‘scatter gun’ approach?).

For example, PB was able to analyse her thoughts quite succinctly when asked about her likely diagnosis from the history:

“Erm, most likely Gastritis, but without any definitive tests you can’t say. I don’t think it’s GORD as it’s not eased by milk and persisting although there is still a chance that it’s manifesting itself slightly differently, but I feel that gastritis is the most likely”.

But when it came to ask for examination features the approach was far from systematic and intra-case comparison illustrated the disparity between the modes of enquiry:

“Physical examination not diagnostic tests? I’d want to know if his abdomen was distended. Tender? General appearance and whether there is sort of guarding or things when you’re touching?”(PB)

Similarly, PA demonstrates this disjunction between using historical data and examination details in a diagnostic context. The fist quote is her diagnostic decision based upon the history alone.

“I would be tempted to go down a gastritis route.
Excess acid irritating the stomach”

When asked about what examination details she would like her response lacks to same clarity of thought;

“I’d like to palpate the abdomen to see if there were any lumps and bumps, any type of anomaly there”

With one or two exceptions there is a sense that participants are reaching out for key pointers to exclude certain illnesses e.g. absence of a mass, presence of distension to suggest obstruction, or generic issues such as inflammation. The conversations also tended to revert towards the explanation on history alone without any integrated thought and blurred thought slipped into a discussion of

investigations occasionally. The systematic nature of the information gathering during the clinical history stood in stark contrast to the rather disjointed thought patterns when the subject of the examination features arose.

The temptation was to compare the findings with the research base which could be construed as ‘forcing the data’ (in particular the Four Stage theory of expertise). Current theory about clinical cognition has little specific to offer about the use of examination features *per se*, except that along with other features they play a part in the formation of elaborated causal pathways that link features of an illness together. In general, the participants’ use of the examination features available after the simulation represents a more chaotic picture, with poor propositional networks to explain relationships between symptoms and signs. It is far more likely that the limited exposure to examining patients in Phase1 acts as a constraint to integrating the physical examination with the features of the history.

6.1.8 Diagnostic Reasoning: Emergent Semantic Ideas and Organisation

Previous sections of the case findings have alluded to limitations in the reasoning processes where cognition is restricted by their inexperience in hearing descriptions of illness (particularly pain). Their reliance upon basic biomedical causality (predisposing or risk behaviour), and misinterpretation of conditional reasoning are examples of poorly developed cognitive strategies; however there are also fascinating insights into the emergent thoughts being demonstrated by the participants which do suggest higher levels of cognition (**Table P)**.

There are examples of a deeper level of interpretation of the symptoms (semantic analysis), what is meant by them, manner in which they are expressed, and the linkage between various parts of the history with inferences made from those observations. There is evidence from the transcripts of consideration of the content of symptoms i.e. the substance, but also at a deeper level the inference or related abstraction implied by the comment i.e. structural semantics (Greimas, 1983; Bordage & Lemieux, 1991), e.g.

"***Thinking fevers and pulse rates, that all seems to be normal for him, so*** *he does seem quite well on his general observations* ***despite his gastric tenderness which perhaps with more acute things he may not be"(PH).***

PH is making an inference that because the physiological parameters of the examination (temperature, pulse, blood pressure) do not show significant constitutional upset, this conveys an idea about what might be causing the problem. This is pitched at a general level of severity, demarcating something straightforward from an illness of more significance, and indeed a consideration of excluding illness of a more acute onset which often causes constitutional deterioration more rapidly. Similarly, PA's comment about a '***fever that would suggest a systemic thing'*** implies that the participant is generating a diagnostic hypothesis about systemic infection

which is ruled about by the absence of a fever and the fact that he '***hasn't seemed particularly unwell'.***

Table P: Semantic qualifiers

Examples of Semantic Qualifying statements	
Quotation	*Analytical memos*
"If there is epigastric tenderness and it came on whilst he was eating fatty foods....uhm... ***then he hasn't seemed particularly unwell, he hasn't had a fever that would suggest a systemic thing****".(PA)*	**Inference** about impact of illness systemically and with time i.e. semantic qualifiers (SQ)
"It wasn't something like one time food poisoning, ***it was getting worse and he considered it important enough to come to the doctor****". (PA)*	**Semantic Qualifier (SQ)**-this is an on-going problem of enough severity to seek advice
"That he's experienced this before and it's not a new dramatic thing to him, that he thinks it's serious enough to come, it hasn't cleared up like it did last time" (PB)	Teasing out the difference between an acute problem against a longer term (and persistent) problem= abstraction
"I certainly doesn't pin point anything for me. Thinking fevers and pulse rates, that all seems to be normal for him, so ***he does seem quite well on his general observations*** *despite his gastric tenderness which perhaps with more acute things he may not be". (PH)*	Inference about impact of disease in systemic terms (looking at the illness at a higher level)
You're looking at the fact that he's presented with this pain for five days and ***it's a fluctuating pain****.* ***I think that's an interesting feature, just trying to work out whether this is an acute pain or something that's more long term.*** *I thought that was an important thing to identify. (PH)*	**SQ- '**acute on chronic' analysis of the temporality of illness
"Perhaps it's got to the point ***cumulatively that drinking or eating this type of food has made it worse,*** *and the* ***condition's progressed......"****. (PF)*	Inference about escalation of illness
"Yeah, ***it made me realise that she was a serious case that had come*** *in, it was something that needed to be addressed straight away, that was the impression that I got more and more as it went on....." (PD)*	

In essence, the participant is making an inference from two bits of data on general health and coming to a conclusion about what sort of illness can be excluded (inductive strategy). This is in keeping with the idea that *semantic qualifiers* provide scaffolding for knowledge, and in this case *systemic* illness against non-systemic illness, characterised by the physiological parameters of the case (Bordage, 2007). Through a process of chunking various details together, there are occasional realisations of a 'tipping point' within the history, or a deeper appreciation of what this means for the patient and the participant.

*"I suppose that they were different**, this was a lot worse, and milk wasn't making this better, and the pain wasn't going away after 3 days but getting worse after 5 days,** made me think that maybe the things that happened before.....I don't know how to describe it**.....pushing towards something bad happening, something had pushed her over the edge; some sort of significant problem had happened within her abdomen" (PD).***

It also illustrates the richness of the meanings and understanding within the discourse of the consultation (and subsequent reflective discussion), This richness is seen in more successful diagnosticians compared with less successful ones who fail to recognise the abstract semantic representations in the data (Bordage, 1986; Chang *et al*, 1998).

*"I'm thinking it's **related to the drinking, potentially the nurofen, and the smoking can irritate the stomach, and combined with food, spicy food & lost of food.** What he called indigestion I might agree with that" (PA).*

There is consideration of the representation of an illness at a higher level than a disparate mix of apparently unrelated symptoms, implying that causal networks are already partly formed and in some cases beginning to adopt an abridged form. In the quotation above there is compilation of the predisposing features encapsulated across the features of risk behaviour (drinking, smoking, food, and medication),

alongside other features in the history to provide an accurate pattern of an early 'illness script', with a diagnostic label of indigestion. What this exemplifies is an emergent ability of *knowledge organisation* i.e. pulling bits of data together that have a relationship using simple terms, and organising them into a format that approximates the features of a defined illness (**Table Q**).

Table Q: Knowledge Organisation and Flexibility

Excerpts	***Analytical comments***
*"I suppose so there is **so much information coming at you at once you want to organise it a little and take it one at a time instead of trying to do everything at once** and forgetting important details and also you want to cover all the posts and I find it helps with structure, just to have it there". (PA)*	***Labels and Memos*** Coping with amount of data in **working memory** and Knowledge organisation
"...but I do find it difficult to hold all that information in your head at once, particularly when you're seeing lots of different patients elsewhere". (PH)	**Limits of working memory** i.e. Bounded Rationality (Simon & Newell). Knowledge organisation
"Like certain things like the presenting complaint that I was discussing later on in the consultation, even though the general flow has moved away, but I felt that they were important to clarify even though it wasn't necessarily in the right place. So I think comes with practice and make sure you're trying to cover all the areas".(PH)	**Flexibility** of thought and **looping** back to presenting complaint
"He said something that I could back to, plot it in, organise my mind a bit, hopefully not miss things out". (PA)	**Flexibility and looping** back to confirm information
*"…….but **I struggle with the overall picture, rather than I think of just one question and its response and focus in on that one piece of information rather than everything that they've told me".** (PI)*	**Limited flexibility** implying problem with globalising problem and retention of data.
Just to ask questions that are relevant to the information being given and try to tailor the questions along the way to the information that I'm getting throughout the interview, whilst at the same time trying to stick to some structure (PI)	Limited remit and restricted **flexibility of gathering data** whilst at the same time keeping structure

However, as we have already seen knowledge organisation is still reliant upon cognitive strategies to act as failsafe mechanisms, and various quotations endorse the idea of limited flexibility in thought, at least sufficient to move significantly away

from the main framework for the consultation if the actor leads them in that direction. This implies that the participants are still reliant upon the TMH as 'scaffolding' to keep them on track during the consultation, ensuring that they have covered all of the sections pertinent to the problem at hand, and conferring a mechanism which in part controls the considerable amount of data evolving from the consultation.

Within the organisational features bestowed by using mental scaffolding such as the TMH format is the ability to enable *looping* which appears to acts as a deductive mechanism, allowing the participant to revisit previous information received earlier in the consultation for the purpose of clarification or corroboration. Clarification and looping were seen frequently during the simulations illustrated by these quotations:

"He said something that I could back to, plot it in, organise my mind a bit, hopefully not miss things out". (PA)

"I think really trying to keep the structure because that gives it a more fluid (rolls hands over one another), and there were times when I was coming and going a little bit,....., it's not necessarily going back and forth that's the problem, sometimes you need to, it's making sure that you are really thorough when you do those things and really cover everything you want to. Just sometimes taking a step back and saying 'I've got this, this, and this', what more could I wanting to ask that's relevant? (PH)

PH conveys the idea that going '*back and forth'* in the history' is expected (looping), but rather this is facilitated by the structured format of the TMH which controls the parameters and components of the consultation or what PI calls 'the struggle with the overall picture' (cf. Benner's novice stage being reliant upon guidelines). He conveys the tension between emergent knowledge organisation and the relative lack of flexibility to respond in a fluid way to incoming information, and not to feel anxious about losing control illustrated by this quotation:

*"**In the middle of interviewing there's a lot of things going on in your mind, you think I have to get through everything else. Cos sometimes it's uncomfortable, I'm not that experienced in taking histories, and I'm not that comfortable in front of patients to***

take a pause to gather my thoughts, I always feel I have to keep going and asking questions". (PI)

However PI goes on to comment about the need to step back and take a pause in proceedings, signifying that she is considering her consultation style and making adjustments for future practice. This implies a higher level of functioning and reflexivity in learning from the experience and constructing a different way of behaviour. Allowing for the continued reliance upon a working framework typified by the novice stage of behaviour, the participants demonstrate reflection upon their actions with metacognitive concepts emerging in some cases, which suggest there are features comparable with the *Advanced Beginner* in terms of some of their thinking. Cf. Benner's Advanced Beginner: '*Can perform acceptably and, from prior experience, will notice recurrent, relevant, general characteristics of a situation, but needs support to prioritise'*.

One or two participants appear to be acknowledging some of the early characteristics of deliberative and metacognitive processes associated with controlling and directing one's own behaviour, with a view to restructuring data collection during the consultation (Schmidt *et al*, 1990; Schmidt & Rikers, 2007). Most of the participants' remarks refer to restructuring or organising knowledge rather than focusing upon the content, which implies they recognise that 'repackaging' or processing information is required through a more flexible approach to data collection.

6.2 Learning from the experience

One of the recognized outcomes of watching filmed interviewing is the impact of transformative learning utilising reflection upon action/performance (Mezirow, 1991; Schon, 1987). The reflective discussions provoked a number of issues including reflection upon performance, performance anxiety, learning to do things differently through intrinsic feedback (Laurillade, 1997), awareness of premature closure in the diagnostic process, active listening skills, and flexibility of thought illustrated by some of the quotations below (**Table R**).

Many of these properties reflect *assimilation* of the experience into the cognitive structures of the participant, but also changes in cognition as a result of the simulation experience (*accommodation*) e.g. PE's earlier comments in Table M about premature closure ("*making her mind up too early*") . She has recognized an error in her clinical judgment and processing of information which now provides a fuller understanding of how this can be corrected (constructivism). This is far more powerful as a message than listening to a lecture about premature diagnostic closure which would have little relevance without such an experience.

There are a number of themes which pervade the comments above, including the idea of managing time within the interview and not rushing the process of information gathering (linked to premature closure). Remarks about allowing space for more thoughtful and reflective ideas about *why they were asking questions*, rather than the taught behaviour of what to ask within the medical history; and finally the skill of active listening which resonates with the concept of cognitive management and ordering of information in short term memory.

Contrast this with the process driven behaviour usually demonstrated amongst novices and it suggests deeper thought about why such skills are important, and in

the case of active listening eradicating lapses in concentration which would lead to errors in information gathering.

Table R: Learning from the experience

Excerpts from data
***Thinking beyond the process of data collection**:* *"Learning to be more thoughtful about what you're asking patients and why you're asking...'cos in the first couple of year we've just been taught a list almost of what you need to ask. We're always being told what things are important to you. So we know you have to ask about family history, aspect of pain, drugs etc but were **not always taught why those things are important.** I think I'll learn to be thoughtful about asking rather than just asking blindly..." (PD)* ***Confidence/comfort within consultation-using time for organisation**.* *"In the middle of interviewing there's a lot of things going on in your mind, you think I have to get through everything else. Cos sometimes it's uncomfortable, I'm not that experienced in taking histories, and **I'm not that comfortable in front of patients to take a pause to gather my thoughts,** I always feel I have to keep going and asking questions. Maybe if I took a few pauses, although I had these ideas **throughout the interview I never paused and tried to couple my ideas together and think out rule something** 'cos I always felt the need to carry on questions, getting the time to **gather the information, and then at the end of the consultation you've got more pieces of information**".(PI)* Researcher; What insight has gained from watching yourself into taking histories, anything as a result of watching yourself back on this? *"I would say be more comfortable with the process but that comes from experience, **feeling comfortable table to take to take a pause to assimilate the information,** and also I've realised this prior to doing this today that at the end of the interview **I kind of rush through it,.....** just to feel more comfortable taking my time, **gathering my thoughts**.(PI)* *"I cringe when I watch myself, I seem really expressionless. When he was talking about drinking with his wife in the evenings and his mates, he meant most days. It's this need to feel that I push on with the interview".* Researcher: So you were so involved with the process that you didn't recognise something as an issue in front of you? *"Yeah. **That's not active listening towards the end**".(PI)*

As observed in other studies on simulation using retrospective discussions about decision making, the concept of *post-hoc rationalisation* was evident as illustrated by the first quotation below from PI (Schmidt *et al*, 1988: Norman *et al* 1989). Retrospective protocols are based upon discussion about what has already happened, rather than '*think aloud'* protocols which verbalise decisions/thoughts as they occur in real time (Higgs *et al*, Ch 17, 2008). It is evident that watching the simulation back elicited different diagnostic ideas when compared to the real time footage.

On several occasions this process was demonstrated and clarification sought by the researcher as to whether diagnostic reasoning was in real time or retrospective. The participants were generally very honest in their appraisal of retrospective thought and admitting to revised diagnoses during the reflective discussion (post hoc rationalisation), and appeared to recognise that this was an inherent part of the process without fear of assessment or criticism. When Participant I was reminded that neither of these two diagnoses were mentioned during her initial diagnostic formulation and that she was rationalising after the event...

"I know (smiling.) So PU (peptic ulcer) or HH (hiatus hernia) can be aggravated by various foods at the party and also he was drinking alcohol, both of them can be aggravated by it, aggravated by acidic food or drink. So also the milk was a neutralising effect and the location was the stomach, so all those three things come together".

Later this comment was added about her realisation of the importance of the impact of the NSAIDs upon the stomach problem:

"I did elicit that he was taking the painkillers for his knee, my impression was that he was taking for his knee, not his stomach. But I should have asked him how long he had been taking the painkillers 'cos now I'm thinking NSAIDS and GI disturbance and at the time, I wasn't! That's like a key thing". (PI)

Similarly, Participant D made this comment about the drug related risk factor never considered in the original diagnostic formulation;

"She seems to suggest that she's taking quite a lot of Nurofen for her knees, and that cause gastric ulcers and things like that, in the stomach, in the abdomen; so now I think about it maybe that could be the issue." (PD)

One of the significant issues arising from explanations after the event is that participants 'descriptions of decision making during the simulation process can be altered by retrospective rationalisation. The participants have recognised their own individual learning needs through a safe and positive environment of the reflective discussion without any negative feedback. Although debriefing with feedback has been highlighted as the 'most important phase for determining clinical judgement' and allows reflection upon learning, this group are achieving this task intrinsically (McGaghie *et al*, 2010; Lasater, 2007). Although this study gave participants the opportunity to opt for a debrief after the reflective discussion (off film), it is clear that the intrinsic conversation that the participants have with themselves during the reflective discussion acts as a form of substantial feedback on the experience, with constructive ideas for future practice (Laurillade, 1997).

In this respect, all of the features mentioned above reflect adaptations in conceptual structures in response to watching back the simulation, and a rationalisation process during the reflective discussion (Bradley, 2003). This idea supports the premise that patient simulation promotes transformative learning through the construction of different cognitive strategies toward becoming an independent practitioner (Parker & Myrick, 2010) and incorporates the suggestion that learners '*construe, validate, and reformulate the meaning of their experience'* (Cranton, 1994: 22). It also resonates with the interlinked concepts of cognitivism and symbolic interactionism which suggest that learners construct new ideas through their interaction with the world (in this case the simulation) through internal mental processes (Blumer, 1969; Bruner, 1966).

6.3 Summary of Findings

The themes that have been discussed create a landscape of interlinked ideas emanating from the reflexive discussions and my interrogation of the data. The various properties arising from the study have generated a significant pattern of related concepts which appear to fashion a substantive theory describing their thinking in the context of the simulation, even though the participants' views about their *global understanding* of diagnostic reasoning are insufficient to attain theoretical saturation.

Two key dimensions emerge from the findings: The first dimension suggests that the participants are using ***intermediary adaptive mechanisms*** within the simulation by employing a number of (learnt) cognitive strategies, and therefore by proxy to any other stand-alone experience involving diagnostic reasoning. However, some of these strategies are poorly refined without full understanding of guidelines and probabilities; this is having an impact upon conditional reasoning which will be discussed in the next chapter.

In varying degrees, these strategies include *context creation* within the simulation which appears to limit role and expectations to passing on data gained from the consultation process. As might be anticipated the participants display *reliance upon learnt framework*s to facilitate and organise the cognitive load created by the influx of information. Immersed within this sudden influx the features of *risk behaviour* (hard data) appear to be used more effectively as causal attributes in the explanation of disease compared with the subjective features of the pain descriptor (softer data unsupported by experiential knowledge?).

The combination of causal attributes conveys more about the development of pattern recognition and chunking of key information by the participants within the clinical history, and by comparison, there is *no significant integration of the physical*

examination features as part of any clinical pattern. The *'black hole'* suggested in the data around the interpretation of the physical features in the case descriptor provided both an examination of my reflexivity, and a stark comparison with the fluency of using features from the history.

Furthermore, the findings provide some important evidence of how adaptation can sometimes contribute towards cognitive errors through the examples of '*naive cognition'* which are underpinned by erroneous anchoring judgments about disease probability (base rate neglect). This is a significant finding as it provides a picture of what can go wrong in data interpretation at this early stage, why it is happening, and how adjustments in teaching methods may provide better understanding of some important clinical concepts.

The *second dimension* confirms that learning from the experience is evident in the reflexive discussions and facilitates intrinsic conversations where clinical practice can be reconstructed by the participant (i.e. Transformative Learning). Within this dimension, there are indications of the appreciation of semantic qualifying statements and higher cognition demonstrated in the quotations, leading to deliberative questioning of aspects of diagnostic practice e.g. premature closure. When considered in the context of the Dreyfus model of skills acquisition this suggests that some areas of cognition have out stripped the novice stage.

Chapter 7 will enlarge upon these points and link the relevant findings to the original research questions.

7 Chapter 7: Discussion

7.1 Link to the research questions

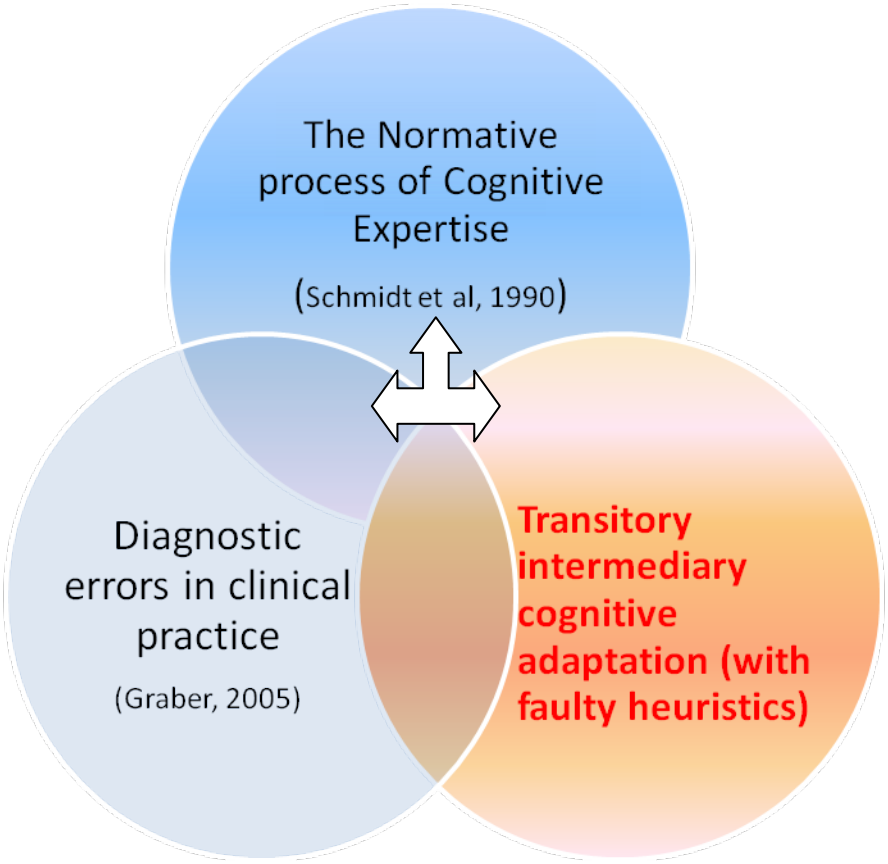
If the ideas within this study are going to be useful, they need to inform future practice (both the students' clinical practice, and the teaching practice of faculty) and create some original thought which furnishes new views on current theory. Any theory must have credibility through utilising a rigorous research process, in this case using the constant comparative process across data from all the participants with theoretical saturation in the key themes (Glaser & Strauss, 1967). The high fidelity simulation approach used in this study has high face validity and it can generate practical solutions to the problems through its influence on the researcher and subsequent teaching in the curriculum.

The original research question posed in the research application was 'How *do novice medical students approach diagnostic decisions and what factors contribute to this process'?* This was broken down into the following sub-questions which were used to explore different aspects of the domain through data from the simulations and reflexive discussions:

- *'What features of a simulated consultation provide the most information for the student to assimilate and process towards a tentative diagnosis'*
- *'How the diagnostic process is constructed from the perspective of the student'*
- *'Are the students able to analyse decision making and stimulate learning?'*
- *'What dimensions can be drawn from the data to provide a more effective theory through which we can understand diagnostic reasoning at this stage of learning?'*
- *'How can teaching methods be further developed to acknowledge the student perspective?'*

The case findings and dimensions of the data will be discussed in the context of the questions in the next four subsections, however the most interesting and thought provoking data from this study arises from the properties labelled '*Naive Cognition'*, and the '*contribution of the physical examination'*. These are both areas which have redefined my thoughts about what is going on in these participants' minds and provide clues as to how they attempt to cope with a fairly new situation in their professional development i.e. stand alone decision making.

Figure N: The substantive theory of intermediary cognitive adaptation alongside other theory



The property of naive cognition contributes appreciably to the substantive theory which suggests that a form of **intermediary cognitive adaptation** is occurring at this particular transition in the curriculum. Some components of this adaptive

process provide an effective support mechanism, others less so. Although this transition is associated with cognitive heuristics which have been encompassed under the term '**naive' cognition,** it does provide a possible link between cognitive expertise expressed through the normative theory, and how errors might originate in subsequent practice (**Figure N**).

Naive cognition reflects a lack of understanding about disease probability and the anchoring judgments that accompany this train of thought (base rate neglect). Subsequent anchoring judgements should be informed by future teaching and most importantly by experiential knowledge gained through patient encounters. However, these participants do not have this luxury at this stage in their development and therefore have to rely upon strategies which are not fully developed or indeed understood e.g. the law of restrictive rule outs.

The phrase, '*rule in, rule out'* appears to be applied with poor discrimination to factors in the narrative and examination without due understanding of the underlying guideline. It conveys a sense of 'black and white' thinking with clear boundaries where individual features of disease are not interpreted through either patterns or indeed using probability. This is not surprising as the participants do not have the benefit of the larger contextual picture created through extensive situated learning in clinical practice (Lave & Wenger, 1991; Durning *et al*. 2011).

In contrast, data gathering reliant upon frameworks appears more robust than the foundations of the participants' conditional reasoning facility. The reliance upon taught frameworks and mnemonics appears to be providing a fallback position in data collection whist they bridge a gap in cognitive expertise where the repetitive nature of patient contact has not created 'automatic' practice. (Ericsson, 2004) These frameworks or schemes only appear to work for the history taking component of the simulation, and the same cannot be said of the way in which the physical examination details are integrated into the whole

picture alongside the history. This is where thought processes appear to become ‘uncoupled’ and the systematic approach used by the participants in history taking is not replicated.

The integrated curriculum approach involving early patient contact has not yet provided a platform through which the participants can start integrating the history with the physical examination. The assumption here is that further experiential practice will facilitate adaptive clinical cognition to replace these faulty heuristics later in the curriculum. These points will be discussed in the next section when the substantive theory will be compared to the prevailing theories on cognitive expertise, and where this study adds to current ideas.

7.1.1 Does this study construct a different view of diagnostic reasoning compared with other research?

The findings from this study provide a valuable counterbalance with existing normative theory through the examples of where cognition appears to *goes wrong*. In this sense it gives provides practical examples of how faulty heuristic thinking might evolve at this stage of professional development. Specifically it adds suggestions as to what may be happening during a transitional stage in development where there are changing expectations in a diagnostic role. Indeed, after the first clinical attachment in year 3 they are assessed using an oral, case-based discussion (CbD) which entails diagnostic justification.

This transition can be viewed from the dual perspective of their interaction with patients, and also what faculty expects of them in the assessment process i.e. they have moved from facilitated practice to 'stand alone' encounters with patients which entails diagnostic reasoning, rather than pure data gathering. Indeed this simulation is likely to be one of the first exposures to stand alone practice with the added burden of being asked to make a diagnostic decision on film.

Any theory purporting to explain how the participants cope in this relatively new setting, has to accommodate the idea of *transition* based upon what has gone before in the curriculum. The integrated curriculum approach provides early exposure to patient contact and amongst the benefits for this group of students appears to be the relative comfort in history taking, backed up by the learnt schematic frameworks; however, this is not demonstrated in integration of the examination features and this represents a divergence in using data of this type in diagnostic formulation. The propositional relationship between narrative cues in the history and the examination details is clearly less refined than the linkage visible in

the descriptions of the causal attributes derived from utilising risk behaviour. The next stage in the curriculum in Phase 2 (years 3 & 4) should provide enough exposure to allow better integration of the examination; however our participants are only just embarking on this transitional period.

Viewed from the perspective of social theory, this stage of professional development encompasses a change in the context of situated learning (conditions) i.e. a change in the interaction with patients and 'self-concept' (Mead 1934; Blumer, 1969). This also influences the development of thinking ability within the social environment (Meltzer, 1975), and the recognition of new symbols and language which involves reconstructing their meanings for ideas and terms through prior interaction (Charon, 1979).

The research perspective has been viewed through the theoretical lens of SI, so *what has been learnt*? The simulations strongly reflect data gathering influenced by frameworks such as SOCRATES and the discussions endorse this perspective. This implies that the meaning of the consultation is primarily data gathering, with little thought beyond that process. Other properties of the data such as context creation and role limitation are aligned to this suggestion. The participants do not appear to have a clear global perspective on the diagnostic process other than for occasional comments about the data gathering role which have not achieved theoretical saturation .

Several properties arise from the data supporting the central perspective of an *intermediate transitory adaptive process in cognition* allied to a specific learning stage (novice) in terms of professional development, and this also resonates with comments about finding a ' *self-image'* at various stages in professional assimilation and development (Becker *et al*, 1961). Although this stage does not appear to encompass a clear view in the participants' mind about DR, there are comments within the discussions which begin to acknowledge some of the basic

principles underpinning the diagnostic process e.g. problems with data gathering, premature closure and an increasing awareness of semantic understanding.

The cognitive errors associated with the property of *naive cognition* furnish us with specific examples of flawed interpretation of guidelines and conditional reasoning. These include a maladaptive way of using restrictive rule outs with leaps of faith in clinical cognition. Using the absence of a mass as a proxy statement for excluding cancer as the denominator for practice, implies faulty anchoring which might result in a heuristic error paraphrased as, *well if there is no mass it rules out cancer* (Edwards, 1968). Implicated in this thinking is the rule of '*modus tollens'* with up to 30% error rates (Evans, 1989; Eysenck, 2001: 358-60) and this includes the faulty inference of the '*denial of the antecedent'*.

Example.

Premises:

If Fred has an abdominal mass, he has cancer.

Fred does not have an abdominal mass

Conclusion

Fred does not have cancer

This is a fairly stark example but nevertheless illustrates how conditional reasoning may influence diagnostic thinking based upon one examination feature. It also resonates with the concept of '*weighting*' of key features within any illness script and the relative importance attributed to specific symptoms and signs as described in Judgement theory.

The examples of faulty cognitive adaptation and interpretation arising from the data analysis provide a further perspective on the contemporary views on the development of diagnostic reasoning in the literature (**Figure L**). It links the prevailing views on the normative reasoning process described by the '*Four Stage Theory of expertise'* (Schmidt *et al*, 1990) with the faults seen in cognition during undergraduate training that lead to the pitfalls associated with cognitive errors seen

in practice amongst qualified doctors (Graber, 2005: Norman & Eva, 2010). This provides *convergence* between the substantive theory of this study and prevailing theories on cognitive expertise, skills, situated learning and memory.

This suggests that abnormal heuristics are already evident in the novice stage of professional development. It is not merely that novice students have difficulty organising and integrating knowledge, and are reliant upon frameworks to reduce the cognitive load during the consultation, but there are some very obvious misconceptions about disease probability which in some domains acts as an abnormal anchoring judgement. This could be predicated by providing a more effective idea on disease probability when biomedical concepts are integrated into clinical teaching. This will make more explicit the constructive links between biomedical knowledge and clinical cognition and their combined contribution towards diagnostic justification (Cianciolo *et al*, 2013).

Intermediary cognitive adaptation can be viewed from a number of interactive perspectives: *firstly,* it acts as compensatory mechanism for the lack of clinical knowledge, and the relative inability to integrate clinical information with biomedical knowledge into elaborated causal pathways (encapsulation). This is illustrated most effectively by the prominent use of risk factors (smoking, alcohol, etc) in chunking key features of the history, rather than interpretation of the features of the pain. Such data is more objectified and is easier to assimilate compared with subjective narratives of pain which requires exposure more clinical exposure.

The quotation from PA amply illustrates this point which is based squarely on the risk factors for disease rather than interpretation of the characteristics of the abdominal pain (PA's opening comments as to what she thinks is wrong with the SP).

*"I'm thinking it's related to the **drinking**, potentially the **Nurofen**, and the **smoking** can irritate the stomach, and combined **with food, spicy food & lots of food**. What he called **indigestion** I might agree with that."*

An expert would rapidly compare the features of the pain with stored scripts exemplifying the same condition and look for discriminatory cues in the description (pattern recognition/non-analytical cognition). However, our participants do not have an extensive store of such pain descriptors (exemplars), and therefore resort to what they have been taught about risk factors in the causation of disease i.e. 'enabling factors' in Illness Script theory. This way of representing causation of disease aligns with the '*essentialist*' view of illness characterised by basic biomedical terminology (the underlying patho-physiological 'fault'), rather than the '*nominalist*' view at a syndrome level exemplified by experts who use the consequences or symptoms and signs based upon extensive exposure to similar events (Norman, 2000).

Secondly, cognitive adaptation is facilitated by, and reliant upon the use of learnt frameworks and heuristics mechanisms which provide security and accessibility in terms of structuring information gathering in working memory i.e. a *failsafe mechanism* which they can fall back upon. This provides a stable platform whilst communication skills and confidence are still evolving in encounters with patients through which students can learn to become more flexible in their interactions.

Thirdly, this study provides ample evidence of ways in which the participants are reconstructing ideas through reflection upon the simulation i.e. transformative learning, which is inherently dependent upon the ability to invoke cognitive adaptation (see 7.1.3). Included in this section are ideas around the reasons leading to avoidance of diagnostic errors (i.e. premature diagnostic closure) such as rushing to confirm one diagnosis. Equally, they are able to reflect upon creating time for themselves within the consultation to promote reasoning that is more effective.

Tempered against the advantages of cognitive adaptation are the apparent '*outliers*' in the data which illustrate the adoption of faulty adaptive processes or misinterpretation of guidelines and rules (labelled as naive cognition). These have most significance to the teaching of clinical skills and the avoidance of faulty heuristic mechanisms. Indeed, they represent the difficulty in assimilating taught guidelines into decision making without the benefits of context driven clinical exposure. This resonates with being on the cusp of the '*advanced beginner'* stage base upon the Dreyfus model of skills acquisition, as an individual who can formulate ideas that dictate actions in terms of some attributes, but clearly cannot encompass all the features of such guidelines, hence they make errors in interpretation (Dreyfus & Dreyfus, 1986; Benner, 1984: 22).

The role of context and clinical experience create the background and expertise in being able to interpret clinical guidelines, however these participants are not in a position to do this. Knowledge of the background probability of disease is yet to be constructed through experiential contact and therefore anchoring judgements are impossible to estimate. Diagnostic errors will therefore arise from a number of sources including faulty data interpretation from the history (e.g. rushing through without active listening), insufficient knowledge (e.g. clinical knowledge of pancreatitis), premature closure, anchoring judgements for disease probability and lastly faulty interpretation of rules (e.g. Murtagh's Law).

The influence of teaching and books can be seen in the anchoring statements used by the participants (e.g. cancer used as a 'worst case' scenario or the diagnosis that has to be excluded first of all). In one of the key texts recommended in reading lists throughout any module in the curriculum ('*Clinical Medicine',* Elsevier*),* the chapter on gastrointestinal disease opens with the following paragraph, *'The clinician's main task is therefore to separate out the patients who require investigation, remembering that 20% of all cancers occur in the gastrointestinal tract' (*Kumar & Clarke, 2005).

With this salutary statement, the reader is immediately given the impression that the ‘bottom line’ in decision making is to exclude cancer and investigation is a key sorting component, and is a view written entirely from a secondary care perspective. It is not surprising that the limited exposure to primary care at this stage of the curriculum is not able to counterbalance this view (‘common things are common’ e.g. dyspepsia due to dietary impropriety with medication, not due to gastric cancer); however it does provide an indication of where the participants’ perspectives are being influenced.

7.1.2 What features of the consultation provide most information towards a tentative diagnosis?

It has been suggested that some 70-80% of diagnoses arise from information collected within the medical history rather than via the examination or subsequent investigations, although this research is dated , was based in secondary care setting in Neurology outpatients, but has been propagated ever since as a central tenet in gathering information (Hampton *et al*, 1975). This study demonstrates that these students rely heavily upon features gathered from the clinical history to provide the main diagnostic cues, yet illustrate difficulty integrating the features of the examination that were provided after the simulation. The properties of the data from the first iteration onwards point towards reliance upon *narrative* features (i.e. the story that unfolds from the conversation between the actor and the participant). The participants' interpretation of this information is what occupies most of the data analysis, beginning with the use of the learnt frameworks such as SOCRATES and the traditional medical history.

The relative absence of discussion about the examination features makes for a stark contrast in the data analysis, and although may appear a divergent property, it actually reflects the lack of integrated pathways in causal networks. The '*black hole'* discussed in the case findings was a term deliberately adopted for an area that pointed towards an undeveloped cognitive skill at this stage of their professional development i.e. being able to link examination features to the clinical history in diagnostic terms. The manner in which the participants asked for, and then utilised the material provided in the examination features generally illustrated an inability to chunk the examination features with those in the history, with a tendency to resort to asking about diagnostic tests first.

The general fluency demonstrated by the immediate use of the TMH and SOCRATES during the simulated consultation illustrated a disparity when compared with the hesitancy in engaging with the examination features. This might indicate that the relative lack of exposure to examining patients within the curriculum prior to this study results in poorly developed propositional networks that relate things to each other i.e. symptoms to signs.

The consistency in using learnt frameworks and a specific mnemonic for subjective complaints during the clinical history indicates a more systematised approach to data collection, with well-defined cognitive structures being utilised. However this is not reflected in the discussions about the examination features meaning that abridged networks (including examination features) explaining both symptoms and signs under a diagnostic label, are not well developed in this group of participants. Indeed provision of examination material often invoked examples of naive cognition such as ‘leaps of faith’ (around the absence of a mass), exemplifying faulty conditional reasoning and anchoring judgements.

7.1.3 Can students analyse their own decision making through reflective analysis?

One of the central tenets of the undergraduate portfolio at the medical school is to foster critical reflective practice. Schon describes this as, ' *the process of internally examining and exploring an issue of concern, triggered by an experience, which creates and clarifies meaning in terms of self, and which results in a changed conceptual perspective'* (1987) This references the aspirations of the GMC for the doctor as a professional (GMC, 2009), but also allows the individual to gain awareness of assumptions and biases influencing decisions in clinical practice (Sandars, 2009). The participants in this study will have completed several reflective assignments as part of their engagement with their professional portfolio before this study, and therefore should be familiar with the processes involved in reflective practice.

It is therefore reassuring to find that the participants are able to discuss learning from the experience, and more specifically illustrate *Transformative Learning* which leads towards constructing future practice (Mezirow, 1991). This applies to issues such as premature diagnostic closure, structuring the consultation process, monitoring thought within the simulation (metacognition), and the emergence of flexibility of thought which some quotations make reference to.

"Learning to be more thoughtful about what you're asking patients and why you're asking...'cos in the first couple of year we've just been taught a list almost of what you need to ask. We're always being told what things are important to you. So we know you have to ask about family history, aspect of pain, drugs etc but were not always taught why those things are important. I think I'll learn to be thoughtful about asking rather than just asking blindly..." (PD)

The quotation from PH above shows a degree of reflection upon the differences between *asking what*, and *asking why* during the medical history which implies reconstruction of motive within the questioning, and also a reflective observation on the influence of teaching.

Quotations such as this can have a significant impact upon the bearing of teaching communication skills, moving away from purely procedural skills towards skilled communication as a creative art with humanising sincerity (Salmon & Young, 2011; Silverman et al, 2011), and this has already been incorporated into the teaching programme as one of the pedagogical changes emanating from this study.

Similar properties reflect *assimilation* of the experience into the cognitive structures of the participant (in this case *asking why* more often). Movement towards more considered thought during history taking (*accommodation*) is aptly illustrated by participant E's comments about '*making her mind up too early*' i.e. she has recognized an error in her clinical judgment and processing of information which now provides a fuller understanding of how this can be corrected (constructivism).

Such cognitive mechanisms provide encouraging evidence for the use of high fidelity simulation in challenging behaviour, but also suggest that some participants are moving out of the novice stage of expertise towards becoming an advanced beginner i.e. '*Can perform acceptably and, from prior experience, will notice recurrent, relevant, general characteristics of a situation, but needs support to prioritise* '(Benner, 1984: 22). The participants discuss the characteristics of the situation with respect to their own thought processes and consultation skills as well as discussing how they put together the diagnostic puzzle together.

Indeed self- explanation of problem solving has been used as an instructional strategy to improve diagnostic performance in year 3 medical students in a PBL curriculum using written cases, without resorting to any feedback process from faculty (Chamberland *et al*, 2011). Examples of written diagnostic explanations

(protocols) were found to improve learning from verbalising diagnostic thought, but only for more unfamiliar cases.

Similar protocols are seen in the transcripts from this study, even though the particular representation of dyspepsia shown below was not viewed in this way at '*first pass'*, it illustrates an effective explanation of disease for the participant to take forward into practice. By recognising a diagnostic error during the reflexive discussion, this participant has reconstructed a pattern of features which elaborate upon his original view during the actual simulation (Schmidt & Boshuizen, 1993). Post-hoc representation of the simulation from PI was verbalised this way:

"So PU (peptic ulcer) or HH (hiatus hernia) can be aggravated by various foods at the party and also he was drinking alcohol, both of them can be aggravated by it, aggravated by acidic food or drink. So also the milk was a neutralising effect and the location was the stomach, so all those three things come together".

Such examples are aligned to the constructivist perspective relating to simulation, in this case at a refined level representing the participant's view of dyspepsia, albeit reconstructed through the reflexive discussion (Bradley, 2003). It also resonates strongly with reflection on action in thinking about the situation differently (Schon, 1987). This may include more awareness of situational components developed through prior experience and may explain why the participants have sought to limit the context of their simulation.

7.1.4 What impact does this study have upon teaching methods?

One of the core messages from the University of Brighton's Strategic Plan (2012-15) is to '*deliver a transformational student experience founded on research-informed learning'* with a commitment to '*using staff based research in the curriculum'* (University of Brighton, 2012).This statement represents the ideological basis of a professional doctorate by informing teaching and driving developments in the curriculum. Adjustments in teaching in both the domains of communication and reasoning have already been instituted during the timeframe of this thesis as a direct result of the emergent findings.

Firstly, the clinical history taking series that runs throughout Phase 1 now goes beyond the 'reductionist' approach of merely instructing students *what to* ask of the patient. It now goes beyond this to ask *why* we ask specific questions about illness. It is hoped that this change in emphasis will align itself with the central themes of reflective practice from the undergraduate portfolio, and at the same time engender *thoughtful reasoning* in due course (Mamede *et al*, 2008).

If the values of reflective practice upon clinical judgment and medical expertise are to be believed, then the combined aspirations of the undergraduate portfolio and teaching on reasoning should provide a beneficial platform in constructing the skills of deliberate induction and deduction. This means the *deliberate willingness to search for alternative hypotheses* and their consequences and thoughtfulness in effortful reasoning (Mamede & Schmidt, 2004). In this way medical students and doctors can critically examine their own decision making processes, particularly beneficial for more complex examples of case processing. Further work to develop formal theory on the potential link between these two features may be productive. However, engagement with reflective practice is often regarded initially negatively early in the curriculum and accompanied by mixed success, replaced eventually by

a more positive attitude later on (Driessen *et al*, 2007). This observation from various studies may represent the different motivational drivers for learning at points in the curriculum, and may also indicate the influence of the spiral curriculum in revisiting topics at greater levels of depth and relevance (Askell-Williams & Lawson, 2006).

The reflective discussions within this study have reinforced the values of reconstructing practice for the participants illustrated by such phrases as '*not rushing things, standing back, giving myself more time, be more thoughtful, listening more effectively'*, made in response to analysing simple process skills in the consultation (which might be termed micro skills in spite of their importance). In addition they are also developing metacognitive ideas on how time and thought can be managed more effectively in future practice, which equate with self-efficacies i.e. broader learning strategies or macro skills?.These skills mediate how students engage with studying topics in education, but also how they might engage with patients without resorting to a reductionist perspective of using standardised questions and responses which lack humanism (Elen & Lowyck, 1999; Askell-Williams & Lawson, ibid). Future modular development to include filmed simulations in formative clinical examinations (Objective Structured Clinical Examinations) with feedback from faculty has been suggested for inclusion in a pilot scheme or the academic year 2013-14.

Secondly, the theoretical load in the CR presentation in Year 2 has been reduced to focus upon relevant learning for the novice stage, and linked with a short, filmed consultation with explicit perceptual comments implanted in the video file as it evolves (which explains the diagnostic thinking of the clinician as the consultation progresses). The UKCC (UK Council for Communication Skills in Undergraduate Medicine) teaching package on Communications Skills developed for all UK medical schools has been instrumental in augmenting this part of the presentation. The main causes of errors in diagnostic reasoning that have been illustrated in the study have

been incorporated into a more explicit statement for this developmental stage i.e. focussing on issues such as *inadequate history taking* and rushing the data gathering process. Such advice relates closely to current activities in the 2nd year curriculum during primary care attachments when history taking opportunities arise most frequently. The advice is therefore both timely, linked to an integrated piece of work in the curriculum (Case based assignment in the portfolio), and relevant to the developmental stage of the students.

Thirdly, the use of filmed simulations with feedback/discussion could be applied to reasoning in terms of therapeutic decisions and patient management at a later stage in the curriculum when issues of management and investigation are becoming encapsulated alongside diagnostic ideas (Norman, 2005: Monajemi *et al*, 2007). Most research in reasoning focuses upon the diagnosis as the end goal, and the role of integrating management issues with data gathering and diagnostic formulation has been largely ignored. It ignores the common scenario of the 'unknown diagnosis' seen in about 50% of cases in primary care where no diagnostic label is applied (Heneghan *et a*l, 2009). Strategies used to define the final diagnosis may include further investigations, a '*test of time*' for self-limiting illnesses ('wait and see' strategy), and a '*test of treatment'* e.g. diagnosis of nocturnal cough caused by Asthma.

The therapeutic and investigatory components of patient management are largely taught in the 'clinical phase' in most programmes before the next significant professional transition (qualification) occurs (Teunissen & Westerman, 2010). It is assumed that synchronisation of diagnostic and management issues in case processing occurs at this stage, however research suggests that internists are quicker and use higher level inferences than final year students, implying that knowledge encapsulation with management issues is more effective in relative experts (Monajemi, ibid). Filmed simulations in examining the cognitive processes

associated with case processing using a therapeutic/management focus would afford a useful insight into a key professional role.

This study has confirmed the benefits of using filmed simulations using SPs in creating an opportunity for *facilitated, transformative learning*. Even amongst the examples of *post-hoc* rationalisation there is a degree of honesty which bodes well for reconstructing future practice. Transformative learning can influence both consultation skills and decision making at a key transition in the teaching programme when stand-alone practice becomes the normative process, albeit very tentatively. Similar benefits will be obvious to other healthcare professionals and generally in the broader field of education at various stages of expertise. With adequate briefing and preparation there should be no barrier to the value of high fidelity simulation used in a similar manner, or used to support vicarious learning in domains of practice where cognitive attributes are being considered.

The two constraints to the introduction of an equivalent process into curriculum design are logistics and time. Support from media services and acting groups have to be organised effectively to accommodate large number of students to replicate this type of simulated learning, although the use of *I pads* may overcome this problem. Furthermore, if explicit debriefing is intended then training for facilitators in giving appropriate feedback is essential using techniques such as ALOBA (Agenda led, outcome based analysis (Kurtz *et al*, 2005: 113-154). The emphasis must be upon building confidence, allowing the student to learn from intrinsic conversations arising from watching performance, and creating an ambience of constructivism for future practice, rather than a critical approach.

From an educational perspective, this study illustrates evidence of faulty heuristic mechanisms occurring at an early stage of professional development (e.g. worst case scenario of cancer used as an anchoring judgement), and there is no reason to deny that similar mechanisms may occur in other professions. This has considerable resonance across various domains in healthcare e.g. nursing, particularly where

situated practice is used in parallel with teaching of biomedical sciences without some explicit signposting as to how cognitive errors can evolve. In addition, teachers should be aware of the reliance upon frameworks and guidelines in novice practitioners, including how they judge when it is best to introduce stand-alone practice with an eye to monitoring cognitive skills, and how such exposure may subsequently influence patient care?

7.2 Reflexivity: how has this changed my perspective?

In parallel with the impact upon teaching methods, this study has realigned *my* perspective upon the introduction of teaching on diagnostic reasoning. Not least of which has been the increasing awareness that I have overestimated the participants' conversance with the idea of what is meant by a diagnosis, and similarly assuming that the exposures to practice during Phase 1 have given them more confidence in diagnostic reasoning than found in this study. The evidence from this limited sample of medical students suggests that they remain firmly in the novice stage of expertise, reliant upon frameworks and mnemonic devices for stand-alone clinical practice. However, some quotations suggest they are developing cognition comparable with advanced beginners and the reflective discussions have unearthed some thoughtful observations upon individual cognition and practice. *Would these observations or intrinsic conversations have occurred without involvement in the study?* The results appear to suggest that we (faculty) can do more to provide similar experiences to promote these ideas in the minds of our students.

Over the last three years since reasoning was introduced into the Phase 1 curriculum, my theoretical anchorage has changed as a direct result of this study (Schatzman, 1991). There is considerable resonance between the concept of '*Natural Analysis'* and the diagnostic reasoning process. The latter may be regarded as a natural extension of an individual's innate powers of natural analysis and provides a clue towards the idiosyncratic nature of some reasoning ability. In this respect, my position as a researcher using dimensional analysis for the first time has moved me back into *novice* mode, and thereby allowed me to gain a better appreciation of the perspective of the participants with respect to the reasoning process. It has provided a warning not to make assumptions about how others think, and this concept is paramount when planning new ideas for the curriculum aimed at

developing cognitive skills. During the analytical process when momentum was pedestrian, my analysis was facilitated by conceptual levers (Glaser's coding families). His coding families acted as a framework or guideline to accelerate the data analysis and also structure my thoughts. Similar levers can be sought to provide different perspectives on experiences in the curriculum for students e.g. portfolio assignments.

My use of conceptual levers within the research process is comparable to the use of mnemonics and history taking frameworks used by the participants i.e. they both **guide and limit** exploration of ideas by creating parameters for use, and by opening up ways of looking at data (symptoms and linkage). These mechanisms could reasonably be represented as scheme inductive reasoning in that they provide the basic framework for organising and collating thoughts through the information received from the simulation. Furthermore, I would hope that the introduction to clinical reasoning in year 2 also acts as a conceptual lever for the student cohort, providing an opportunity to think more effectively about their decision making and suggesting ideas about framework mechanism to guide thinking.

The study has augmented an appreciation of the peripheral factors associated with communication and reasoning by adopting a more sociological perspective of the interaction called the 'medical consultation'. If the central tenets of symbolic interactionism are applied to the findings of this study, the meaning of diagnostic reasoning is not cemented in place yet for these participants, and the interpretive process that '*shape, handle and modify the meanings of the things for them*' has a transitional component which is adaptive and cumulative. The multiple realities suggested by Charmaz are not static and the interpretative processes than the participants depend upon are reactive, constantly realigning understanding through changing knowledge, experience and context (Charmaz in Morse, 2009).

7.3 Strengths and limitations of the study

This study has illuminated some of the cognitive strategies associated with diagnostic reasoning as seen through the 'lens of the student', and has provided an insight into the specific features associated with their cognition at a key transition point in the curriculum where changes in role and expectation are considerable. The conceptual framework using Symbolic Interactionism is appropriate to the research questions and provides congruence with Dimensional Analysis as a research approach to build theory. Procedural precision has been maintained through the use of the constant comparative process, comparing emergent ideas and properties across the participants to allow theoretical saturation of the themes discussed in the case findings. Methodological rigour has been achieved through acknowledgment of prior theoretical anchorage utilising memos with sufficient reflexivity, with the outcome that empirical data is not biased by my perspectives.

Logical connections or resonance exists in most of the case findings with the theories relevant to this domain (convergence), which strengthens the theoretical congruence of the study without falling prey to the concept of 'forcing data' (Glaser, ibid). The substantive theory illustrates alignment with prevailing theories which include the skills acquisition model (Dreyfus & Dreyfus, 1986; Benner, 1984), the development of the cognitive perspective of expertise (Schmidt *et al*, 1990), Schon's work on reflection (1987), and the formal models in cognitive psychology which include the use of mnemonic strategies in facilitating memory (Levin, 1993; Cowan, 2001).

There are no significant deviations by comparison with current theory, although two new findings have emerged in cognitive behaviour that can be seen to constrain the performance of the participants at this stage of professional development (based upon the examples of *naive cognition* and the *lack of integration with the physical examination*). These particular findings have created an important link between the

normative theory of cognitive expertise and the errors seen in clinical practice amongst qualified doctors (Graber, ibid), as it suggests the manner in which errors in anchoring judgements are already developing in medical students. Even in a small sample, the ramifications of this sort of reasoning are significant for future clinical practice and therefore one of the strengths is the relevance to professional practice. As a consequence the impact and nature of clinical teaching in the early stages of the curriculum can be re-examined and modified to minimise the development of fault heuristics in anchoring (the '*raison d'être'* of the professional doctorate).

Good face validity has been achieved using a high fidelity, simulated environment of this type, reflecting an office based setting as would be seen in General Practice or a hospital clinic. It also demonstrates both process and content validity, in that the data generated in the simulation provides an accurate representation of their performance, but without assessment criteria being used (Andreatta & Gruppen, 2009). The case scenario was developed through a small expert group with considerable clinical experience, and is appropriate to the biomedical content in the curriculum. It also reflects the procedural skills taught in teaching clinical practice i.e. contextual validity. However, it covers only one domain of clinical practice and therefore its content specificity is limited as reasoning ability is known to vary across case types (Elstein *et al*, 1978; 292-94).

The participant group is by necessity small using a grounded theory technique without the use of a translation product such as 'Envivo'. An explicit decision was made early in the project not to use this method of data capture, and transcription was done wholly by the researcher in order to view the non verbal cues that might provide further data to incorporate into the data analysis. The limited generalisability provided by a qualitative study of this nature and size is a potential limitation; however, the study has generated immensely rich data from which to draw out emergent themes with appropriate theoretical saturation in the areas discussed in

the case findings. Recruitment of participants was more challenging than first assumed, and the timing of the simulations coincided with the start of the transitional modules in Year 3, providing competition with availability and free space in the media laboratory. In theoretical terms, the timing was ideal (the start of a key transition), however for recruitment purposes this was less than ideal and the intended participant group of approximately 15 students was not achieved (this would have been 10% of the cohort). Three potential participants also dropped out during the data collection period.

7.4 Conclusion

A professional assimilation process is known to exist in Medicine, which includes key transitional stages in the curriculum which are not always signposted for either students or indeed faculty. This process includes subtle changes in identities with an ever changing self concept influenced by new symbols and language, and teaching staff must take this into account when overseeing such critical transitions (Becker *et al,* ibid: 419; Charon, 1979). At this stage of professional development, the participants are immersed in a data gathering rather than a diagnostic mode, and impose limitations on their role. In spite of this, they demonstrate some perceptive, semantic ideas which illustrate transformative cognition and an appreciation of illness at deeper levels.

Their cognitive strategies reflect the dependence upon framework mechanisms to control and organise information within the simulation, which places them firmly in novice mode using the skills acquisition model (Dreyfus & Dreyfus, 1986). However, there are examples of semantic links involving higher conceptualisation of illness which would indicate forward movement along the spectrum of expertise. This would suggest an intermediary ***transitional adaptive process in cognition*** occurs at this stage of the curriculum, necessitated by the transition from facilitated practice in Phase 1 to stand alone exposure during subsequent clinical attachments.

The reflective discussions illustrate representation of illness using semantic qualifiers and emergent metacognition, which are being formulated through constructive thought and the intrinsic conversations during the reflective discussions. This is evidence that some higher level concepts are being encapsulated into diagnostic ideas which provides some explanation for symptoms and signs as exemplified by PH's comment below (Schmidt & Rikers, 2007).

"You're looking at the fact that he's presented with this pain for five days and it's a fluctuating pain. I think that's an interesting feature, just trying to work out whether this is an acute pain or something that's more long term. I thought that was an important thing to identify." (PH)

Such ideas enable progression in cognitive expertise to the next stage of professional development, but with the continuing reliance upon fall back mechanisms apparent in the use of frameworks and mnemonics for collecting data. The idea of adaptive expertise using *innovative* problem solving is clearly not applicable to this level of professional development and cognitive adaptation at this particular stage of development resonates more with belief in the '*achievement model of expertise'*, linked to the acquisition of knowledge and skills through experience e.g. proficient data collection (Mylopoulos & Regehr, 2009). The data analysis includes indirect references to semantic theory through an appreciation of the meanings of symptoms and signs e.g. Participant A's inferences about the absence of systemic infection;

"If there is epigastric tenderness and it came on whilst he was eating fatty foods...Erm... then he hasn't seemed particularly unwell, he hasn't had a fever that would suggest a systemic thing." (PA)

Since increased use of semantically rich inferences is associated with increased diagnostic success and reflects the gradual elaboration of knowledge associated with experts, this is indeed encouraging evidence of enhanced cognition (Bordage, 1994). As these rich inferences illustrate higher levels of understanding it would be reasonable to extrapolate that cognition of this sort is more likely to be associated with the ideas of deliberate induction and deduction facilitated through engagement with reflective practice in the undergraduate portfolio (Mamade *et al*, 2008).

The engagement with critical reflective practice *may* be acting as a preparatory process for subsequent adaptive cognition when faced with the ensuing curriculum transition which awaits this group of students, together with the increasing complexities of healthcare across a number of specialist domains yet to be encountered. The emphasis upon developing critical thinking in the portfolio *may* be shifting the disposition of the students along the spectrum of analytical thought and thereby facilitating the diagnostic reasoning process through deliberative induction. Formal theory to support these suggestions would require another study to substantiate the underlying ideas, although grounded theory would act as a suitable methodological approach.

Although there is evidence of cognitive transformation, it remains limited to certain aspects of the participants cognitive attributes (e.g. semantic appreciation), whilst other areas remain anchored to taught guidelines through reasoning processes that ultimately require more substantial exposure through patient contact (e.g. integration of the physical examination into diagnostic thought). To paraphrase Schatzman's comment, this mixture of cognitive attributes '*both limit and direct natural analysis, ...and directs organisation of relationships''* applied to the diagnostic reasoning process, with an explanatory matrix which centres upon cognitive adaptation for this group of participants (Schatzman in Morse, 2009: 93).

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Appendices

Appendix 1: Research Application and Ethical Approval (BSMS REGC)

Research Governance and Ethics Committee (RGEC)

Application Form

Section A – to be completed for ALL projects

<table>
<tr><td colspan="6">Title of Project: Diagnostic Reasoning in medical students using a simulated environment</td></tr>
<tr><td rowspan="2">Is the project a;
(please highlight or tick box)</td><td>PhD/MD/ProfD/ MPhil study</td><td></td><td>BSc/BA/MSc/MA study</td><td colspan="2"></td></tr>
<tr><td>Staff Research</td><td></td><td>UG student project</td><td colspan="2"></td></tr>
<tr><td colspan="6">Name of Principal Investigator / Supervisor: Dr Wesley Scott-Smith
School/Division: Medical Education Unit
Contact Details – Email: w.scott-smith@bsms.ac.uk Telephone 01273 644595</td></tr>
<tr><td colspan="6">Names of all Researchers/Students: Wesley Scott-Smith.
Participants; Volunteers from BSMS students following completion of Phase 1 study (24 months)</td></tr>
<tr><td colspan="2">Does this project require NRES approval? NO</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Proposed start date: March 2011</td><td colspan="5">Proposed completion date: October 2012</td></tr>
</table>

Section A continued

Risk Assessment (Please tick or highlight the appropriate boxes) Will the study involve:		
Causing participants physical damage, harm or more than minimal pain		**No**
Manual handling of participants, vigorous physical exercise, or physical activity from which there is a likelihood of accidents occurring?		**No**
Physiological interventions or procedures outside of standard practice - These might include the administration of drugs or other substances; taking bodily samples or human tissue (e.g. blood, saliva, biopsy or urine) from participants; use of probes or other equipment to measure or monitor bodily performance		**No**
Psychological interventions or procedures outside of standard practice - These might include techniques such as hypnotherapy, psychometric testing		**No**
Exposure of participants to hazardous or toxic materials, such as radioactive materials		**No**
Inducing psychological stress, anxiety or humiliation	**Yes**	
Questioning of participants regarding sensitive topics, such as beliefs, painful reflections or traumas, experience of violence or abuse, illness, sexual behaviour, illegal or political behaviour, or their gender or ethnic status		**No**
Children under 16		**No**
Incapacitated adults and/or people with learning disabilities or mental health problems		**No**
Groups where permission of a gatekeeper is normally required for access to its members, for example ethnic groups?		**No**
Access to records of personal or confidential information?		**No**
Storage and analysis of tissue samples		**No**
Any other risk not identified above		**No**

If you have answered 'Yes' to any of the above questions please describe the safeguards and monitoring procedure.

Although evidence from research studies using simulated interviews in medicine have shown a subsequent benefit in the participants' interviewing skills, such occasions can undoubtedly produce some apprehension about performance. Therefore all participants

will be offered a 'debrief' session at the end of the reflective discussion. This will provide an opportunity to deal with any emotional issues arising from the simulation and participants' anxieties over performance. Pendleton's rules for feedback will be adopted in these cases as is recommended in similar teaching sessions in the BSMS curriculum.

Even though the researcher is not acting as an assessor in this study, in the unlikely event of the researcher observing unprofessional behaviour or practice that raises concerns from a participant during the simulation he has a professional duty to report that those concerns to the Phase Leader for further action

Section B – Project Protocol/ Proposal

Please submit your project protocol or proposal or complete the template below.

Please ensure your protocol covers the points listed in the template.

What is the purpose of this study? Please clearly state the aims of the study or hypothesis to be tested.
How do novice medical students approach diagnostic decisions and what factors contribute to this process? (The sub-questions are cited in section A). The aim is to *develop a substantive theory on how students at this stage in their development approach the key skill of diagnostic reasoning* by asking them to reflect upon their actions and decisions within a simulated consultation. The data derived from the filmed consultations and the reflective discussion will provide material to observe real time decision making and illustrate the sources of knowledge and experience that underpin the diagnostic decisions chosen by the participants during the simulation.
What is the methodology
This study will use a qualitative analytical method called Dimensional Analysis, a form of Grounded Theory which is rooted in symbolic interactionism (acknowledging that views and interpretations of events are influenced by interaction with others, and that data cannot be analysed in isolation from knowledge and prior experience). Each participant will be filmed in real time during a simulated consultation with an experienced actor (working from a standardised script initially), using a common clinical case scenario in an area of medical practice familiar to the student (covered already in the curriculum). Such simulations are recognised as the nearest approximation to real practice (high fidelity) and are used extensively in medical training. Following completion of the simulation the participant will be asked to make tentative diagnoses based on the history *alone*. The participant will then be asked what features of an examination they would like to know to augment their diagnoses from the history (the attached case scenario provides some limited examination features which the researcher can provide for the participant to consider alongside the history). The participant will be asked once more to consider the diagnoses in the light of the history and examination *together*.

At this point to the participant will be asked to comment and reflect upon the filmed simulation, prompted by further questions from the researcher where necessary (filmed also). The focus will be upon information gathering, decision making and factors affecting these ideas derived from their individual experiences.

Data from both the simulation and the subsequent discussion will be analysed by the researcher. Recurrent themes from the data will be drawn together to form dimensions will might support a substantive theory to describe the evolution of diagnostic decisions in the participant group.

What sort of participants will be involved? (i.e. how many, gender, ages)

15-20 volunteer students who have successfully completed Phase 1(years 1 and 2) of the five year curriculum at BSMS, excluding those with significant healthcare experience e.g. qualified nurse (as they will have already refined some decision making processes from prior experience or teaching). This number of participants should provide enough material to achieve theoretical saturation for the study.

If vulnerable groups (i.e. children, incapacitated adults) will be involved please give full details and outline steps that will be taken to protect them.

N/A

What are the inclusion/exclusion criteria?

Inclusion criteria; the participants are undergraduate medical students at BSMS who have successfully completed Phase 1. They will therefore have no connection with the researcher as an examiner or assessor in the curriculum.

Exclusion criteria: The participants should have no prior experience from another healthcare setting (e.g. nurses)which might influence their decision making processes from prior professional experience.

Please state your rationale for your participant choice

The participants are considered as **novice** clinicians as defined by the 'Experiential Model of Skills acquisition' and therefore show limited situational perception and a tendency to adhere to rigid rules

How will participants be identified and recruited? (Copies of any recruitment material must be attached.)

Undergraduate volunteers will be asked to participate in this study by the researcher through student central by web invitation posted by an independent administrator with additional posters in the medical school. An 'opt in' policy will be used so that students interested in participating can then provide the researcher with contact details.

Participants must have successfully completed the Phase 1 examinations at the end of year 2 and be embarking upon Phase 2 of the BSMS programme.

What measures will be taken to ensure confidentiality, privacy and data protection?

Data should be secure against unauthorised access and comply with data

protection legislation. Where possible the data should be anonymised, where this is not possible confidentiality should be maintained.
The identities of all participants in the study will remain confidential for data analysis and any subsequent discussion/publication. Digital recordings of consultations will be loaded onto a storage device with encrypted access and kept in a locked cabinet in Mayfield House to comply with the Data Protection measures recommended for research at UOB.
What is your procedure for obtaining informed consent? If it is not possible to obtain informed consent, full reasons must be given. (Participant information sheets and consent forms must be attached)
Before agreeing to involvement in the study each participant will have read the Participant Information Sheet(PIS) form with a verbal reiteration from another member of the Medical Education Unit (MEU) to allow opportunity for questions and clarification of the research process. If they are happy to proceed the consent form will be signed.
What are the risks to participants or researchers, and how will these be managed?
These students have already been exposed to simulated consultations in the curriculum using Pendleton's rules for feedback. It is acknowledged that such events can provoke performance anxiety and therefore each participant will be offered a 'debrief' session after the reflective analysis if they choose so. Other studies have suggested that reflective analysis of simulated consultations improves subsequent interviewing skills so the experience may be beneficial to participants. If practice is observed that raises concerns then the participant will be asked to see the Phase Leader for further advice/action.
Will participants be reimbursed for expenses or given any inducements? ***If so, please give details.***
No
How, where and when will the data be collected? ***Please include a copy of any questionnaire that will be used or sample questions used in structured or semi-structured interviews.***
Simulated consultations and the reflective analysis will be filmed in the clinical skills suite at BSMS using an experienced actor familiar with simulation for consultation activities. The actor will be provided with a standardised clinical case scenario from which to work from, however the interaction will depend upon the consultation skills of the participant (see attached case scenario). • Participants in the study will be asked to treat the simulation as a medical consultation using the traditional medical history rather than a focussed interview technique. Participants will be allowed approximately 20 minutes to complete the consultation. • They will then be asked to provide some tentative diagnoses from the

history alone. Following this they will be asked what information from physical signs they would regard as useful in this case to accompany the history.

- The researcher will provide the physical signs from the case scenario only.
- The participant will be asked to refine the first diagnoses in the light of the additional examination features.

The filmed material will be analysed retrospectively using reflective analysis from the participants' perspective prompted by semi structured questions from the researcher. (See attached document). The participants will have the facility to stop the film to comment upon decision making processes at any stage and to expand upon their thoughts and diagnoses.

What facilities will be needed and who will provide them?

Clinical skills room at BSMS with two way mirror for filming/recording of the simulated consultation. The actor will be provided through the '*Playout'* group who currently provide actors for collaboration with BSMS in simulations and OSCEs.

How will the results be analysed and by whom?

The filmed consultations and subsequent reflective discussions will be analysed by the participant in the first instance, allowing them to pause the film to discuss components of the simulated consultation in the context of information sources and decision making. Further analysis will reside with the researcher and on occasions the project supervisor for advice only (Professor J Scholes).

What are the expected benefits of the research to participants or researchers?

Other studies using reviews of simulated consultations with participants have shown that there is a clear benefit in subsequent interviewing skills, primarily through reflective insight into performance.

Analysis of the data derived from this study will provide the researcher with a clearer idea of what influences the diagnostic decision of medical students in this context with ramifications for the teaching of Diagnostic Reasoning in the BSMS curriculum and beyond.

What means of dissemination will be used?

Internal communication at research meetings at UOB/UOS and external publication

What arrangements will be made for giving the participants access to the results?

The participants will be able to view both the initial filmed consultation and the subsequent reflective discussion. The final study conclusions will be distributed to all participants.

What results/end points are to be measured/noted?

It is envisaged that this study will provide enough data to construct a theory of diagnostic reasoning through the 'conceptual lens' (perspective) of the student

by watching diagnosis in action during the filmed consultations. The various influences of modelling/observing doctors in practice, interaction through teaching and assimilation through experience may be recognised alongside other emergent themes within the data.
How will this project be funded? ***List all sources of funds e.g. grants, commercial sponsorship, school's funds etc.***
No funding required
Has the project been subject to scientific or peer review? If 'Yes' please give details or submit the report with this form.
No
Do any researchers have any financial interests in this research or its outcomes, or any relevant affiliations? ***If 'Yes' please give details and include an appropriate comment on the Participant Information Sheet.***
No

Appendix 2:
Participant Information Sheet

Diagnostic Reasoning in medical students using a simulated environment
Please read this document carefully. Any questions that arise from reading this will be clarified by a member of the Medical Education Unit before taking part in the simulation.

Who is doing this research?
This research is being undertaken by Dr Wesley Scott-Smith for completion of the thesis stage of his Professional Doctorate in Education (EdD) at Brighton University.

What is the aim of this study?
This research is concerned with understanding what factors influence the views of medical students on the diagnostic process during a simulated consultation, and is one of the first times that decision making is being viewed from the perspective of a novice medical student.
The outcomes of this research may inform any further developments in how diagnostic reasoning is taught at BSMS and other medical institutions.

What are the potential benefits in taking part?
Similar studies using simulated consultations have shown that participants improve in their consultations skills as result of their involvement, and a deeper insight into decision making improves diagnostic skills.

What will I be asked to do?
Involvement in the research will entail your participation in a simulated consultation using a trained actor lasting approximately 20 minutes, which will be filmed for subsequent discussion with the researcher. Afterwards he will ask you to analyse some of your diagnostic ideas and decisions during a play back of the consultation (this will also be filmed).

What happens in the simulated consultation?
- In the clinical skills suite at Mayfield House, you will be asked to take a comprehensive medical history during the consultation with the actor (*not a focussed interview*).
- When you have indicated that you have finished the researcher ask you to provide one or two tentative diagnoses based upon the history alone.
- You will then be asked what further information you would require from a physical examination that would help clarify your diagnoses. The researcher will provide some of these details.
- You will be asked to consider those diagnoses in the light of the examination details and may reconsider your diagnostic opinion at this stage

What happens after the simulated consultation?
The researcher will then ask you to review the filmed consultation with him. You will be able to stop/pause the film at any point to make comments or reflections upon your decisions, information gathering and analysis. The focus will be upon diagnostic decisions (reasoning). The researcher may prompt the discussion with some questions.

What if I have any concerns over my performance?
There will be an opportunity to undergo a debrief session with the researcher should you wish to address any concerns over your performance. Your involvement is **not** being assessed and is not part of your degree at BSMS.

Will my involvement in this study be kept confidential?

Confidentiality will be a key issue; each filmed consultation will be viewed by the participant with the researcher (WSS), and on occasion with the academic supervisor of the researcher for advice purposes only (Professor Scholes). Discussions will remain confidential and individual anonymity will be maintained during analysis and reporting through the use of coded identity. Material from the study will be kept in a locked cabinet at Mayfield House, UOB and encrypted access will be used for storage devices.

What if I want to pull out of the study?

If you consent to being part of the research, you nevertheless retain the right to withdraw at any stage should you so wish. This will not affect your progress at BSMS.

What will happen to the results of this study?

The results of this research will be used for the EdD research and will be disseminated within BSMS through research seminars and a paper for publication will ensue. We will also ensure that you, as a research participant, are made aware of our findings and of any resulting changes that might be made to the teaching programme.
Any complaints that may arise should be addressed to the Heads of Research, Professor Kevin Davies (BSMS) or Dr Carole Robinson (UOB).

THANK YOU FOR YOUR CONTRIBUTION TO THIS RESEARCH

Researcher contact details:
Name: Dr. Wesley Scott-Smith, Medical Education Unit, 344A Mayfield House, Falmer.

Tel: 01273 644595

E-mail: w.scott-smith@bsms.ac.uk

Appendix 3: Consent form
Title of study- Diagnostic Reasoning in medical students using a simulated environment.

	Initial box
I agree to take part in this research which is looking at '*Diagnostic Reasoning in medical students using a simulated environment'.*	
I have read the Participant Information sheet and understand the procedures and possible risks. I understand the purpose of this research and what my involvement in it would entail. I have had the opportunity to raise any questions that I might have had about the study and have had them answered to my satisfaction.	
I am aware that I will be filmed in a simulated consultation with a trained actor and that I will be able to view the filmed material and make reflective comments upon my decision making. More specifically, I agree to the material to which I have contributed, on film and transcript, being used for research purposes, as part of the above study, subject to the conditions specified in the Participant Information Sheet. I understand that access to it is restricted to Dr Wesley Scott-Smith and his academic supervisor (Professor Julie Scholes), unless additional agreement is obtained.	
I understand that my anonymity will be preserved where possible in the use of the materials via the use of pseudonyms and I understand that direct quotations from the filmed consultation may be quoted in the study, although such quotations will be anonymised.	
I understand that the limits of confidentiality apply if unprofessional behaviour is witnessed by the researcher during the simulation.	
I understand that I can withdraw from the study at any time without reason or consequence for this action.	

Signature of participant
…….....

Name (Please print) …….....Date
…….

Name of person requesting
consent.....Date.....

Contact details.
e-mail: ……..Phone contact:
…….....

Appendix 4: Standardised Case Scenario for the Actor

Study: Diagnostic Reasoning in medical students using a simulated environment

Case Scenario for Actor

Your name is Sam Cooper and you are a 35-45 year old married estate agent and you have been suffering from bad stomach pain for 5 days which has been increasing in severity day upon day. You thought this was indigestion initially following a family celebration.

There have been two similar episodes in the last year where the pain was not a bad and lasted for 3-4 days but eventually settled without any specific help or remedy.

Pain: This pain is situated between your chest and umbilicus, felt like a deep seated ache initially but has worsened considerably (you would now rate it 7/10 on a pain scale if asked). It lasts for an hour or two and you feel sick, but haven't vomited. It eventually eases a little but there is always some background pain. There is no problem with swallowing food or drink.

Aggravating factors: This episode of pain happened since you attended a family wedding and indulged a bit too much. You enjoy spicy foods and have a liking for curries. You also enjoy a Whisky (or two) in the evening. Rich food appears to bring on the pain (Roast pork at the wedding as an example). You have drunk milk during previous episodes with limited effect but there has been no relief with the current pain.

Weight: You are a 'little overweight' and think you get enough exercise by walking the dog once a day in the park. You lost a few pound in weight after the last episode of pain but have since regained them.

Smoking: You smoke two or three cigarettes a day, cut down in the last two weeks from at least 10 per day because at the back of your mind you were worried about heart disease.

If asked by participant
The pain is not in the chest and does nor radiate into the neck or arms
You do not suffer from palpitations or a cough, but you get *short of breath* going up two flights of stairs at work or playing in the garden with your kids
Bowel habit is normal-you go every other day. No blood seen and normal brown colour.
You have no urinary problems
There are no gynaecological complaints (if scenario played by woman)

Past Medical History
You had your appendix removed age 19 year.
You have a *painful right knee* from a ligament injury playing Squash during you twenties. This is worse after walking the dog and is eased by *Nurofen* which you have taken quite recently for your knee problem.

Medication:
Nurofen 200mg three time daily when required for painful knee.
Codeine and paracetamol for current pain with partial relief

Allergies: None

Family History;
Your father and mother are alive; father is 65 and had heart surgery (a 'bypass' if asked) a couple of years ago following an episode of chest pain. Mum has been a diabetic for 10 years (controlled by tablets).
Your older brother had an operation on his stomach last year but you can't remember what the condition was called.

Work: Your partner works in part time publishing company and your children are 12 and 10 yrs old (boys).Work has been difficult recently due to the recession and finances at home are becoming stretched.

Overall: You are a bit concerned about the cause of this pain because of your family illnesses but hope it is only indigestion, however feel it is far worse than you would expect. You've not asked the pharmacist for advice. You partner has urged you to come along for tests.

Advice on playing the role:
The participant will be asked to take a *full medical history* from you over about 20 minutes. You should remain polite, interactive but not provide too much information too quickly. You should appear in pain at times during the interview by the occasional grimace. The participant should piece together the information from the questions that they ask you.

There is no prescribed order to divulging the information except that you start with the '*severe pain in your stomach'*. The participant should seek to clarify the site of the pain from you, the length of symptoms and all the associated features described in the scenario.

Additional examination features after completion of history:

Researcher: Question to participant (who should state what specific features they would like to hear about).

What additional features of an examination would you like to know?

The patient examination details:

No jaundice visible or signs of liver disease
Temperature: 36.8C
BP 116/82, Heart rate 88 sinus rhythm
Heart Sounds: normal
Chest examination: Normal
Abdominal examination: Epigastric tenderness with no mass (On light palpation if the participant asks specifically). Bowel sounds normal.

Appendix 5: Semi structured prompts for reflective discussion (adapted from Benner)

Diagnostic Reasoning in medical students using a simulated environment

Semi-structured questions for prompting the reflective discussion with the participant whilst viewing play back of filmed consultation:

Before playback:

1. What is your overall experience of the simulation?

2. How do you view the medical diagnostic process in general?

3. From what sources have you formed your opinion of making diagnoses? (probes: watching GP tutor/ other clinicians/teaching at the medical school/family members who are doctors/TV)

During Playback stops:
Generic prompts to facilitate discussion and perspectives on decision making during the reflective discussion.

4. Why did you think these features were more useful?
5. What did you think about this bit of information?
6. How did this information influence your thinking?
7. What were you thinking at this point?
8. Did you think that at the time of the simulation? (checking for post hoc rationalisation)
9. To what extent of you think it is beneficial to reflect upon this consultation?
10. How do you think you can learn from this type of activity?

Appendix 6: Ethical Approval

Research & Development Directorate
Royal Sussex County Hospital
Clinical Investigation & Research Unit
Eastern Road
Brighton
BN2 5BE

Dear Dr Scott-Smith

Full Study Title: Diagnostic Reasoning in medical students using a simulated environment
R&D Ref No. : 11/040/SCO

I am writing to inform you that you have Research Governance approval to proceed with the above named project. This letter acknowledges that you have all the necessary internal and external regulatory approvals. The sites covered by this approval include:

University of Brighton

Conditions of Approval

The approval covers the period stated in the Research Governance & Ethics Committee (RGEC) application and will be extended in line with any amendments agreed by the RGEC. Research must commence within 12 months of the issue date of this letter. Any delay beyond this may require a new review of the project resources.

Amendments

Project amendment details dated after the issue of this approval letter should be emailed to the R&D Office for formal approval.

ICH-GCP Monitoring

The Medical School has a duty to ensure that all research is conducted in accordance with the Research Governance Framework and to ICH-GCP standards. The R&D Department will take responsibility for the ongoing monitoring of the study and reporting of any adverse events. In order to ensure compliance the department undertakes random audits. If your project is selected you will be given 4 weeks notice to prepare all documentation for inspection.

I wish you luck with your project and would grateful if you could inform me when the project is complete or due to be closed on this site.

Yours sincerely
Caroline Brooks

Appendix 7: Summary of Simulations

Participant	Simulation (History only)	Examination features	Reflective Discussion with researcher
Participant A	22 minutes 18sec	7 minutes 17sec	47 minutes 20sec
Participant B	14 minutes 20sec	4 minutes 45 sec	34 minutes 38sec
Participant C	9 minutes 3sec	7 minutes 13 sec	12 minutes 32 sec
Participant D	9 minutes 27 sec	4 minutes 41 sec	27 minutes 25 sec
Participant E	7 minutes 20sec	8 minutes 13 sec	27 minutes 32 sec
Participant F	13 minutes 20 sec	10 minutes 3 sec	44 minutes 16 sec
Participant G	11 minutes 36 sec	7 minutes 29 sec	30 minutes
Participant H	17 minutes 38sec	8 minutes 52sec	46 minutes
Participant I	10 minutes 21sec	10 minutes 6 sec	52 minutes 12 sec
Total	115 min 23 sec	68 min 39 sec	321 min 55 sec
Average (nearest minute)	13 min	8 min	36 min

(Word Count 57, 697 excluding references and appendices)