EXPLORING THE ROLE OF ‘SLOWING DOWN WHEN YOU SHOULD’ IN OPERATIVE SURGICAL JUDGMENT

by

Carol-anne Evelyn Moulton

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Graduate Department of The Institute of Medical Science
University of Toronto

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Institute of Medical Science
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Abstract

Context: The study of expertise in medical education has tended to follow the traditions of describing either the analytic processes or the non-analytic resources that experts acquire with experience. We argue that a critical function of expertise is the ability to transition from the automatic mode to the more effortful mode when required – a transition referred to as ‘slowing down when you should’.

Objectives: To explore the phenomenon of ‘slowing down when you should’ in operative surgical practice and its role in intra-operative surgical judgment, and to develop conceptual models of the factors involved in the display of this transition in surgical operative practice.

Design: In Phase 1A, 28 surgeons were interviewed about their views of surgical judgment in general and their perceptions of the role of this phenomenon in operative judgment. In Phase 1B, a subset of surgeons from Phase 1A was re-interviewed to explore their perceptions of automaticity in operative practice. In Phase 2, observational sessions (and brief interviews) were conducted of surgeons in the operating room to explore the nature of this phenomenon in its natural environment.
Results: The surgeons in this study recognized the phenomenon of ‘slowing down’ in their operative practice and acknowledged its link to surgical judgment. Two main initiators were described and observed: proactively planned ‘slowing down’ moments occurring intra-operatively initiated by critical events anticipated pre-operatively and situationally responsive ‘slowing down’ moments initiated by emergent cues intra-operatively. Numerous influences of this transition were uncovered. A control dynamic emerged as surgeon’s negotiated ‘slowing down’ moments through trainees in their supervisory academic practice. Numerous manifestations of this phenomenon were observed in the operating room and considered using a cognitive psychology attention capacity model.

Conclusions: This study offers a conceptual framework for understanding the role of ‘slowing down when you should’ in operative surgical practice, providing a vocabulary that will allow more explicit consideration of what contributes to surgical expertise. Consideration of this framework with its consequent ability to make surgical practices more explicit has implications for self-regulation in practice, surgical error, and surgical training.
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Chapter 1
Introduction

Problem Statement

A crucial component of expertise in the medical professions is the ability to display sound clinical judgment. This has been the focus of a great deal of research in the medical education literature over the last three decades. Despite this, the construct of judgment – what it means and how and why it is enacted or not enacted in daily professional life – remains elusive. One reason for this is the plethora of terms that are linked to and appear to overlap with the construct of judgment, making it difficult to delineate what the boundaries of this construct are. Terms such as decision-making, clinical reasoning, intuition, clinical acumen, problem-solving, and critical thinking all share common ground with the term judgment, yet judgment can be separated from each to remain a construct of interest in its own right. Where exactly are the boundaries between each of these terms and what would be a useful way of defining judgment so that it stands alone from these other categories? To answer these questions, the construct of judgment has to be better understood and defined as it occurs in daily practice.

This thesis is the product of the researchers’ attempts to deconstruct the term judgment in clinical practice. Interested in learning more about judgment, the principal investigator asked many colleagues to define judgment, and more specifically, surgical judgment. Grappling for words to define it, they would often say, “I just know it when I see it”, or inversely, “I know it when it is missing”. Wondering what it was they were ‘seeing’, the principal investigator performed some preliminary research observing surgeons in the operating room. Several phenomena were identified and observed, with ‘slowing down’ being one of them. This phenomenon represents the transition that occurs when experts are confronted by the unusual, the uncertain, the more critical, or the non-routine aspects of practice. Others identified included ‘readjusting retractors to gain better exposure’, ‘asking for help’, ‘dealing with a crisis’, ‘adapting to a new plan’, ‘searching for new information’, etc. It was decided that, although each phenomenon identified was of interest and related to some degree to the topic of judgment, we should concentrate on one to develop a deeper understanding of it. From here we could explore other phenomena to
develop an elaborate network of what is involved in clinical judgment, clarifying definitions and boundaries that are currently ‘muddying the waters’.

Further to the definitional issue, the means of studying naturalistic phenomena and understanding what occurs in ‘real’ clinical practice has been a difficult one. Armed with experience and knowledge, expert physicians and surgeons carry out their daily activities in the medical environment. Problems are not necessarily presented as problems and the formulation of how problems are perceived and how the expert interprets them is not straightforward. Experts are required to constantly ‘negotiate’ the cues and stimuli in their dynamic environment to retain an accurate picture of what is being presented to them. This dynamic environment is ‘messy’ and imbued with complexity and contextuality that will likely be lost if the phenomenon is isolated, for research purposes, in a laboratory context. Within the medical profession, with its dominance of positivist epistemological views, quantitative methods have prevailed with the pursuit of a single truth and the elimination of ‘bias’ and subjectivity. These methods have been used to test hypotheses and study ‘judgment related issues’ (like decision-making and clinical reasoning) and have taken place often in laboratory settings that attempt to control for confounding variables. This method, however, does not provide means for setting out to, a priori, better understand phenomena occurring and embedded in contextually relevant settings. Recent interest in qualitative methodologies has opened up avenues for exploring such naturally occurring phenomena not accessible to quantitative research methods previously.

Previous work in expertise has described two modes of thinking that experts engage in during their daily activities: thinking that is ‘automatic’ and thinking that is ‘effortful’. With experience and practice, activities that were once ‘effortful’ become ‘automatic’. The development of expertise is accompanied by the accumulation of many automatic resources that enable the expert to engage in a quick, effortless, and automatic mode of functioning. However, due to the complexities of their responsibilities they cannot remain in this mode all the time, having to transition to the more effortful mode when the situation requires it. Though much work has focused on these two modes of thinking – automatic and effortful – little work has been done on how professional experts flow between the two. When confronted by the ‘messy’ or non-routine aspects of professional practice, physicians, as an example, must transition – or ‘slow down’ – to
the more effortful mode, engaging in more deliberate thinking and problem solving processes. This phenomenon marks the critical moments of practice that require judgment. Some literature has shown that experts coordinate the two forms of thinking but so far the literature cannot provide us with an understanding of how physicians negotiate between the two in their daily practices, cannot provide a description of what this transition looks like, what factors initiate this transition, and how this transition is experienced. This study provides an exploration of the phenomenon of ‘slowing down when you should’ in the setting of surgical operative practice.

This program of research is guided by 4 objectives:
1. To explore surgeons’ perceptions and experiences of operative judgment and the phenomenon of ‘slowing down when you should’;
2. To observe the phenomenon of ‘slowing down when you should’ in the operating room, to understand what cues initiate it and how surgeons manage it;
3. To develop a conceptual framework for the ‘slowing down’ phenomenon as it occurs in the operating room; and
4. To further our understanding of the construct of surgical judgment.

These objectives have been addressed through a two-phase grounded theory study. Interview data were collected from semi-structured interviews and observational data were collected while surgeons operated in the operating room. Through an iterative and constant comparative analysis, this study explored the phenomenon of ‘slowing down when you should’ in the setting of surgical operative practice.

Overview

Consistent with research tradition in the domain of medicine, the results of this dissertation have been reported through publication in the medical literature. The core of this thesis consists of 4 published/submitted manuscripts: one review paper providing the background and relevant literature review and three research data papers containing the results of the study. The papers are included in their entirety within this thesis document. Given the various constraints imposed by the individual journals (i.e., word limit, intended audience) this thesis might appear to lack a consistent format for the reader. Therefore, information is included at the beginning of each
paper to frame it with relevant contextual details and to provide an understanding of how the paper fits with the larger program of research in this study. The background and literature paper, discussing questions of broader appeal in the medical education community, is also followed by a post-script to provide relevant contextual information to the present study.

The background chapter (Chapter 2) provides a review of the relevant literatures from both theoretical and applied domains that inform the transition from the ‘automatic’ to the ‘effortful’ modes of thinking in professional practice. The embedded paper (entitled: Slowing Down When You Should: A New Model of Expert Judgment) discusses the ways in which expert professionals think in the course of their daily activities and provides a definition of judgment within this context. Using this definition of judgment, this paper outlines a larger program of research that not only explores judgment in professional practice but also considers the contributions of the cognitive and metacognitive levels of functioning on the display of judgment in practice. The post-script to this paper introduces the specific line of research adopted in the present study: a qualitative study exploring the perceptions of and display of judgment as conceptualized by the phenomenon ‘slowing down when you should’ in a surgical academic practice.

The methodology and study design chapter (Chapter 3) reviews the origins of the grounded theory tradition and addresses the critiques of grounded theory in light of its evolution within the constructivist paradigm. Details of the study design are elaborated, including the specifics of Phase 1 - interviews with surgeons from a multitude of specialties - and Phase 2 - operating room observations of hepato-pancreatico-biliary (hereafter referred to as HPB) surgeons. This chapter provides a description of the research team and an account of the reflexive approach adopted in this study.

The first results chapter (Chapter 4: Exploring the Role of ‘Slowing Down When You Should’ in Surgical Judgment) is based on data from Phase 1. It primarily addresses the first and third objective in this study, to explore surgeons’ perceptions of judgment and the ‘slowing down’ phenomenon in their operative surgical practice. This chapter presents two dimensions of the evolving framework: the initiators of the phenomenon and the influences on the phenomenon.
The two broad categories of the phenomenon based on what initiates them are the *proactively planned* ‘slowing down’ moments and the *situationally responsive* ‘slowing down’ moments. Proactively planned ‘slowing down’ moments seemed to be considered pre-operatively during the creation of the “game plan”. When approaching these critical points intra-operatively surgeons described focusing more intently, recruiting additional cognitive resources from elsewhere. However, surgeons also described ‘slowing down’ moments that emerged intra-operatively in response to unexpected ‘cues’ or stimuli, alerting the surgeon to the unanticipated need to pay more attention. The second dimension this chapter presents is the influencers on the ‘slowing down’ transition. Surgeons described various influencing factors on their ability to ‘slow down’ appropriately. Some were transitory ‘internal’ factors (e.g., fatigue), others were perceived to be related to personality factors (e.g., humility), while others were seen to be situational (e.g., time pressure). This chapter also considers two related phenomena – ‘plowing through’ and ‘speeding up’ – as examples of where the surgeon transitions from the routine to the effortful but describes the experience as different from the ‘slowing down’ phenomenon.

The second results chapter (Chapter 5: Staying out of Trouble in the Operating Room: Remaining Attentive in Automaticity) is based on data from Phase 1 and Phase 2 and addresses primarily the second objective in this study. The results from this chapter represent a third dimension of the evolving framework – the *manifestations* of the ‘slowing down’ phenomenon in the operating room. This paper describes the various manifestations of the ‘slowing down’ phenomenon as it occurs in the operating room and uses the cognitive capacity model of attention to provide a means of explanation. This paper problematizes the term ‘automaticity’ as it is described in the expertise and cognitive psychology literature in its ability to properly represent the surgeons’ perceptions of their own functioning during routine aspects of surgery as well as the ways in which they were observed to function during the routine aspects of surgery. The constructs of ‘attentive’ and ‘inattentive’ automaticity are introduced in this chapter and their potential implications to practice are discussed.

The third results chapter (Chapter 6: Operating from the Other Side of the Table: Control Dynamics and the Surgeon Educator) is an exploration of an emergent theme representing a
secondary analysis of the data from Phase 1 and 2. From both phases of the study, it became
apparent that surgeons experienced this phenomenon of ‘slowing down’ as a need to gain more
‘control’ of the operation. This experience of the ‘slowing down’ phenomenon represents the
fourth dimension in the framework of the ‘slowing down’ phenomenon. This was particularly
apparent when surgeons were discussing their ‘slowing down’ moments in the context of their
academic teaching practices when control needed to be negotiated away from the trainee. The
dual responsibilities to patient safety and education were often competing responsibilities during
these moments, posing a particular challenge for the academic surgeon. This paper describes this
challenge and explores the negotiation process initiated by the surgeon in these situations.

The implications chapter (Chapter 7) provides a summary of the results of this program of
research to date, integrating important contributions from the three results chapters. This chapter
focuses on how the emergent framework from this study contributes to our understanding of
expert surgical practice and considers how this framework fits within the context of other
frameworks found in extant literatures on judgment and decision-making. In this chapter, the
main theoretical and practical implications of this framework are discussed as they relate to three
points of interest, Firstly, a vocabulary to consider what is done in daily operative practice
provides surgeons with the potential ability to discuss, reflect on, and critically evaluate their
own ‘slowing down’ moments. A language recognized by all might also provide an opportunity
to have different research groups exploring, in a more consistent manner, the teaching and
assessment of what contributes to expert intra-operative practice. Secondly, consideration of this
framework opens up possibilities for creating a taxonomy for surgical error – one that recognizes
the role of the individual surgeon in surgical error. Thirdly, the results of this research, with its
consideration for the role of attentive monitoring and ‘fine tuning’ as a means for counteracting
the propensity to become inattentively automatic, brings the metacognitive aspect of expert
practice into focus. The literatures on mindfulness and self-regulation are explored in the context
of their role in expert performance and their potential for diminishing medical error. Embedded
within this chapter is an exploration of future research agendas made possible from the results of
this study.
Significance

In recent times, research in the prevention of medical error has shifted away from factors and actions related to the individual and towards an analysis of the systemic pressures and factors that enable humans within these systems to fail. This has provided the impetus needed to hold organizations and systems in healthcare accountable for their role in medical error and has brought about many significant organizational and structural changes improving the safety and delivery of healthcare. However, this systems approach to medical error has done little to further our understanding of the individual’s contribution to medical error. The expert physician, working within organizations, teams and systems, is required to develop and maintain an accurate picture of his immediate medical situation, and it is his ability to do so that promotes correct diagnoses, safe procedures, and early detection of emergent problems. The results of this study will be an important addition to the literature with our analysis of how experts effectively self-regulate their activities in order to maintain situation awareness and avoid errors in practice. Future research studies, using similar methodologies as described in this study, can expand and investigate other avenues of expert performance to provide a more elaborate network of what contributes to expert surgical practice. In addition to guiding our understanding of what contributes to expert surgical practice, this study has the potential to improve practice by making explicit the transition from the routine to the effortful. A greater understanding of this phenomenon in practice provides the opportunity for it to be held up as an ‘object’ that can be critically evaluated ‘in the moment’ potentially leading to an improvement in self-awareness, self-monitoring and self-regulation.

The framework provided in this study also has practical significance in the teaching arena, where surgeons are better able to understand more explicitly what contributes to expert surgical practice and what it looks like in the operating room. The close relationship between the preparatory activities for surgery and the appropriate management of the proactively planned ‘slowing down’ moments endorses and validates surgeon’s opinions of the importance of trainee preparedness. The tension between patient safety and education that exists in the academic surgeon’s supervisory practice and the negotiations that occur because of it have implications for clinical practice and teaching. A better understanding of these implications provides an avenue towards
developing mutually agreeable expectations for both surgeon and trainee and a framework to consider future research efforts to improve surgical training.
Chapter 2
Background and Literature Review

The review paper presented here is the result of a search of the relevant literatures that might inform the construct of judgment in professional practice. Very few original data papers exist in the medical education or surgical literatures on judgment, though several explore the related constructs of expertise, decision-making, clinical reasoning, and problem solving predominantly from a cognitive psychology perspective. Judgment, because of its elusiveness, is covered in the literature similar to other non-descript topics, such as, clinical acumen, intuition, tacit knowledge, and critical thinking mainly as opinion pieces with no substantive data. Searching the broader literatures outside the medical domain, several relevant literatures were identified that informed the way expert professionals think and function within their daily activities as experts. Particularly interested in the transition from the routine or ‘automatic’ mode of functioning to the more attentive or ‘effortful’ mode of functioning, literatures that informed this transition were selected as the basis behind this literature review. A desire to introduce these literatures to the broader medical community culminated in the publication of this review.

This paper was presented in 2007 in a review paper session at the annual meeting of the Research in Medical Education (RIME), a group affiliated with the American Association of Medical Colleges. The manuscript was published in the supplement edition of Academic Medicine in October, 2007. The paper introduces the two broader perspectives on the way experts think in practice – the fast, and effortless ‘automatic’ mode made possible through accumulation of automatic resources as part of the development of expertise, and the slower, more deliberate ‘effortful’ mode required when the situation is not routine. The appropriate transition from one mode to the other is suggested in this paper to be the hallmark of expertise and a new definition of judgment in clinical practice is put forward. It is suggested that one of the key issues that hinder research efforts to further understand expert medical/ clinical/ or surgical judgment is a lack of a clear, widely recognized definition. The various literatures are then explored for how they might inform the construction of judgment in this way. A wide-ranging research agenda is suggested to address questions that are relevant to understanding the individual expert’s role in the display of clinical judgment. The literatures represented in this
paper formed the core theoretical framework that underlay the motivation and design of the studies that embody this thesis. One of the lines of research suggested in this paper was adopted as the methodological structure for this study: a qualitative approach exploring the transition from the ‘automatic’ to the ‘effortful’ mode in the context of clinical practice. A post-script to the review paper introduces the context that is relevant for this particular study.
Introduction

The nature and development of expertise has been a research cornerstone in the “basic science” of health professional education for decades. Over that time, many theories of expert performance in the clinical domain have been proposed, and these theories have taken several forms. One broad set of theories has attempted to understand the apparent differences between experts and non-experts with regard to the **effortful, analytic processes** that experts use (and non-experts do not) in addressing clinical problems. Theories of this form have assumed that experts apply a “better” set of processing strategies than non-experts and have tried to deconstruct the nature of these expert processes in order to teach them to novices. The processes themselves have been identified using several labels, such as problem-solving (Elstein, Shulman, & Sprafka, 1978; Harasym, Baumber, Bryant, Fundytus, Preshaw, Watanabe, & Wyse, 1980; Neufeld, Norman, Feightner, & Barrows, 1981; Norman, Feightner, Tugwell, Muzzin, & Guyatt, 1983), diagnostic reasoning (Barrows, Norman, Neufeld, & Feightner, 1982; Elstein, Ravitch, Swanson, Bordage, & McNeil, 1980; Patel & Groen, 1986), clinical judgment (Elstein, 1976; Redelmeier, Ferris, Tu, Hux, & Schull, 2001), decision making (Gorry, Kassirer, Fineberg, Pauker, Elstein, & Peirce, 1979; Kushniruk, Patel, & Fleiszer, 1995) and critical thinking (Dobrzykowski, 1994; Koch & Speers, 1997; Schull, Ferris, Tu, Hux, & Redelmeier, 2001). Yet despite extensive research and writing, there continues to be difficulty in specifying the exact nature of these expert processes. The broader construct underlying these labels has remained largely ill-defined, and the labels themselves are often used interchangeably. Further, research highlighting situational-specificity (Bereiter, 1997) and case-specificity (Elstein et al., 1978; Schmidt, Norman, & Boshuizen, 1990) has begun to undermine confidence that expert analytic processes even exist, at least in a useful generic sense.

In the absence of evidence that experts have a ‘better’ set of analytic processing strategies, another broad set of theories of expertise has grown from an interest in ‘what is in the expert’s
head’ and attributes the acquisition of automatic, non-analytic resources (obtained through experience) as the source of expertise (Schmidt et al., 1990). These non-analytic resources have several variations, such as instances (Allen, Brooks, Norman, & Rosenthal, 1988; Hatala, Norman, & Brooks, 1996; Norman, Rosenthal, Brooks, Allen, & Muzzin, 1989), scripts (Custers, Regehr, & Norman, 1996; Schmidt et al., 1990), schemas (Custers et al., 1996; Lemieux & Bordage, 1992) and heuristics (Eva & Norman, 2005), and have been associated with processes such as pattern recognition (Custers et al., 1996; McGaghie, McCrimmon, Mitchell, Thompson, & Ravitch, 2000; Norman et al., 1989), chunking (Chase & Simon, 1973), encapsulation (Rikers, Loyens, & Schmidt, 2004), and the situationally driven restriction of solution sets (Wiley, 1998). An explanation for the inherent value of automatic resources may be found in the literature on attention (Kahneman, 1973). In this literature, there is consensus that humans must coordinate a constant flux of environmental information and personal intentions with limited cognitive capacity. Humans have become very good at adapting to this limitation through the development of automatic processing that requires less intentional capacity and thereby frees up cognitive resources for additional activity (Logan, 1988). Therefore, the development of pattern recognition, the formation of scripts and schemas, the restriction of solution sets, the accumulation of instances in memory, and the processes of chunking and encapsulation could be considered mechanisms that experts use to carry out their daily activities with minimal demands on cognitive load. For the expert, activities that were initially effortful become mundane and routine. This leads to greater efficiency, with experts getting to the right answer more often, more quickly and with less effort than novices. The extreme of this process can be appreciated when experts can no longer verbalize the thought processes involved in reaching a decision or cannot accurately explain details of actions involved in carrying out a procedure (Ericsson & Smith, 1991; Dreyfus & Dreyfus, 1986).

Anecdotally, evidence for the automatization of once cognitively effortful processes of clinicians is everywhere. Surgeons perform standard operations while talking about their tennis game, internists diagnose a patient from the end of the bed, emergency physicians immediately initiate multiple tasks in a trauma victim, and family doctors recognize the chicken pox rash instantly. Yet conceptualizing expertise exclusively as the accrual and efficient use of non-analytic resources and load-reducing automatic processes is likely insufficient (Eva, 2002). As Bereiter
and Scardamalia (1993) have described, the individual who makes exclusive use of non-analytic resources and automatic processes is unlikely to manage novel situations or unusual cases appropriately. Such an individual will tend to adapt the presenting problem to known solutions rather than adapting new solutions to the presenting problem, and, in the taxonomy of Bereiter and Scardamalia (1993), represents not an expert, but an experienced non-expert. Thus, although progressing toward automaticity is essential for the development of expertise, experts must also be able to engage more cognitively effortful processes when the automatic approach is not sufficient (Bereiter & Scardamalia. 1993; Eva 2002).

While gaining an understanding of both the cognitively effortful, analytic processes and the automatic, nonanalytic resources of expertise is important, it might be argued (consistent with Bereiter and Scardamalia) that the true hallmark of expertise may be more importantly related to the effective interfacing between these two modes of processing (Eva, 2005). When a clinical presentation is atypical, a post-operative patient goes ‘off-course’, an unusual reaction occurs from medication, or an anatomical anomaly is confronted, will the clinician, in automatic mode, take heed and recognize the intricacies and complexities of the case and leave automatic mode, or will that clinician plow through, oblivious to its uniqueness and unaware of its consequences? When a clinician does ‘slow down’ and shifts into a more effortful mode of processing, what does that look like? How is the transition from automatic to effortful coordinated? And what are the cues that the expert is using to initiate the transition? Perhaps the best phenomenological description of the two processes side by side has been provided by Schön (1983; 1987) in his comparative descriptions of ‘knowing-in-action’ vs. ‘reflection-in-action’. Yet further research is clearly needed if we are to properly understand this potentially critical aspect of expert performance: the act of slowing down when you should. Toward this end, we will review the literatures that might inform the way experts transition between the automatic and the effortful. The expertise literature examines the development and application of expertise, while the attention and effort literature provides a model for understanding the limits of cognitive capacity. Using the situation awareness literature, we will explore the factors that influence the moment to moment control of complex environments. Finally, we will present a new model for examining expert physician judgment: one that focuses on the interface of the automatic and the effortful.
Our first review focuses on expertise literatures that have explored the daily activities in which experts engage that define them as expert, rather than explore how experts are different from novices. As Scardamalia and Bereiter (1991) point out, “no one is disturbed by the fact that experienced physicians are better at diagnosis than interns” (pp191). What we might be disturbed by is a practicing physician whose expert judgment is inadequate (Bereiter & Scardamalia, 1993). The recognition that not all those who have the title of expert are truly functioning as an expert is an important feature of this body of literature. It challenges us to revisit and redefine what we, the medical education world, should accept as our goal in creating an expert. To this end we will examine the theories of Dreyfus and Dreyfus (1986), Bereiter and Scardamalia (1993), and Schön (1983; 1987) from the perspective of how an expert manages analytic and non-analytic resources in daily practice.

Dreyfus and Dreyfus (1986) describe a staged theory to explain the acquisition of skill (or development of expertise). As each of these five stages is traversed (novice, advanced beginner, competence, proficiency, and expertise), the individual exhibits qualitatively distinct features representative of that stage. The development and display of automaticity increases with each stage as the individual progresses from the initial rule-guided ‘knowing that’ to the experience-based, intuitive ‘knowing how’. The medical student, when confronted with an apneic infant, may explicitly search a list of differential diagnoses and in a calculated series of specific steps, stumble through the resuscitation. The anaesthetist, on the other hand, will simply ‘intuitively’ resuscitate the infant. As expertise develops, features of individual cases are no longer considered independently, but form a holistic pattern that is recognized effortlessly from years of experience and practice. As Dreyfus and Dreyfus (1986) describe, “when things are proceeding normally, experts don’t solve problems and don’t make decisions: they do what normally works” (pp. 30). A toddler trying to open a door, for example, is problem solving, whereas an adult doing the same is simply opening a door.

Dreyfus and Dreyfus (1986) depict their model of expertise as addressing the management of “unstructured problem areas” which they define as “areas in which the goal, what information is relevant, and the effects of our decisions are unclear” (pp. 35). Though they state that
interpretation plays a significant part in expert judgment, they predominantly view judgment as non-conscious and automatic. Their model specifically celebrates the non-analytic nature of human expertise (the title of their book is ‘Mind over Machine: The Power of Human Intuition…’) and focuses almost exclusively on the automatic mode of processing that experts are ‘normally’ using, even in these unstructured problem areas.

What is less clear in their model is what happens when things do not proceed normally; what does effortful processing looks like in the expert? They acknowledge that, at times, experts use critical thinking and reflect on the situation at hand when “time permits and outcomes are crucial” (pp. 31). However this reflection appears to be more a monitoring or checking process of automatic and intuitive responses to the ‘routine’ (if unstructured) problems of an expert’s daily practice, and has little to say about the expert’s reactions when this checking process detects anomalies or cause for concern. Thus, while Dreyfus and Dreyfus (1986) acknowledge that experts may not spend all their time in the automatic mode, they appear to equate expertise with increasing use of the automatic mode. As a result, they do not bring us substantially closer to an understanding of what an expert’s effortful problem solving looks like or what the transition between the automatic and the effortful might involve. Rather, they equate expertise with the ability to increasingly rely on automatic resources.

By contrast, Bereiter and Scardamalia (1993) make a clear distinction between ‘experts’ and ‘experienced non-experts’ in order to explicitly set apart individuals who do not limit themselves to this unreflective, automatic mode. In Bereiter and Scardamalia’s (1993) model, ‘experienced non-experts’ are technicians who perform well on routine problems by unreflectively and automatically applying standard theories and techniques. However, they will not display creativity in finding solutions to ill-defined or unusual situations, the problems for which the standard techniques will not work. ‘Experts’, on the other hand, explicitly identify the subtle complexities of situations and, by addressing and readdressing the problems of daily practice through an effortful process, develop a very deep understanding of the particular systems they are working with. The experienced non-expert emergency physician, having treated hundreds of patients with abdominal pain and diarrhea, may be quick to make a diagnosis of gastroenteritis. By contrast, the expert emergency physician may recognize the inconsistencies with the
presenting signs and symptoms, and will feel uncomfortable with fitting the common diagnosis of gastroenteritis onto this problem. Instead, through thoughtful reflection and by addressing and readdressing his concerns, he will consider the alternative diagnosis of intestinal ischemia.

Thus, while Dreyfus and Dreyfus (1986) suggest that experts almost never require the use of reflective analytic tools in daily practice, Bereiter and Scardamalia (1993) seem to suggest that the true expert is constantly using these analytic resources. We might interpret Bereiter and Scardamalia’s (1993) notion of the expert process of reflection even during routine cases as a form of ongoing practice in the integration and coordination of non-analytic, automatic resources and more effortful reflective processes. Thus, experts are well prepared to transition from moment to moment between heavier reliance on automatic and heavier reliance on effortful processes to complete the task at hand.

It is worth noting that Bereiter and Scardamalia (1993) suggest that individuals who are ‘experts’ may become ‘experienced non experts’ in the same domain. Circumstances such as ‘burn-out’, disillusionment and complacency can cause ‘experts’ to begin to act in less thoughtful, non-reflective ways. Doctors may, for example, cease to engage in thoughtful reflection of the complexities of clinical cases and begin to process patients. Again, therefore, expertise is not a state of never having to engage in an effortful manner with the problems of daily practice. Rather, for Bereiter and Scardamalia (1993), expertise is achieved when one constantly and intentionally engages with one’s environment during the routines of daily practice. Failing to do so represents a loss of expert status.

A third model for understanding the nature of expertise is represented in the work of Donald Schön (1983; 1987), which is based on the premise that practitioners require practical knowledge to deal with the uncertainties of everyday practice, and that this practical knowledge cannot be taught in the classroom. To gain an understanding of what this practical knowledge looks like in action, Schön (1987) observed trainees and experts interacting together during the course of their working day, both in practice and in educational settings. Observing many different professions, he was able to find between them a common thread that he used to explain how experts think in action. He coined the terms ‘knowing-in-action’, ‘reflection-in-action’, and ‘reflection-on-action’
to describe the thought processes a professional engages in during the challenges of daily practice.

Knowing-in-action refers to the ‘know-how’ a professional displays when carrying out daily routines of practice. This knowing-in-action is generally routinized and enacted without reflection, using non-analytic resources and knowledge that is ‘built-in’ from years of practice and experience. Examples may include a surgeon tying a knot or a dermatologist immediately recognizing a case of contact dermatitis. Detailed descriptions of the pathways the experts use to arrive at a particular solution often cannot be accurately reconstructed. Reflection-in-action, by contrast, describes an ability to improvise on the spot to unexpected events or surprises. It requires ‘thinking on our feet’. A jazz band improvising and reacting to each others’ improvisations (Schön, 1987), or a surgeon reacting to sudden bleeding, are examples of this in practice. Reflection-on-action completes the reflective cycle and describes an effortful process performed some time after an event that cannot influence the outcome of that particular event. It is done in an attempt to make sense of previous situations of uncertainty or uniqueness, either out of a curiosity or an effort to prepare for future cases. An unsuccessful resuscitation attempt of a ward patient, a death of a trauma victim, or an unexpected clinical outcome may lead to reflection-on-action, either formally in a debriefing session, or informally as the physician drives home and considers what took place.

One of Schön’s (1987) important contributions to our thinking on expertise was his insight into the different types of problems that professionals face in their daily practice and the effect these problems have on the expert’s use of automatic resources and effortful processes. Routine problems, according to Schön (1987), are often dealt with by way of ‘knowing-in-action’ where the deployment of automatic resources is sufficient. However, as Schön (1987) argues, problems of professional practice do not always present themselves as nice, neat packages that can be solved with standard theories or techniques. Many problems are messy, uncertain, ill-defined and ethically challenged, occupying what Schön (1987) referred to as the ‘indeterminate zones’ of practice. To deal with these types of non-routine, ill-defined problems adequately, the professional must effortfully attend to the situation and understand the intricacies and complexities of the particular case. Schön (1987) calls this practice the ‘naming’ and ‘framing’
of the problem. That is, the ill-defined problem must first be identified or ‘named’ as a problem. Subsequently the problem must be situated in the larger picture or ‘framed’ in order to address it effectively. A surgeon may fail to notice on the pre-operative CT scans that there is an abnormal vessel that will be of utmost relevance to his procedure. He fails to ‘name’ the problem. On the other hand, he may recognize the abnormal vessels but may fail to appreciate the impact it will have on his operation. He fails to ‘frame’ the problem adequately. Or he may recognize the problem and its relevance and therefore, accurately ‘name’ and ‘frame’ the problem. It is this process of converting a ‘messy’ ill defined problem into a well-formed problem that Schön (1987) identifies as ‘central to the art’ of practice.

Interestingly, Schön (1987) recognized that problems were not stable with regard to their status as routine or non-routine. In fact, he explicitly described the phenomenon whereby a problem may start as routine, but during the expert’s engagement with the problem it evolves into a non-routine, ill-defined problem. In doing so, he also provided a personal, anecdotal description of the transitional process of moving from knowing-in-action to reflection-in-action. This process involved stages of initially smooth functioning, followed by increasing struggles with the activity (possibly, he suggests, without explicit awareness of the struggle), followed by explicit awareness of the struggle and a transition into the explicit effortful problem solving process of naming and framing. We might speculate, therefore, that for Schön (1987), expertise involves not the predominant use of automatic, non-analytic resources or the predominant use of effortful analytic processes, but critically depends on the ability to transition appropriately and effectively from heavier reliance on one set of resources to heavier reliance on the other. Crucially, clinicians may ‘miss’ this step and proceed to manage the unnamed (and now missed) problem automatically.

Within the expertise literatures, emphasis is placed on the management of these ‘ill-defined’ (Bereiter & Scardamalia, 1993), ‘unstructured’ (Dreyfus & Dreyfus, 1986) and ‘indeterminate’ zones of practice (Schön, 1987). Each body of literature acknowledges that differences between various levels of expertise can most likely be accounted for in the way the experts manage these problems. How the expert responds to these situations not only contributes significantly to the outcome of the situation but also determines their level of expertise. If we can begin to
understand the factors involved during this process - what the individual pays attention to and why, how the information obtained affects her understanding of the situation, and how she uses this information to make predictions about what will happen in the future – we may begin to obtain a greater understanding of the factors that influence expert judgment.

**Attention and Effort**

If we are to seriously consider a model of expert judgment that highlights the effective and timely transition from automatic, non-analytic resources to effortful, analytic processing, it is important to understand the mechanisms by which such a transition might be triggered. Theories of attention focus on how individuals effectively utilize their cognitive resources to select the information to which they should attend, to process that information, and to act in response to it. To this end, the literature on attention and effort provides an important additional framework for understanding the performance of experts.

It is a basic premise in cognitive psychology that the human cognitive ‘space’ available for mental activity is limited (Cowan, Elliot, Saults, Morey, Mattox, Hismjatullina, & Conway, 2005; Kahneman, 1973; Moray, 2007). Different mental activities place different demands on this limited capacity; easy tasks require little capacity and difficult tasks require more capacity (Kahneman, 1973). Research has shown that our limited cognitive resources can be divided between simultaneous activities with considerable freedom (Moray, 2007) However, each additional task requires additional cognitive resource. If there is enough cognitive capacity available, the additional task can be accommodated and divided attention is successful. If the resources are unavailable and cannot be recruited from other activities, performance falters (Kahneman, 1973; Posner & Rossman, 1965).

Kahneman (1973) in his book *Attention and Effort*, points out that paying attention itself is an effortful activity. He suggests, in fact, that ‘paying attention’, ‘exerting effort’ and ‘investing capacity’ are terms that can be used synonymously. It is not possible to pay attention without exerting effort and without using available cognitive capacity. Yet, at any one time, there are numerous environmental stimuli or information inputs to which one could potentially attend. To be attended to, each input must be “activated” through the use of additional attentional resource
from the limited capacity (Kahneman, 1973). Attending to multiple stimuli simultaneously requires divided attention, and the extent to which a given stimulus can be attended to depends on attentional resources being available (Moray & O'Brien, 1967). By necessity, therefore, humans must limit what they attend to, and how attention is allocated becomes an important consideration in understanding how experts interact with their environment.

According to the cognitive capacity model of attention and effort, there are several factors that control the allocation of resources. The first factor that affects allocation of attention involves the rules of involuntary attention (Remington, Johnston, & Yantis, 1992). That is, there are certain stimuli that are not expected, but nonetheless grab our attention because of their salient features. Some of these features are fairly hardwired, such as fast moving or novel stimuli (Barcelo, Escera, Corral, & Perianez, 2006), while others are acquired by association over time, such as our name being mentioned in a peripheral conversation (Corbetta & Shulman, 2002; Trevarthen, 1977). A second factor that determines allocation of attention is anticipation of the stimulus (Leblanc, Norman, & Brooks, 2001; Simons, 2000). If, for example, we are asked to listen to the voices in our right ear, we are more likely to hear the voices in our right ear than the voices in our left (Moray, 1959). Similarly, if we are asked to look for a fracture in an X-ray, our chances of identifying it are increased. Through anticipation, we reduce the effort required for adequate identification of relevant features in the environment. As a third factor, there is an evaluation system such that incoming, simultaneous demands on capacity are assessed and either given the necessary resources or not (Kahneman, 1973). When two stimuli arrive simultaneously, the stimulus that is judged as more important by the evaluation system gets priority. Attention to stimuli that are deemed less important or unimportant can be effectively depressed allowing us to ignore many irrelevant items in the environment (Kahneman, 1973).

Finally, at a more generic level, it is worth noting that alterations in arousal can affect the allocation of resources (Kahneman, 1973). For example, arousal levels alter the absolute capacity limit in the form of an inverted-U shaped function. Increased arousal can increase cognitive capacity but too much arousal can be problematic. Thus, very low or very high arousal levels may impede performance by decreasing the absolute cognitive capacity (Johnston, Driskell, & Salas E, 1997; Yerkes & Dodson, 1908). Arousal not only affects the absolute amount of
cognitive resource available, it also affects the effectiveness with which it is allocated (Easterbrook, 1959). For example, in more stressful contexts, attention becomes highly focused on tasks we identify as being of dominant importance. Peripheral (or more accurately, less dominant) stimuli are not attended to - referred to in the stress literature as tunnel vision (Johnston et al., 1997; Simons, 2000). In addition, our ability to differentiate between relevant cues and irrelevant cues is impaired, often resulting in a perseveration of attention on a narrow, sometimes inappropriate set of stimuli (Johnston et al., 1997). Therefore, in states of high arousal, our ability to allocate our attention effectively can deteriorate (Easterbrook, 1959).

The attention literature, therefore, provides an interesting perspective for understanding the development and enactment of expert performance. Both the expert and the experienced non-expert have a limited cognitive capacity. Through experience, increasingly complicated and complex activities become automated, and therefore cognitive resources are freed up for engagement in other activities. In professional practice, these activities may include metacognitive monitoring, reflective activities, and attention to a variety of stimuli in the environment. Thus, the expert should be able not only to engage a set of effective automatic resources, but also to use the resulting freed up cognitive resources to maintain an attentional vigil on the environment, determine whether the automatic resources are functioning effectively in the particular circumstance, and slow down, engaging more effortful processes, when the situation requires it. In contrast, the experienced non-expert may fail to reinvest the freed up attentional resources into the situation at hand, and therefore may not slow down when necessary.

**Situation Awareness**

Building on the attention literature, with its theoretical and conceptual frameworks for what commands our attention, is another body of literature – the situation awareness literature – grounded in the measurement of human performance within complex, real-world situations. Situation awareness most commonly is defined as the “perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future” (Endsley, 1995). More simply it is defined as a “constantly evolving picture of the state of the environment” (Jones & Endsley, 1996). Because
of its grounding within real-life complex environments, it is not a construct that exists for its own sake, but rather, provides the backdrop for human decision making and action selection within these environments (Endsley, 1995; Klein, Calderwood, & Clinton-Cirocco, 1986). The airline industry, for example, has ascribed most incidents involving human error to inaccurate situation awareness (Jones & Endsley, 1996). Often, the decision made in a critical situation was the correct decision given the parameters that the individual was considering, but the parameters themselves were wrong or incomplete due to failures of situation awareness. Poor situation awareness has also been considered a primary causal factor for errors in many diverse domains, including medical dispatch (Blandford & Wong, 2004), medical diagnosis, and anesthesia (Gaba, Howard, & Small, 1995).

Several of the dominant models of situation awareness have their roots in early cognitive information processing models, which presume a linear progression of information processing from data collection to data integration to interpretation and prediction. Jones and Endsley’s (1996) taxonomy of situation awareness errors, for example, classifies errors according to the level at which they occur. Level 1 errors result from a failure to perceive or a misperception of elements in the environment, level 2 errors result from improper integration or comprehension of those elements into a coherent picture of the situation, and level 3 errors result from incorrect projection of future actions of the system. Where errors involve multiple levels, errors at the higher level are presumed to have resulted from errors at the lower level and therefore the lowest level is presumed to be the ‘root’ of the error. Within cognitive psychology, it is now largely recognized that human information processing is much less linear than this taxonomy would imply. Perception of elements in the environment, for example, can depend very much on what information is being sought which can be affected by what one anticipates will happen in the future (Leblanc, Brooks, & Norman, 2002; Simons, 2000; Treisman, 2006). As a dramatic example of ‘inattentive blindness’ from the cognitive psychology literature, Simons (2000) demonstrated that when asked to watch a video and count how many times a basketball was thrown between players standing in a circle, half the subjects failed to notice that a black gorilla walked directly through the circle of players. Our perception of stimuli in any environment very much depends on what we regard to be stimuli and what we anticipate the relevant stimuli to be (Treisman, 2006). As Endsley (1995) suggests “people are not helpless recipients of data from
the environment but are active seekers of data in light of their goals”. It is likely that a combination of ‘bottom-up’ processes (driven by environmental stimuli) and ‘top-down’ processes (guided by the operational goals) run simultaneously during the attainment of situation awareness within dynamic environments (Casson, 1983; Folk & Remington, 2006).

The development and attainment of situation awareness in complex environments can be likened to the practice of ‘naming’ and ‘framing’ in the indeterminate zones of practice introduced by Schön (1987). The accurate perception of a problem that coincides with the accurate framing of the problem establishes accurate situation awareness; this in turn will lead to correct decision making, action selection and ultimately satisfactory patient outcomes. The physician who will do well in the ‘muddy, indeterminate zones’ of practice will be the physician who can attain accurate situation awareness. Further, the factors that have been demonstrated to affect situation awareness are mirrored well in the literature on attention and effort. Thus, the construct of situation awareness may be the cross-road where many relevant literatures - attention, effort, automaticity, and professional expertise, as well as issues related to human factors – intersect. The research questions being asked in the situation awareness literature may therefore provide interesting insights into the notion of expert judgment as a process of ‘slowing down’ appropriately. Situation awareness not only needs to be attained, but maintained, involving constant attention to the pertinent cues of the environment, with an evolving understanding of what that means in light of the goals and objectives, and a prediction of where this course will lead to in the future. At any moment in time, attention needs to be allocated to monitoring the environment for unexpected and unanticipated cues, as well as for assessing results of actions already taken. Thus, questions of how situation awareness develops, how it functions and where and why it fails may be critical to our understanding of expert performance in daily practice (Hogan, Pace, Hopgood, & Boone, 2006).

**Discussion**

There is difficulty in defining precisely what expertise means as it comes with many ‘social and evaluative connotations’ (Bereiter & Scardamalia, 1993). From everyday experiences and interactions with people labeled ‘expert’, we have all developed our own ideas, perceptions and prejudices of what expertise or what an expert means to us. An expert is often thought of simply
as having achieved a certain stature – a person who performs at an elite level, a person who holds a particular position, a person from a particular occupation, a person with experience in a particular field, a person with a certain degree, a person who is a specialist or a sub-specialist. However, thinking of expertise in this way implies that it can be achieved through a series of steps or hurdles and once achieved is always attained. However, as Bereiter and Scardamalia (1993) argue, expertise is not an inevitable consequence of experience and not synonymous with stature or titles. It would seem more accurate, sensible, and useful to consider expertise not from an achievement perspective, but rather from a process perspective – when one is behaving in an expert manner what differentiates that behavior from the one who is behaving in a non expert manner. The term expert or expertise in this paper, therefore, refers to this ‘process’ of expertise, and is not restricted by questions related to ‘achievement’ or ‘job-related’ definitions of ‘what’ or ‘who’ is an expert. Although there are many aspects to this expert process – meeting new challenges, keeping on top of the knowledge base, evolving and transitioning within the field – there is one vital aspect we believe is essential to expert judgment: slowing down when you should. Considering expert judgment from this perspective allows fluctuations in individual performances and provides an explanation of why a resident may behave in an expert manner, exerting expert judgment - or slowing down when he should - while the staff physician may not always do so.

Together, the literatures on expertise, attention and effort, and situation awareness provide a valuable context for considering the process of expertise in daily practice and in particular, the process of expert judgment. Although the term ‘judgment’ has been used rather loosely in the past within the medical literature, we would advocate that it be reserved to describe physician performance when confronted by the ‘indeterminate zones of practice’. That is, we would propose that expert judgment be considered as an expert’s ability to respond effectively in the moment to the limits of her automatic resources and to transition appropriately to a greater reliance on effortful processes when needed. With adequate judgment, the expert will slow down when appropriate and take the time to ensure that the muddy problems of practice will be correctly ‘named’ and ‘framed’.
If we consider expert judgment in this light, different research questions arise. Rather than concentrating on what is in the head of the expert, we would instead focus on how the expert coordinates these analytic and nonanalytic resources. If expert physicians spend most of their time applying automatic resources to routine ‘problems’, how do they recognize the unusual, more ill-defined areas that require a transition to the effortful processes? What are the cues from the environment that initiate reflection-in-action for the physician? What does this ‘naming’ and ‘framing’ process look like? Exploring these questions may provide a valuable first step towards achieving the ultimate goal of ensuring and enhancing physician performance.

As one example of a potential program of research, we might examine the meta-cognitive aspects of this form of expert judgment. We implied earlier that situation awareness is likely made possible, or at least enhanced, through the freeing of cognitive resources as automaticity is developed. But how effortful and consciously directed is the process of situation awareness, and how ‘reflective’ is the decision to ‘slow down’ (Reason, 1984)? The transition from the automatic to the effortful, by definition starts while the individual is within the automatic mode. Thus, the expert may be struggling or slowing down for some time, utilizing additional cognitive resources to do so, prior to becoming aware of the fact that she is struggling. For example, a surgeon may be working in a relatively automatic mode, using freed up cognitive resources for other activities such as monitoring the situation, chatting with her resident, and listening to music. At some point, however, the case may increase in complexity. The surgeon may start to struggle with exposing a vessel that is normally obvious, and utilize more cognitive resources. During this process, she may disengage from the conversation, but not be aware that she is doing so. This may continue for some time before it reaches awareness, at which point the surgeon may ask that the music be turned down so that she can focus her attention on the task at hand. Such a scenario would imply that the surgeon did not ‘know when to slow down’, she simply ‘slowed down when she should’. Thus, it becomes a matter of future research to determine how much awareness is involved in situation awareness and how reflective reflection in action truly is.

To answer such questions, we must consider the methodologies to use. Schön (1983; 1987) conducted fieldwork of the experts in their workplace. He observed experts interacting with students during the course of their normal working activities. The teaching provided a valuable
tool for identifying the indeterminate zones of practice. The teacher and student engaged in a verbal think aloud session while they worked through the issues. By contrast, researchers studying situation awareness, with its roots in the aviation industry, use simulators to mimic real-life performances (Endsley, 2000). With an ability to manipulate the environment, experts observe and monitor pilots during simulated flight sessions. The flights can be intermittently interrupted to seek out what the pilot is paying attention to and why, as well as to obtain an understanding of his level of situation awareness.

What would such a research program in the medical field look like? It is difficult with the exception of certain specialties such as anaesthesia (Angus, 2005) to simulate real-life problems in the laboratory. As Schön (1983) describes, the interest is not in discovering what the expert does with well-packaged problems, but rather to observe what the expert does in the muddy, ill-defined zones of practice. Such work might best be accomplished with ethnographic observational studies of clinicians in their workplace to examine the ‘in-vivo’ recruitment of additional cognitive resources and reflection-in-action (Angus, 2005; Malterud, 2001). Another possibility would be to make use of think aloud protocols (de Groot, 1978; Ericsson & Smith, 1991; Neufeld et al., 1981). Although this method has its limitations, such an approach may be useful for highlighting some of the ill-defined areas that occur in the natural setting and how the expert thinks about them. Conducting these studies in a teaching environment could provide a natural think-aloud session as the teacher and student discuss the issues at hand (Barrows et al., 1982; Farrington-Darby & Wilson, 2006). As a third complimentary approach, interviews with expert teachers could explore their ideas of whether they are able to detect students who lack this judgment and compare them with those who demonstrate it (Silverman, 1994). Physicians who are experienced with training residents should be a rich data source for exploring and understanding what this ability to slow down (or lack thereof) looks like, and what causes the expert to become nervous when supervising trainees. Finally, more controlled manipulation of stimuli such as videotapes of student performances might provide additional information through an exploration of the consistency amongst experts at what causes this nervousness.

By pursuing such questions and methodologies we may be able to develop a deeper understanding of this construction of expert judgment for health care professionals. It may also
provide us with the common language or taxonomy necessary to disseminate findings to the medical community at large and to build upon with further research. And finally, it may assist us with reorienting our research and efforts in medical education toward a better goal, one that is more closely aligned with Bereiter and Scardamalia’s (1993) notion of expertise. That is, the goal of medical education research should not be to establish how to turn medical students into physicians quicker or with less effort, but rather it should be to ensure that medical students develop into experts rather than experienced non-experts. If we train with this as our goal, we will provide physicians with the tools to pursue their job as an expert – “addressing and readdressing, with cumulative skill and wisdom, the constitutive problems of the job, rather than reducing the dimensions of the job to what one is already accustomed to doing” (Scardamalia & Bereiter 1991, pp. 18). To ensure this goal, we must understand better how the automatic and the effortful are coordinated. Until we are able to understand this form of expert judgment, we will not be able to formally teach it, assess it, or provide any remediation for those who are deficient in it.
Post-Script

The above review paper provides an exploration of the relevant literatures that inform the phenomenon of interest – the transition from the ‘automatic’ to the ‘effortful’ in expert practice. Bringing the literatures of expertise, automaticity, reflection, attention and situation awareness together, we begin to understand that a transition occurs in a professional’s practice from a mode of relative ‘automatic’ functioning when dealing with the routine aspects of practice to a mode of more ‘effortful’ or attentive functioning when confronted by the non-routine aspects of practice. The research program reported in this dissertation takes up one of the proposed lines of research from the review paper: interviews and observations of a selected group of clinicians to explore the coordination of this transition in clinical practice – whether clinicians recognize it, what cues initiate it, what the transition looks like, and how it is experienced in practice. The purpose of the study was to develop a theory and taxonomy to understand the phenomenon itself as it plays out in expert clinical practice and for this reason, grounded theory methodology was chosen.
Chapter 3
Study Design and Methods

Overview
This project is a grounded theory study designed in two phases – Phase 1 and Phase 2. Phase 1 yielded two datasets: Phase 1A and Phase 1B. Phase 1A involved 19 semi-structured interviews with 28 surgeons (9 paired interviews and 10 individual interviews) across various surgical specialties. These 19 interview transcripts produced the first dataset (Phase 1A). Further interviews were conducted with 8 surgeons (out of the original 28) to explore an emergent theme. These interview transcripts formed the second dataset (Phase 1B). Phase 2 involved 10 months of participant observations with pre- and post-operative interviews of HPB surgeons. These observations and interviews formed the third dataset (Phase 2). The final dataset developed from a series of 7 semi-structured interviews and reflective notes from informal discussions with a key informant, a colleague of the researcher and a HPB surgeon (also involved with the observational sessions of Phase 2). This chapter presents the methodological framework of the study, a description of the research team, a detailed description of the study design and methods, a section on reflexivity from the position of the principal investigator, and a discussion of relevant ethical issues.

Methodological Framework
Grounded theory methodology, as originally described by Barney Glaser and Anselm Strauss (1967) was at the front of the ‘qualitative revolution’ (Denzin & Lincoln, 1994). It has since inspired generations of qualitative researchers in fields as diverse as education, sociology, psychology and more recently, medical education. Essentially, grounded theory is a research methodology that is designed to develop, through collection and analysis of data that are primarily qualitative, middle range theoretical frameworks that provide explanations of a social phenomenon (Strauss & Corbin, 1998). There are a few key components of the grounded theory methodology (Glaser & Strauss, 1967). First, there is an iterative approach to study design that involves a simultaneous approach to data collection and data analysis. Analyses start early in the data collection phase with reflective memo writing and coding of the data and this process informs further data collection – both in terms of future participants (e.g., purposive sampling).
and future data collection strategies (e.g., questions for further exploration in future interviews). This collection and analysis occurs in cycles and is considered complete when no further emergent themes arise from the analysis process that require ongoing exploration with subsequent data collection. Second, as categories are refined and theoretical constructs are developed, conceptual gaps and holes are likely to be found, requiring further data collection. For this reason, sampling is selected purposefully as the analysis progresses. This process of *theoretical sampling* is also used to provide data that would confirm, challenge, or expand the developing theory and to find out when, how and to what extent the theories are useful. Finally, a constant comparative approach to data analysis occurs that captures similar and dissimilar instances in the data set according to their properties and dimensions and uses descriptions to create conceptual categories and develop themes – precursors to the theorizing process. Theories, therefore, are grounded in the data through this process rather than being pre-determined.

Grounded theory provides a systematic approach to qualitative analysis through the use of specific strategies, contributing to the strength of this methodology. These include a clearly articulated analytic process, the ‘self-correcting’ nature of its data collection process, an intrinsic predilection for theory generation, and its emphasis on comparative methods (Charmaz, 2000). However, there have been several challengers of the grounded theory methodology (Miller & Fredericks, 1999) and in response to these challenges, several proponents of the grounded theory methodology have developed innovative approaches that expand the use of grounded theory methodology across paradigmatic boundaries (Charmaz 2000). The remaining methodological framework section will include a description of the original grounded theory methodology, outline major critiques of the original grounded theory methodology, describe subsequent innovative approaches that address such critiques, and a provide a description of methodological implications for this project.

**Origins of Grounded Theory**

Grounded theory was developed by Glaser and Strauss (1967) at a time when the dominant view in the social sciences was that quantitative methods provided the only means to systematic, rigorous inquiry (Charmaz, 2000). Glaser, a sociologist from Columbia University with expertise in survey methods of sociological research, and Strauss, a qualitative sociologist from the
University of Chicago, presented grounded theory methodology as an alternative means of providing rigorous research - through systematic inductive qualitative inquiry. Glaser and Strauss (1967), themselves positivists, developed a qualitative methodology that upheld the ‘rigors’ of quantitative research, using language and methods that would satisfy those in the positivist paradigm. The epistemological stance and ontological views of those in the positivist paradigm are consistent with the belief that there is a singular truth that can be pursued and attained for the generation of new knowledge. This pursuit of knowledge through the process of research is undertaken in a ‘non-biased’ objective fashion with a detached researcher, demonstrating ‘reliability’ and ‘validity’ (Lincoln & Guba, 2000). One step away, in orientation, is the post-positivist paradigm, an evolution of the positivist framework, borne out of a belief that although truth is ‘real’, as the positivists contend, it is only partially and imperfectly apprehendable by the physical senses (Denzin & Lincoln, 2000).

This evolution opened up the field for alternative methodologies in the pursuit of ‘truth’, such as grounded theory, making it possible to research complex social and cultural phenomena (Harris, 2003). Prior to the introduction of grounded theory methodology, qualitative research was taught through the process of mentoring (Charmaz, 2000). The introduction of systematic methods of study design, data collection and analysis that was presented with the introduction of grounded theory served to appease those in the positivist and postpositivist tradition. Concepts like ‘accuracy’ and the ‘informed detachment of the researcher’ were presented (Glaser & Strauss 1967). Strauss and Corbin (1998) state that “theory that is derived from data is more likely to resemble the “reality” than…theory that is speculative” (pp. 12), and Glaser (1992) writes that “the participant not only tells what is going on, but tells the researcher how to view it correctly” (p.2). The original description of the grounded theory methodology with its emphasis on the notion of an accurate reality firmly situates this approach within the postpositivist paradigm.

**Constructivist Approach to Grounded Theory Methodology**

In time, other paradigms emerged rejecting the notion of a single truth and supporting the ontological view of relativity. Within these paradigms, some researchers abandoned grounded theory, turning to alternative forms of research, like narrative analysis, while others turned away from empirical research altogether (Reissman, 1990; Richardson, 1993). Some researchers
continued to use grounded theory as a methodological ‘tool rather than a ‘prescriptive’ way of doing research, applying approaches aligned with their own ontological perspectives and epistemological positions (Charmaz, 2000; Charmaz, 2005; Rennie & Fergus, 2006). Charmaz (2000) was one such researcher who sought to address her ‘criticisms’ of the original description of grounded theory with its roots in the positivist tradition that were inconsistent with her constructivist paradigmatic views. Each of these inconsistencies or ‘criticisms’ will be addressed in the following paragraphs, using a constructivist lens, and will therefore highlight the constructivist approach to grounded theory methodology used in this study.

‘Decontextualization’ and the development of theory
The original process of grounded theory analysis has been criticized for ‘concealing’ or ‘fracturing’ the data by separating the context from the transcript. In its pursuit of objectivity, the original description implies that through the process of analysis, the researcher can separate the experience from the experiencing subject, the meaning from the story, and the viewer from the viewed (Charmaz, 2000). As Barney Glaser (Glaser, 2002) stated, the “data is what it is – [sic]” (p.1), asserting his faith that the progressive abstraction involved in the process of seeking emergent theory can ‘erase’ or almost completely remove the biases and influences of the researcher. This is an ideal position for those in the positivist paradigm, but inconsistent with those in the constructivist paradigm who view context as an essential consideration in the development of new knowledge (Reissman 1990; Richardson 1993).

Moving into the realm of interpretivism, there is no assumption of a unidimensional external reality, but rather multiple social realities that may co-exist (Denzin & Lincoln, 2005; Madill, Jordan, & Shirley, 2000). Interpretivism and constructivism are related approaches to research that are characteristic of particular philosophical world views. Knowledge is co-created by both participant and researcher as an interactive process taking into account social, cultural, environmental and structural contexts (Charmaz, 2000; Madill et al., 2000). The story that is created reflects “the viewer as well as the viewed” (Charmaz, 2000)). The constructivist approach to grounded theory can be seen as a middle ground between the positivist approach on one end, with a search for one absolute truth and the postmodernist approach, on the other, with the rejection of all notions of truth (Madill et al., 2000). A constructivist approach to grounded
theory is concerned with searching for meaning, rather than searching for truth, seeking the tacit meanings and interpretations of both researcher and participant as a co-creation of their interpreted reality (Madill et al., 2000, Charmaz, 2000).

‘Atheoretical’ positioning and the development of theory
Another common critique of the grounded theory method is that researchers must assume a naïve or ‘atheoretical’ stance in relation to the phenomenon under study to “preclude the theoretical tunnel vision” (Charmaz, 2000; Sandelowski, 1993). Glaser and Strauss (1967), in their original descriptions of this methodology, claim that researchers should “literally ignore the literature of theory or fact on the area under study” (p. 37). One of grounded theory’s basic processes is the analytic search for ‘emergent’ themes within the data, and many traditional grounded theorists claim that by starting out with a preconceived theory, emerging theories may not be discovered as researchers lay a theoretical framework on to emerging data. In a sense, the researcher who enters the research process with a preconceived theory subsequently ‘forces’ the data to fit within that theoretical perspective (Glaser, 1992). Critics of this position, however, claim that theoretical frameworks can be used to inform the research without interfering with the process of emergence. Further, they claim that it is impossible for a researcher to completely discard their theoretical perspective as it has informed the creation of the research question up to that point, has informed their study design and subsequently determines to a large extent what they see, hear and do within the data collection and analysis process (Kushner & Morrow, 2003; Rennie, 2000). They argue that theory does not only pertain to the conceptualization of the target phenomenon (in my case, ‘slowing down when you should’) but also to the ontology, epistemology, and method of inquiry itself (Sandelowski, 1993). Although a theoretical orientation is not always described and may be denied, Sandelowski (1993) argues that “it is always implicit in the way a problem is presented, in the literature reviewed, and most importantly, in the selection and description of the method itself”.

Many grounded theorists use a theoretical perspective to explore or explain research questions that will illuminate emergent analytic constructs. Sandelowski (1993) refers to this as “theory entering qualitative projects from the outside”. For example, consider the work of Lingard and
colleagues (Lingard, Garwood, Schryer, & Spafford, 2003) whose approach to studying case presentations was informed by rhetorical theory, while results of the emergent analysis were such that sociological theory also provided a relevant theoretical lens for discussion of the results.

Inductive, deductive and abductive logic and the development of theory

One further methodological critique of grounded theory relates to the theories of logic on which the premises of grounded theory rest. Glaser and Strauss (1967) emphasize that grounded theory is an inductive process (i.e. a process of making generalizations based on a series of specific observations) where theories are created from the data analysis and are firmly embedded in the data. The dominant discourse at that time was the deductive model used by the quantitative researchers in hypothesis or theory testing, where theories are stated \textit{a priori} and research is then conducted to assess whether the hypothesis is ‘true’. Proponents of grounded theory claim that the problem with work that depends on logically deduced theory is that the ‘cart comes before the horse’; researchers untrained in inductive reasoning will then gather data to merely verify and confirm their theory. Consistent with the tenets of the original description of grounded theory, grounded theorists through systematic inductive reasoning, dispassionately gather the data and then pull the strand cleanly from it. The theory emerges from the data.

Critiques of this inductive reasoning logic assert that discoveries are rarely made on induction alone, and that inductive reasoning through the process of interpretation cannot infer explanatory or predictive power. As Thomas and James (2006) suggest, “there is a difference between the noticing of an association and the confident issuing of an inference ticket”. Ryle (1990), the originator of the ‘inference ticket’ idea states that the natural sciences have demonstrable and clear methods for issuing these ‘inference tickets’; “Bacteriologists do discover causal connections between bacteria and diseases…and so provide themselves with inference tickets which enable them to infer from diseases to bacteria” (p.117). These inferences depend on fact finding and reasoning to develop the associations as well as attempts at testing, replicating, and falsifying. Thomas and James (2006) question the legitimacy of grounded theory in providing the power that other kinds of theory have, without providing an account of the legitimacy of the ‘grounded theory’ itself. They reject the notion that grounded theory, developed through inductive reasoning, provides anything more from an epistemological point of view than
“everyday noticing” (Thomas & James, 2006). Glaser (Glaser, 1992), in response to such criticisms, maintains that validation of the theory is assumed under the systematic methods of ‘grounded theory’ itself, particularly the constant-comparative method, bracketing, and theoretical memoing.

Strauss (1987), on the other hand, appears not overly convinced with Glaser’s (1992) arguments, and takes the data analysis process in a different direction citing a combination of inductive and deductive reasoning as being central to the process of theorizing. Along similar lines, others have taken a different view on the theorizing process with ‘abduction’ a central theme to it, claiming this provides more credibility to the development of ‘theory’ than induction alone (Atkinson & Delamont, 1994; Miller & Fredericks, 1999; Rennie, 2000). Borrowing from Peirce’s theory of logic (Peirce, 1965), Rennie (2000) stresses an abductive/ inductive cycle of analysis as a process of creative generation of theoretical hypotheses, that is subsequently verified by further inductive processes of data gathering. This stresses the contribution of scientific creativity as being central to scientific theory development, no matter what paradigm one is situated in. Though Rennie (2000) does not stress the deductive component, original descriptions by Peirce (1965) outline an abductive, deductive and inductive cycle that seeks to create a set of ‘explanations’ for the data, deductively apply these explanations in the appropriate form of data collection, while allowing the data to inductively confirm or disconfirm the hypothesis. The argument here is that all science is borne out of a creative mind that seeks to understand that which is identified and chooses the most plausible explanations and hypotheses to be considered.

For the purposes of simplification, Peirce (1965, p.5.189) illustrates with a symbolic example: “The surprising phenomenon, X, is observed. Among hypotheses A, B, and C, A is capable of explaining X. Hence, there is a reason to pursue A.”

After suggesting a plausible hypothesis, the next stage, according to Peirce (1965), is to refine the hypothesis with logical deduction. Deduction is drawing logical consequences from premises. The conclusion is true given the premises are true also. In this model, the abduction and deduction gives propositions, with inductive reasoning forming a self-correcting process that
gives support to these propositions (Peirce 1965). Relating this to grounded theory, Rennie (2000) states that the creation of a category is, in effect, an abduction, as it is the creation of an imaginative and plausible explanation for a set of observations. Codes are developed from the original datum using inductive techniques and then plausible categories are created that group the codes together using abduction. The categories and frameworks as they are modified with ongoing analysis are reapplied to the data set (one could say, deductively, though Rennie does not use this term) and further refined through the inductive process using further data collection. Rennie (2000) states that the process of generation of grounded theory is an “interplay between abduction and induction” (pp. 494), providing a theoretical basis for the ‘self-correcting’ nature of the data collection and analysis, and supports the validity of theory generated through this method.

As researchers from paradigms other than the positivist or post-positivist paradigms, embrace grounded theory as a methodological tool, an analysis of how their epistemological and ontological views affect the methodology is critical. In the following section, methodological implications for the present study, using the constructivist approach, will be explored.

**Methodological Implications for the Present Study**

This study was designed using a constructivist’s approach to grounded theory. This section will describe the methodological implications for this on the present study, highlighting how the aforementioned criticisms of the original (post-) positivist approach were managed in the conception, design, data collection and analysis of this study.

‘Decontextualization’ critique

Recognizing the effect of the researcher position, as surgeon and colleague to the study participants, a deliberate effort was made to reflect on this throughout. This was not done to eliminate ‘bias’ but to recognize the influences, to the extent that it was possible, that such a position might have on the study. Relevant contextual information was collected in all phases of data collection and considered in the analysis. A research assistant was chosen from a non-medical field and was heavily involved in the research process, to assist in recognizing emergent issues that may have been overlooked by the principal investigator, following the premise that
having been socialized into the surgical culture, she might perceive, filter, select, and interpret sensory cues from the environment according to meaningful patterns that have already been learned (Gilchrist & Williams, 1999). The intention was for the research assistant to provide a different lens through which the phenomenon of ‘slowing down’ could be viewed and considered. The different perspectives afforded by both researcher and research assistant provided interesting insights into not only the phenomenon under study, but also the interaction between surgeon participants and researcher in this setting. These will be elaborated further in the section on reflexivity.

‘Atheoretical’ critique
The ‘atheoretical’ critique was addressed through a transparent description of the influence of theory on the research process. A number of theories were used to inform the development of the research question (e.g., cognitive psychology theories of dual processing models (DeNeys & Glumicic, 2008; Kahneman, 1973), automaticity theories (Dreyfus & Dreyfus, 1986), and Schön’s model (1983) of reflective professional practice) and to provide explanatory perspectives on the results of the analysis (e.g., attention capacity theory (Kahneman, 1973) and situation awareness theory (Endsley, 1995). However, careful adherence to the principle of emergence was undertaken through the analysis process. Of particular note, the researchers were well aware of the influence that naming the phenomenon of interest (‘slowing down when you should’) might have on the data collection and analysis process. The term ‘slowing down’ was purposefully left out of the interview introductions, with discussions developing from general ideas of surgical judgment, and eventually leading to a description of the transition from the ‘automatic’ to the ‘routine’. Eventually surgeons were asked what they thought of the term ‘slowing down when you should’ to describe the phenomenon, but care was taken not to introduce it too early, allowing the data to emerge without the influence of descriptive terms.

Inductive, deductive and abductive logic and the development of theory
Finally, the critiques related to logic and the validity of category formation were addressed through the process of developing preliminary thematic codes (i.e., abduction) and then testing or considering these codes (i.e., deduction) in ongoing data collection, and revising such codes with emergent information (i.e., induction). This included careful documentation of the resultant
revisions to the coding structure through the memo-writing process. Data collection and analysis were conducted in an iterative, cyclic fashion to provide opportunities to confirm and refute preliminary findings, and thus to test and revise emerging theory.

Research Team
At the time of the commencement of this thesis, the principal investigator was a trained HPB surgeon, having completed a clinical fellowship 2 years prior, at the institution where this study took place. In the two years preceding the commencement of this project, the principal investigator completed a Masters of Education, with a randomized controlled trial studying the effects of different practice distributions on surgical technical skill acquisition. The principal investigator was also involved in a large multi-centred, randomized controlled clinical trial throughout this PhD project, and she had never been involved in a qualitative project before this dissertation. The impetus for the studies in this thesis came from a longstanding interest in surgical judgment, encouraged by many discussions with members of the research team in the months preceding the commencement of the PhD. It was decided that a qualitative approach to the research questions was necessary, starting the principal investigator on a journey towards understanding qualitative research.

There were five other members of the research team. The research assistant was a Masters student who entered into a PhD in anthropology during the course of this study, with practical experience in qualitative research. The project supervisor was a cognitive psychologist with long-standing expertise in the domain of medical education, and experience collaborating on qualitative research projects. The third member of the team was a surgeon with experience in qualitative research and an interest in surgical judgment and education. The fourth team member was an education scientist with a background in rhetoric and expertise in qualitative methodology (in particular, grounded theory). The final member of the team, a senior HPB surgeon, friend and colleague of the principal investigator, became increasingly interested and involved in discussions about this research, eventually assuming the role of ‘key informant’. He served as an interesting member of the team as he became a participant for Phase 2, providing particularly rich, reflective information about his own ‘slowing down’ moments. He also served as a ‘member check’ as interpretations of the data from Phase 1 and 2 were recycled back to him.
Study Design

Overview

This project was a grounded theory study designed in two phases which created four separate datasets (see Table 3A; page 39). The first phase resulted in two sets of interviews and hence, two separate datasets, subsequently referred to as Phase 1A and Phase 1B. Phase 1A involved 19 semi-structured interviews with 28 surgeons (9 paired interviews and 10 individual interviews) across various surgical specialties, forming the first dataset. Phase 1A was designed to explore surgeons’ perceptions of the phenomenon ‘slowing down when you should’ and its link to surgical judgment in the operating room. Phase 1B involved semi-structured interviews of 8 surgeons (a subset from Phase 1A) to further explore an emergent finding from the first set of interviews. These interview transcripts formed the second dataset (Phase 1B). Phase 2 involved 10 months of participant observations in the operating room, to witness the phenomenon ‘slowing down when you should’ and to refine the framework created from Phase 1. The participants were HPB surgeons and this third dataset included field notes, reflective notes and transcripts from brief pre- and post-operative interviews. The fourth and final dataset from this study developed from a series of 7 semi-structured interviews and reflective notes from informal discussions with a key informant, a colleague of the researcher and HPB surgeon (also involved with the observational sessions in Phase 2).

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<th>Phase 1</th>
<th>First Dataset</th>
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<td>Phase 1A: Transcripts from 19 semi-structured interviews</td>
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<td>Second Dataset</td>
<td>Phase 1B: Transcripts from a subset of 8 interviews from Phase 1A</td>
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<td>Phase 2</td>
<td>Third Dataset</td>
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<td>Phase 2: Field notes and transcriptions from OR observations and on-site interviews</td>
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<td>Key Informant Interviews</td>
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<td>Fourth Dataset</td>
<td>Transcripts from 7 formal interviews and reflective notes from informal discussions</td>
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Table 3A: Description of the datasets
The project took place in urban tertiary referral centers affiliated with the University of Toronto, Ontario, Canada. Institutional review board approval was obtained from each site. Being affiliated with the University, these centers were teaching institutions where the majority of surgical residency took place. They were also centers where complicated and complex surgery was performed and where many notable experts in the field of surgery were employed. The decision had been made earlier in the design of the study to explore this phenomenon focused on the ‘expert’ population of surgeons – those considered to have ‘good’ judgment by word of mouth and reputation. Complex and complicated cases were pursued as they were considered to provide a richer source of the phenomenon than the routine cases. Acknowledging that this phenomenon also exists outside the operating room in everyday clinic and ward surgical practice, a deliberate decision was made early in the project to restrict the study of this phenomenon to operative room experience. Given the stress and time constraints that were unique to the operating room, it was felt that this phenomenon might be sufficiently different inside the operating room to warrant separate attention. Further study of this phenomenon in other areas of surgical and medical practice would warrant exploration in future research endeavours. All participants for the studies were senior surgeons considered ‘expert’ in their specialty. The project timelines are outlined in Table 3B.

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<th>Phase 1</th>
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<td>Phase 1A) Semi-structured interviews and analysis</td>
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<td>Phase 1B) Subset of interviews and analysis</td>
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<th>Phase 2</th>
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<td>OR Observations and on-site interviews and analysis</td>
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**Table 3B: Project timeline**
Phase 1: Semi-structured Interviews

Phase 1A

This phase was designed to explore surgeons’ perceptions of surgical judgment as they related to the phenomenon of ‘slowing down when you should’ in operative surgical practice. Surgeon’s experiences with this phenomenon, whether they acknowledged it, how they discussed it, and what contributed to it were explored. Data were collected through semi-structured interviews. The purpose of this phase was to create a preliminary framework of the phenomenon of ‘slowing down when you should’ that could be further refined and explored with observations in Phase 2.

Phase 1A participants

The participants for this phase included 28 surgeons across different specialties (9 general surgery, 4 neurosurgery, 3 orthopedics, 3 cardiac surgery, 3 vascular, 2 otolaryngology, 2 plastics, 1 thoracic and 1 trauma general surgeon) from four different tertiary referral hospitals affiliated with one university. Given that ‘slowing down’ moments were thought to occur in every sub-specialty, we chose to include as many surgical specialties as possible to capture any potential nuances of this phenomenon within each specialty that were unknown at the outset. The sampling strategy was to interview surgeons involved in the complexities of their field and challenged daily by non-routine aspects of practice. Through this purposive or theoretical sampling strategy (Emerson, Fretz, & Shaw, 2001), we targeted surgeons who were considered, by word of mouth, to have ‘good’ surgical judgment and thought to be reflective. This reflective ability was considered essential to be able to deconstruct the phenomenon of ‘slowing down’ in an interview.

Surgeons were contacted via email with a letter from the PI explaining the request for an interview. They were informed that the purpose of the interview was to explore their perceptions of surgical judgment and that the interview would be approximately one hour. All surgeons who were contacted agreed to participate and the scheduling of the interviews was arranged through the research assistant with each surgeon’s clinical assistant. Informed consent was obtained at the start of the interview. Initially, interviews were conducted in pairs. Surgeons were notified before the interview which surgeon they were being paired with. The decision to match up surgeons to another in their own specialty was based on an assumption that surgeons would talk more
enthusiastically and in more detail with a similar surgeon who ‘understands’ the details of the operative events. After 7 paired interviews were conducted, a surgeon refused to be interviewed with another colleague and requested to be interviewed alone. Both of these surgeons were interviewed alone. The next surgeon was serendipitously interviewed alone. It became apparent with the ongoing iterative cycles of data collection and analysis that individual interviews with surgeons seemed to encourage more critical self-reflection and thoughtfulness about their experiences. This informed the ‘slowing down’ phenomenon in a different way than the paired interviews that provided more surgical detail. Most of the remaining interviews were conducted individually, though paired interviews that had already been scheduled were kept.

Qualitative methodologists have established that five to eight sampling units will generally suffice for the collection of a data set that provides an appropriately rich understanding of a well-defined subject area (Kuzel, 1999). A sampling unit is a more useful term to consider than sample size as it gives a clearer idea of what was involved in the data collection. For example, one person (a sample size of one) may be interviewed 3 times and observed 2 times, giving a sampling unit of 5. A sampling unit may be an interview, a day of observations, or a single unit of observation when the phenomenon of interest occurs (Hupcey, 2005). Each 60-minute interview was considered to be a rich source of data, constituting one sampling unit, provided the surgeons had an ability to verbalize and reflect on their experiences. Being unsure how this would unfold, we set a sample size of 12 interviews as the recruitment target. However, saturation - the point at which no new emergent themes are found in the data - was the ultimate guide to sample size (Morse, 1995). Data collection and analysis proceeded simultaneously, and as further themes emerged and developed, more interviews were scheduled. There were 10 individual interviews altogether in the data set and 9 paired interviews (28 surgeons). More interviews were conducted than expected by Kuzel’s (1999) prediction and this was thought to be due to a combination of factors. Firstly, individual and paired interviews elicited different aspects of the phenomenon with one encouraging reflection and the other encouraging storytelling. Secondly, because of surgeon’s busy schedules, interviews were arranged ahead of time and so interviews continued even though researchers felt they were reaching saturation. And finally, some world renowned expert surgeons were amongst the final few to be interviewed and the principal researcher made a decision to interview them for their potential to be rich sources of
data. The final stages of Phase 1 overlapped with the commencement of Phase 2 (see Table 3B; page 40). The evolving framework that was developed in Phase 1 was refined in the operating room observations of Phase 2. This contributed to further interviews being scheduled to explore surgeons’ perceptions of the researcher’s observations from Phase 2. Further interviews provided a forum for checking the emerging theoretical constructs and served as a means for probing particular aspects of the evolving framework further.

Phase 1A Data collection: Semi-structured interviews
Semi-structured interviews were conducted with 28 surgeons in 19 interviews (9 paired and 10 individual) across various surgical specialties. The interviews took place in the surgeon’s office or a suitable place recommended by the surgeon(s). The length of each interview ranged between 40 and 90 minutes. The first interview was conducted with two investigators (CAM and HM). Most subsequent interviews were conducted with both research assistant (CEM) and primary researcher (CAM). During these interviews, it was mainly the researcher who was engaged in questioning and discussions, though the research assistant took part as well. The research assistant assisted in reflective note taking and process/ non-verbal notes and at the conclusion of each interview, the research assistant and the researcher shared their views of the interview. Having the research assistant available at the interviews to keep track of memos and questions covered allowed the researcher to concentrate on discussions with the surgeons, with the research assistant filling in gaps from the interview template when necessary. Most surgeons directed their answers and discussions at the researcher rather than the research assistant, regardless of who asked the question, and it was decided that the research assistant conduct some interviews alone (n=3) to assess whether different aspects of the phenomenon could be revealed. These interviews revealed similar codes, but the content of discussions of the operative cases were covered in much less detail. There was also less follow-up of the surgeon’s responses of the operative details because of the lack of surgical training on the part of the research assistant. The research assistant also felt that surgeons were dismissing her as not understanding “their surgical world” and hence did not give her the respect or time that was afforded to the principal researcher.
The first two interviews started with an explanation by the primary researcher (CAM) of the ‘slowing down’ phenomenon in the surgical setting and followed with an exploration of the surgeons’ perceptions of the phenomenon. This was considered necessary as surgeons were not familiar with the ‘slowing down’ term or the various literatures that inform it. For these interviews, surgeons very quickly adopted the phrase ‘slowing down’ in their subsequent discussions and descriptions of the phenomenon in their practice. Fearing that the discussions of the ‘slowing down’ phenomenon might be limited by preemptively labeling it ‘slowing down’, it was decided to commence the interviews on a more general note – exploring surgeons’ perceptions of surgical judgment and introducing them to the phenomenon by calling it a transition rather than ‘slowing down’. During the interviews, surgeons were asked whether they recognized the phenomenon in their operative practice of transitioning out of the ‘automatic’ mode and into the effortful mode, and were asked to discuss their experiences with it. They were also asked to reflect on their teaching experiences around these transitional moments in their surgical practice. Interview questions were added and refined as part of the iterative process between data collection and analysis (refer to Appendix A and B). All interviews were audiotaped and transcribed following the interview.

Phase 1B
All surgeons recognized the phenomenon in their operative practice, though eight surgeons adamantly denied ever being in ‘automatic’ mode. Given that automaticity was a well recognized phenomenon in the expertise literature, researchers were somewhat perplexed by these surgeons’ indignant denial of ever being in ‘automatic’ mode. However, once the observation sessions had started, researchers began to call into question their understanding of ‘automaticity’ and the theoretical concept of ‘automaticity’ in professional practice in general. This led to a renewed interest in the term and a decision to explore this with the subset of surgeons from Phase 1A who had already problematized the term. Further interviews were conducted with this subset of surgeons, forming a separate dataset of 1B.

Phase 1B participants
The participants for Part 1B were a subset of those involved with Part 1A and included all surgeons who denied ever being in ‘automatic’ mode in the course of their surgery. They
included 8 surgeons across different specialties (2 general surgery, 1 vascular surgery, 1 neurosurgery, 2 cardiac surgery, 1 otolaryngology, 1 plastic surgery) from four different tertiary referral hospitals affiliated with one university.

**Phase 1B Data collection: Subset of further semi-structured interviews**

Surgeons were re-interviewed individually in 30-45 minute interviews where their perceptions of automaticity were explored. Surgeons were contacted via email with a letter from the PI explaining the request for a second interview. They were informed that the purpose of the interview was to explore an issue that had emerged from the first interview. All surgeons who were contacted agreed to participate and the scheduling for the interviews was arranged through the research assistant with each surgeon’s clinical assistant. Consent was subsumed under the first interview. Surgeons were asked to elaborate further on their view of ‘automaticity’ in the operating room and were questioned about whether staying out of an ‘automatic’ mode was intentional or not. Their general approach to their surgical practice was explored including their approach to other team members in their operating room. Their views on listening to music and allowing social “chatter” in their operating room were also explored.

**Phase 1A and 1B data analysis**

The reflective notes and transcripts from Phase 1 interviews were read by the researcher (CAM) and the research assistant (CEM) and analyzed for emergent themes using grounded theory methodology (Charmaz, 2000; Strauss & Corbin, 1998). In the grounded theory tradition, preliminary data analysis occurred in conjunction with data collection in an iterative and constant comparative process. When incidents of interest were noted in the data, they were compared against similar incidents in the other transcripts noting similarities and differences. Through the iterative constant comparative process, emerging theoretical constructs were refined and elaborated through comparisons with ‘fresh’ examples from ongoing data collection. The process of data analysis informed the process of data collection with further exploration of these emerging constructs in subsequent interviews.

During the readings, the researcher and research assistant, separately and together, wrote notes and memos in order to “develop tentative ideas about categories and relationships” (Maxwell,
This process of open coding (Strauss & Corbin, 1998) grouped instances together according to their meaning. The process of constant comparison of themes was employed to rename, redefine, and reorganize thematic categories and a process of abduction and induction was employed (Rennie, 2000) to further refine thematic categories. This open coding process produced a preliminary coding structure that was discussed and refined through meetings with the project supervisor and other members of the research team.

Once the major themes were developed, a second level coding process, called axial coding, (Strauss & Corbin, 1998) was performed to explore and define the connections between categories. Memos were written to define the properties and characteristics of themes and categories, to elaborate patterns identified within categories, and to formulate emergent theory at progressive levels of abstraction. This process of axial coding was discussed and refined at regular meetings with members of the research team where extensive collections of coded transcripts and reflective notes were examined. Discrepancies between research team members were resolved through direct referrals to interview transcripts. Maintaining an audit trail of all analytical memos, minutes of the meetings, and revisions to the coding structure assisted with ensuring confirmability. Following the meetings, the research assistant applied the revised coding structure to the complete data set, using NVivo software (2007, QSR International Pty) for data management and facilitation of cross-referencing in the large data set (Kelle, 2002).

The significant involvement of all members of the research team in the coding process was a deliberate methodological decision. Consistent with the constructivist lens of multiple perspectives and multiple social realities, it was neither the intention, nor the expectation that multiple researchers from different backgrounds would obtain ‘true meaning’ from the data set. It was, however, carefully considered that various perspectives would add richness to the interpretation of the data and depth to the evolving theories. It was intended through group discussions that the research team, with 5 varied disciplinary perspectives (surgery, education, cognitive psychology, rhetoric, anthropology), could agree upon an interpretation that was useful for explaining the phenomenon under study and capable of generating practical implications for clinical education, research, policy, and practice.
Many interpretations were recycled back to the key informant as a means of engaging in an in-depth discussion. This provided an avenue for ‘member checking’ as well as a search for ‘disconfirming evidence’ of evolving theories at many steps in the research process. It provided a forum where the researcher could be reflective about interpretations and emerging theories, using a colleague interested in the phenomenon of ‘slowing down’ as a ‘sounding board’ (Gilchrist & Williams, 1999).

**Phase 2: Participant (and Non-Participant) Observations and Brief On-Site Interviews**

In order to understand more fully what the slowing down phenomenon looks like in the setting of the operating room, and to refine the preliminary thematic framework from Phase 1, participant observations of expert surgeons were conducted during surgical procedures. Brief on-site interviews were conducted with the surgeon before and after most OR observations. The preliminary framework from Phase 1A described two main groups of initiators of the ‘slowing down’ phenomenon intra-operatively. The first group, referred to as ‘proactively planned slowing down moments’, were planned according to anticipated critical events prior to surgery. Surgeons in Phase 1A described the creation of a “game plan” prior to surgery where they consider and anticipate the critical events of surgery. It was this “game plan” that was explored with the surgeons in the pre-operative interview. The second group, referred to as ‘situationally responsive slowing down moments’, were caused by an emergent intra-operative issue. The purposes of the post-operative interviews were to confirm observed operative details, to explore surgeons’ thoughts on observed ‘slowing down’ moments, and to hear their reflections on moments in which they ‘failed to slow down’.

**Phase 2 participants**

The study participants for Phase 2 were a group of HPB surgeons who routinely perform complicated operative cases. Toronto General Hospital (TGH) is a tertiary referral centre where complex HPB surgical cases are sent from all over Ontario. Sampling estimates were based on Kuzel’s (1999) ideas of five to eight sampling units (i.e., interviews, observational sessions) for the collection of a data set that provides an appropriately rich understanding of a well-defined subject area. A sampling unit for this phase was considered the observations and interviews associated with one operation, as this type of tertiary level surgery that lasts approximately 4-6
hours would likely constitute a rich sample of ‘slowing down’ moments. During the study period, there were 5 senior HPB surgeons on staff. Our estimates were that each surgeon should be observed at least two to three times, providing 10-15 sampling units. This group of 5 surgeons was chosen for several reasons. Firstly, the principal investigator is a junior HPB surgeon on staff at TGH. Given her specialty interest of HPB surgery, it was thought that she would be in the best position to be an informed observer of operative details and procedures. In order to identify the subtleties of the slowing down phenomena, it was felt that the observer had to understand the intricacies and complexities of the procedure. As a HPB surgeon, the principal investigator would be able to identify these intra-operative moments and understand the thought processes, or at least be able to probe the thought processes, behind any concern and decision-making. Secondly, it was considered important to study surgeons performing at an expert level. Defining who an expert is may be somewhat controversial. Choosing to study HPB surgeons at a downtown teaching hospital where outcomes are peer reviewed and monitored and where surgical procedures are standardized and conducted repeatedly allows for some assurance that they are expert at what they do. Thirdly, choosing to study complex operative cases was thought to provide the intensity and depth of information necessary to capture the phenomenon of ‘slowing down when you should’ (Kuzel, 1999). Complex operative cases tax the cognitive resources of experts in this domain so that the phenomenon of ‘slowing down’ should be observed and displayed. And finally, the teaching environment was thought to be the ideal setting to study this phenomenon as it encourages an open dialogue between surgeon and trainee as the ‘slowing down’ moments are encountered.

Phase 2 data collection: Participant observations

The preliminary framework from Phase 1 guided our observations in Phase 2. Observations took place at the Toronto General Hospital and were conducted by the principal investigator and the research assistant. Observations were conducted over a 10 month period. Five surgeons were involved in this phase and all were considered ‘expert’ HPB surgeons. A total of 29 cases were observed for a total number of hours of 147 (see Table 3C). The principal investigator observed 14 cases for a total of 72 hours. The research assistant observed 15 cases for a total number of 75 hours. For similar reasons explained previously, it was felt that the non-surgical research assistant might offer different perspectives than the surgeon researcher and so observations were
carried out by both members of the team. The length of each observation session ranged from 2 to 12 hours.

<table>
<thead>
<tr>
<th>Surgeon</th>
<th>Number of Cases</th>
<th>Number of Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td>33</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>36</td>
</tr>
<tr>
<td>C</td>
<td>6</td>
<td>28</td>
</tr>
<tr>
<td>D</td>
<td>7</td>
<td>37</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>147</td>
</tr>
</tbody>
</table>

Table 3C: Phase 2 operating room observational sessions

Consent was obtained at the beginning of the study period from each of the 5 HPB surgeons eligible to participate in this study. Each week the operating schedule was studied and the cases selected. Initially the intent was to capture only the more complicated cases to maximize the number of ‘slowing down’ moments. However, as an emergent theme appeared problematizing the term ‘automaticity’, we selected more routine cases so we could observe the surgeon in the ‘automatic’ mode. This range of cases allowed the full range from automatic to effortful to be captured, contributing to the richness and credibility of the data.

The observers were able to get close enough to the surgical field so that details of the operative cases could be witnessed. Study participants were requested at the start of the observation sessions to refrain from asking the principal investigator her opinion on any matters related to the case. The principal investigator initially wanted to observe the OR events during these ‘slowing down’ moments with little influence from her as a surgeon so it was suggested to the surgeons that they call a third person for a second opinion if required (more on this in the ‘Reflexivity’ section). Surgeons were told they might be asked to explain their thought processes during the ‘slowing down’ moments if the researcher wanted verification of her own thoughts on what was unfolding. This was not done if the situation was tense or patient safety could have been jeopardized.
The research assistant, who had prior experience with qualitative research but no prior experience with observational methods, was trained over a period of 2 weeks. After completing a series of reading assignments, the research assistant was briefed on the specific techniques to be employed by the research team (e.g., participant identification by code, handwritten notes in double columns to capture both observational and analytic reflections, immediate post-operative reflective note taking and transcription of field notes to maximize recollection). The research assistant was involved in the development of the preliminary framework from Phase 1 that guided the observations in Phase 2. The research assistant observed 2 operations with the principal investigator, becoming familiar with the operating room regulations and the general flow of the HPB rooms. Data were collected separately and discussed immediately after the case. After the training phase, the principal investigator and research assistant continued observational sessions and met after each case to discuss data collection strategies and techniques as well as findings. Regular additional discussions with other members of the research team focused on how the observations impacted the existing framework and considered what changes, if any, were required in where to focus subsequent observations for the purposes of refining emergent theories.

It was a methodological decision to have both the principal investigator and the research assistant conduct the observations. Given the complexity of the operative cases and the requirement for expertise in the area, the research team agreed that much could be gained from having primary researcher – herself an HPB surgeon – conduct the observations. This would enable detailed discussions of the ‘slowing down’ phenomenon and would also importantly provide means for detection of incidents where the surgeons may have ‘failed to slow down when they should’. A surgeon also has knowledge and understanding of operating room dynamics, hierarchical issues and other sensitivities that a non-experienced observer may not. This knowledge and experience was thought to be crucial in capturing sensitive observational data that might contribute significantly to the interpretation and elaboration of emerging theories. On a similar note, given the status of the principal investigator as a surgeon and colleague to the study participants, it was felt that having a non-surgeon observe would be valuable in observing aspects of the phenomenon (e.g., tension in the room, certain surgeon-nurse interactions) that the principal investigator as a surgeon may fail to notice. ‘Insider status’ can provide insights into cultural
meaning, but has the potential to limit perspectives to those consistent with the status quo (Bishop, 2005). Issues pertaining to the principal investigator’s ‘insider status’ including perceived benefits and limitations will be discussed in the ‘Reflexivity’ section.

The participant observation method was employed to gather data pertinent to issues involved in moments of increased surgical effort surrounding the phenomena of ‘slowing down’ in the operating room (Atkinson & Pugsley, 2005; Emerson et al., 2001). Using the conceptual framework derived from Phase 1 as a guide, observations focused on the staff surgeon, particularly noting transitions from the routine mode to the effortful mode, and the details of the procedures as this was occurring. These transitions are largely observable as a change in behaviour occurs that is either subtle or obvious: surgeons might disengage from conversation, ask that the room be quiet, ask that music be turned off, discuss uncertainty with the rest of the surgical team, ‘take over’ part of the procedure, or simply focus more intently on the procedure. Information from the interviews in Phase 1 guided these observations with many surgeons describing a sense of a need to regain control of the operation during these moments. Observations also focused on the interactions between various team members during these transitions, including surgical trainees, nursing staff and anesthetic team. Researchers used the framework that was developed in Phase 1 (described in Chapter 4) as a paper template for jotting down observations and interpretations and elaborated and refined this over time with observational sessions. Concurrent data analysis guided subsequent observations. The researchers kept structured field notes during the observations in order to record details of the surgical procedures during the ‘slowing down’ moments: the content of the conversations, the thought processes verbalized by the surgeon, the context of the discussions, and the non-verbal cues that accompanied these transitions and interchanges between the surgeon and the various team players (Hammersley & Atkinson, 1995). Particular surgical details of the ‘slowing down’ moment (e.g., cues that initiated the transition) were recorded and were of particular interest to the principal researcher.

Consistent with the constructivist paradigm where knowledge is interpreted and co-created by the research participant and the researcher, it was not the intention of the research team to
eliminate the ‘Hawthorne effect’ (Roethlisberger & Dickson, 1939) nor is it their belief that this 
is possible. It was not known, however, whether knowledge of the ‘slowing down’ moments 
could cause activities to become exaggerated or explicitly contemplated so that it alters normal 
behaviour. Methodological choices, therefore, were made to minimize the exposure of the 
participating surgeons to the explicit language of the phenomenon of ‘slowing down’, especially 
at the start of the observational period. Employing the principles of incomplete disclosure, we 
did not explain the phenomenon during the consent process or during the first two pre-operative 
interviews with each surgeon. We were also unsure about the effect on the participating surgeons 
of being watched by a fellow surgeon and colleague, which was another reason for having the 
research assistant, unknown to the study participants, perform many observations. Watching each 
surgeon perform several procedures over many hours increased the chances that the surgeons 
would become accustomed to the observer’s presence. Finally, the very nature of the ‘slowing 
down’ transition means that cognitive resources are recruited to focus on the task at hand, 
minimizing awareness of extraneous thoughts or activities. This would serve to minimize the 
‘Hawthorne effect’ during these moments (Holden, 2001).

*Phase 2 data collection: Brief On-Site Interviews*

Brief pre-operative interviews (approx 10-30 minutes) were conducted with the surgeon prior to 
each case to identify areas the surgeon considered to be potentially problematic. Surgeons were 
also asked to discuss their “game plan” (an emergent theme from Phase 1) – what they did to 
prepare for the case and when, how they did it, their general approach to these sorts of cases, and 
what resources were used. The pre-operative interview alerted the observers to areas the surgeon 
may proactively ‘slow down’, providing additional information on how the surgeon planned on 
managing the situation. Brief (approximately 10-30 minutes duration) post-operative interviews 
with the surgeon were also conducted to discuss the observed intra-operative ‘slowing down’ 
moments. If not done satisfactorily during the procedure, the surgeon’s thought processes were 
explored and the researcher’s interpretations of the observations were discussed. The pre- and 
post-operative interviews (audiotaped and transcribed) acted as a source of triangulating data to 
enhance the explanatory power – through clarifying and verifying the data - of the developing 
conceptual model (Harris, 2002). Data derived from the research assistant during the
observations seemed to focus on surgical behaviours and social interactions during the ‘slowing down’ moments, requiring the post-operative interviews to provide surgical explanations of what was occurring. In contrast, data derived from the principal researcher during the observations focused more on surgical detail, creating explanations for certain events that required confirmation, refutation and/or elaboration from the surgeon in the post-operative interview.

Phase 2 data analysis
The field notes and reflective notes from the participant observations and the transcripts from the brief on-site interviews were analyzed for both emergent themes and pre-selected themes. Although a rigorous adherence to emergent themes was central to our analytic process, Phase 2 of this study was designed to build upon the results of the analysis of Phase 1, and the dominant themes from the Phase 1 analysis informed the orientation towards the analysis process for Phase 2. An iterative and constant comparative method, in the grounded theory tradition (Strauss & Corbin, 1998) was used in the analysis as described in Phase 1 above. Regular meetings with the research team to examine the field notes and emergent theoretical framework were scheduled. Interviews with the key informant to discuss details of the surgical phenomena and interpretations of the data were held on both a formal and informal basis. This process of axial coding was discussed and refined at regular meetings with members of the research team where extensive collections of coded transcripts and reflective notes were examined. Discrepancies between research team members were resolved through direct referrals to interview transcripts. NVivo software (2007, QSR International Pty) was used to facilitate the comparison of themes and to allow for cross-coding and to reveal inter-relationships among themes (Kelle, 2002). Confirmability, as in Phase 1, was ensured by maintaining an audit trail of all analytic memos, minutes of the meetings, and revisions to the coding structure. Each member of the research team, including the key informant, was instrumental in this process.

Key Informant
Through the early stages of the research, the principal researcher discussed emergent ideas from interviews with a friend who is also a colleague and senior HPB surgeon. He had been a keen ‘observer’ of surgeons for some time and had reflected previously on surgeon’s reactions in the operating room when confronted by uncertainty. Our provision of language and a framework
with which to consider these ‘slowing down’ moments enabled him to analyze intra-operative
events and his own reactions in a way he was unable to before. He was very active in his surgical
practice and was able to reflect on that world, qualities essential in a key informant (Gilchrist &
Williams, 1999). He developed an interest in the phenomenon of ‘slowing down’ and started to
share stories with the principal investigator from his experiences in the operating room. Not only
was he able to describe events and actions of his experiences in the operating room, he was also
able to offer insightful analysis and interpretation, making an excellent informant (Spradley,
1979) He became a valuable resource for the principal researcher in providing feedback on her
reflections throughout the research process. Because of this, it became clear that he should be
included on the research team in a more formal way, and has subsequently been referred to as a
‘key informant’. There were 7 formal interviews that were audiorecorded and transcribed
between principal researcher and key informant (some with the research assistant present) as
well as many more informal discussion sessions. Following most of these sessions, the
researcher engaged in reflective note-taking to document the discussions.

The key informant, through involvement with the research process, experienced a change in his
approach to practice, with an increased awareness of his ‘slowing down’ moments, an increased
comfort level with uncertainty in the operating room, and an increased ability to critically self-
reflect on his own ‘slowing down’ experiences. This suggests ‘catalytic validity’, when change is
experienced by the researcher or informant through being involved in a research process (Lather,
1986). Through involvement with the research process, the informant thinks about his or her
world in a different way, invoking a change in practice. The research involvement may act as a
catalyst for change, and is one of Guba and Lincoln’s (1989) ‘authenticity criteria’ for
educational research. Asking people questions causes them to think about their answers, and that
thinking becomes part of their perspective going forward – a co-creation and construction of
knowledge between researcher and participant. Further evidence of this occurred in the hallways
shortly after interviews with a few surgeons from Phase 1 stopping the principal researcher in the
hospital hallway to describe their own recent ‘slowing down’ moments in the operating room.

With an awareness of this phenomenon and words to describe it, the key informant was aware of
his own ‘slowing down’ moments in the operating room, making for a valuable, reflective
participant for the Phase 2 observations. This was particularly useful during Phase 2 where the research team began exploring the construct of ‘automaticity’ and refining a category they labeled as ‘fine tuning’. The key informant provided useful insights into his experiences with ‘fine tuning’ and offered frank admissions of when ‘paying attention’ failed and ‘drifting’ occurred. The data derived from the key informant interviews were incorporated into the developing conceptual framework and appear embedded within the results sections of each paper. His personal reflections of how his practice changed as a result of his ‘key informant’ role is provided in the implications chapter through the medium of a reflective excerpt – a paper written as a combined effort by the key informant and the principal researcher.

Reflexivity

I, the principal investigator, am a HPB surgeon working in the institution where this study was conducted. My interest in this thesis started as a surgical resident, making the observation that not all ‘expert’ surgeons, or clinicians, were as ‘safe’ as others. Being a surgical resident provided the opportunity of observing many different surgeons in the course of a relatively short time period. Being interested in the subtle differences between ‘experts’ led me to wonder what underlying factors exist that might explain these differences. I have witnessed many examples of surgical error resulting in significant injury. This has certainly influenced my thoughts at the conception of this thesis and throughout. How do these errors occur? What is occurring in the mind of the surgeon that allows him to make such an error? Why do they not have an accurate picture of the surgical situation? My position as an assistant professor, likewise, has provided numerous examples of residents who display poor judgment and residents who fail to appropriately ‘slow down when they should’ – inside and outside the operating room. I have certainly reflected – in the moment – on their behaviour and thought processes and have reflected with them – after the fact – in an attempt to uncover where the problem lies. Without an understanding of what leads to good judgment in clinical practice, it was difficult to effectively pinpoint the problem in their thinking. As I have heard many times at out local Division of Surgery meetings where these residents’ evaluations were discussed, they simply had

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1 I have written my dissertation in the third person, passive voice, in order to maintain consistency (the papers embedded in the dissertation were written for a medical audience whose conventions include the use of passive voice for research reports). For this brief reflective section on personal positioning, I have written in the first person, in keeping with the intention of this paragraph to reflect my personal experience.
‘poor judgment’. The best form of remediation was unknown. In my own surgical practice, as a junior HPB surgeon, it has become clearer to me that I, alone, am responsible for many decisions that I make in the course of surgery. Whether I engage in extraneous and distracting conversations, whether I remain focused on the task at hand, whether I maintain situation awareness of the surgical field, and whether I let ego get in the way of asking for help, all have the potential to influence the result of my surgery. A desire to understand the factors involved in our ‘self-monitoring’ role as surgeon and taking ‘self-regulation’ to a personal and serious level form the foundation for this research project.

As a surgeon embedded in the world I was studying with a long history of interest in surgical judgment, it was vital that I examine the assumptions and presuppositions I brought to every stage of the research process. I reflected on the work of Goodwin (Goodwin, Pope, Mort, & Smith, 2003), an anesthetic nurse studying anesthetists and anesthetic nurses. Goodwin was cognizant of the benefits that having similar backgrounds brings to researchers; there is an ease and understanding of the environment, you are considered an ‘insider’ and are given certain privileges, and barriers are broken down enabling easier communication (Lipson, 1991). I was familiar already with the implicit rules and conventions of the participants of this study and had intricate surgical knowledge, essential I believe to carrying out this study effectively. My position as surgeon and a colleague, I believe, allowed for rich discussions and reflections with the study participants that would not have been possible for a non-surgeon. In the observation phase, I was able to see and understand the detailed surgical issues and this not only allowed for more in depth discussions and honest reflection but also, to some degree, held the surgeon accountable for what had occurred. Having a surgeon observe their operative performance with a particular interest in judgment, led to surgeons ‘confessing’ when things did not go ‘quite right’. My research assistant was not able to elicit the same response as she was not able to identify the nuances of the surgical details, nor could she engage in a lively discussion with the surgeon about their experience of it. She could, however, observe interactions in the room and manifestations of the ‘slowing down’ phenomenon – dynamics that I might overlook if absorbed in the surgical details – and she was, therefore, directed to concentrate on this.
As a surgeon and colleague to the Phase 2 participants, there was a fine line between researcher and surgeon. Negotiating that line was difficult at times. On numerous occasions, I was asked my surgical opinion which was clearly stepping over the line into my role as surgeon and colleague. I was concerned that this may have prevented me from observing what would have happened next had I not been there. I was interested in the ‘slowing down’ phenomenon, what initiated it, influenced it and manifestations of it. I was also interested in observing them work through issues of uncertainty; by being there, my surgical colleagues might ask me for advice sooner than if I were not there. At the start of the operative case, therefore, I told them that I was not to be asked for advice. If they got the point of requiring advice I would be happy to call a 3rd person in for these purposes. In one instance, however, I did step out of the researcher role and into the surgeon role. During a complex case that I had intimate knowledge of, an urgent situation arose when only a fellow was scrubbed. The staff had left momentarily and being the only staff present I called for the responsible staff surgeon and then scrubbed in until he arrived. Stepping into and out of the role of surgeon was an interesting experience. As an observer, I intentionally tried not to get involved with each surgical detail, whereas, as a surgeon I was catapulted to a lead role having to get familiar with all surgical details instantly. Although this was avoided for most of the study, I thought it was necessary for patient safety that I step out of my role as researcher for this event. Similarly, two episodes occurred that required me to verbalize my concerns from a surgical perspective. Again, this was clearly stepping out of the researcher role, but it was done for ethical reasons. Many other instances, I walked the fine line on the side of the researcher, and did not step over the line even though I had concern. My decision of whether I step over this line was based on patient safety concerns, holding off until I thought it was critical.

Like Goodwin (2003), I found that I had to be careful, when having a conversation in the familiar medical language, not to assume to understand what surgeons participating in the study were telling me. In her study, Goodwin (2003) prompted them to explain further – to explicate the information. I entered the research process mindful of this and took care not to assume to have understood all that was said or displayed. It was therefore a key methodological decision early in the study to involve an experienced qualitative researcher outside the medical domain as the research assistant to provide a different theoretical ‘lens’. Having a non-surgical set of eyes and ears served to help me with ‘reflexive bracketing’, not for the purposes of being more
‘objective’ but for the purposes of being more perceptive and in tune with parts of the data that might be represented or interpreted differently. Bracketing, a contentious issue for many qualitative researchers, was originally described by Husserl (1931) and later by Patton (1990). It implies that the researcher can hold up a phenomenon for serious inspection, taking it out of the world it is occurring in, and dissect it to uncover its elements. It is removed from all preconceptions and meaning and treated as a text or document for the purposes of being uncovered, defined and analyzed. Originally described for phenomenology, it is also used as an analytic tool as part of the reflexive process for the researcher to ‘bracket’ out or hold aside their own assumptions that may be culturally based for the purposes of being able to see the phenomenon a different way (Gearing, 2004). From a constructivist point of view, removing all context is neither possible nor desirable, and this was not the intention here. What I wanted, however, was an “outsider” to help question my assumptions when they were obvious to her. She was told at the start of the research process that her ideas and challenges were very much welcome. An ability to challenge me and other research members, as well as an ability to talk with surgeons about some sensitive topics, were considered essential qualities when hiring for the research assistant position. Throughout the iterative cycles of data collection and analysis, she and I were actively and sometimes independently involved in the process, so that we both had the chance of seeing the data through our own lenses. We worked closely together and I made the decision at the start to intentionally listen to her interpretations of the interviews and observations before I discussed mine, signaling their legitimacy and ensuring they were tabled. For the same reasons, I entered each interview and observation reminding myself that I was the researcher – not the surgeon. I wanted to see the environment as a researcher, intentionally searching for questions that may not have come to mind otherwise, not assuming I understand what is being said, and looking through lenses that may not have been on as a surgeon.

Other analytic tools learned in qualitative data analysis courses were also used as a guide to navigate some of the limitations that having ‘insider status’ brings. I learned to apply the process of *problematizing the obvious* (Atkinson & Delamont, 1994). During my reflections immediately post interview or observation I would think about what seemed obvious to me and try to force myself to apply a different set of lenses to it. Asking questions like, ‘what assumptions am I making to believe this?’ , ‘what else could this mean?’, or ‘if I were not a surgeon, how might I
view what was just said?” were useful ways of uncovering my own limitations to interpreting the
data. Understanding my own positionality and perspective was crucial for me to be able to
understand the implications for these questions. As a surgeon from the positivist paradigm,
understanding my perspective was a journey in itself. For a long time, I could not understand
what my perspective was, other than a surgeon asking a research question of clinical relevance. I
had never been asked that question before, nor had I heard anyone else be asked the question
when presenting their research. In retrospect, I think it is obvious why it had not been perceived
as an important or relevant question. As a community of surgeons, we took for granted, without
having knowledge of the vocabulary or existence of paradigms, that we were all talking the same
language – as positivists. A breakthrough moment came when I was able to understand that I had
a particular perspective on the ‘slowing down’ phenomenon and that it was only one perspective.
Discussing this phenomenon with another student from a different background, she enlightened
me (with great effort!) to her perspective – the sociological perspective. Once I understood that
different lenses can alter research questions and impact methodological choices, I finally
understood the importance of theoretical perspective. Developing an appreciation and
understanding of how perspective influences the whole research process, from inception of
question to analysis and writing up of results, has not only sparked a curiosity for how others
view issues of surgical judgment but has also reinforced my alignment with the cognitive
psychology perspective. What does the individual bring to the situation rather than how does the
situation drive behaviour? How do various cognitive theories, like limits of attention and
problem solving, affordances and actions of the individual, help organize my understanding of
the ‘slowing down’ phenomenon? Further, my interest in moving away from concerns about
individual differences (i.e., who has good judgment and who has bad judgment and what are the
properties that make them bad or good) and towards a general understanding of the ‘slowing
down’ phenomenon (i.e., what does it look like in people) reflects my transition to cognitive
perspectives rather than “personality psychology” perspectives.

Developing an understanding that talk is rhetorical and that people are positioned and position
themselves within an interview (Lapadat, 2000), I realized not only the difficulties I had with
eliciting thoughtful and honest reflections in the paired interviews, but also the sensitivities that
are necessary when asking surgeons to talk about surgical judgment to me as a colleague. A
further analytic tool I applied was paying attention to the ‘surprises’ or the silences in the data. This was an important learning step for me as a surgeon researching a field I had thought so much about. Focusing on things that did not seem to fit with my understanding or things that I thought were irrelevant (that I almost discarded) created some interesting avenues of exploration, eventually contributing significantly to the emerging theories.

This research project was my first qualitative research project and was the impetus for me to learn qualitative research methodology. Initially, this was a means to an end - in order for me to develop an understanding of surgical judgment, qualitative methods were necessary. I set out to learn ‘how to do’ qualitative research, but in the process have learned ‘how to be’ a qualitative researcher. I understand the difference now. In learning about qualitative research, I was introduced for the first time to many different paradigms and their respective positions on truth and knowledge. I learned that my ontological and epistemological approaches located me firmly in the positivist paradigm; I had believed that there was a ‘real’ truth that was apprehendable through objective methods. Besides the obvious difficulty in learning a new vocabulary and language, learning about epistemology and how it affects research processes was difficult, rocking the core of my being and belief in what ‘truth’ was. This education process has significantly altered my perspectives on the bio-medical model, surgical culture and research ideas. My roots in the positivist paradigm were disrupted as the opportunity to see through other lenses presented itself. This shift in thinking towards the constructivist paradigm that occurred in the process consumed a great deal of time and energy in the early parts of my PhD preparation and still, to this day, clashes occasionally with my positivistic roots. My position as a surgeon and teacher and the reasons I got involved with this PhD at the start – to make surgery safer, to teach judgment better – leads me often to a mindset of “let’s just find the answer and fix the problem”. I have been reminded by my supervisors on numerous occasions that our role here is to understand the issues better and to pose different questions that might lead to better understanding.

Informally, through the supervised educational nature of this project and formally through qualitative coursework and studies, I noticed a change in my epistemological position and ontological approach through the progress of this study. Through my journey into the
constructivist’s mindset, I realized that my thoughts and impressions were a critical component of the research process and shaped questions and observations throughout. As a surgeon, I brought to this study many years of training contemplating the construct of surgical judgment and observed and reflected on surgeons displaying both good and bad judgment. At the start of this project, as a practicing surgeon, I thought a lot about the phenomenon of ‘slowing down’ and related it to my own operative experiences discussing it at length with other colleagues. This constituted data, with the collection and analysis that continued during the project a co-construction of my views as the researcher (and a surgeon) and the surgeon’s views as the study participant (Holden, 2001).

As a researcher moving from the positivist paradigm towards the constructivist paradigm, I sometimes feel I have a foot in both worlds – that perhaps I don’t completely fit into either one. That has been a disturbing revelation in recent times as I struggle interacting with clinicians, and colleagues in my surgical world with their assumptions about truth and knowledge. It can be a lonely time as I view my surgical world with new constructivist lenses, as the revelations that are produced cannot be communicated effectively to the people in that world. Opportunities to present my research to the surgical world are limited by their positivist approach to truth and what constitutes real ‘data’. On the other hand, my research colleagues who have an interest in this research have a limited understanding of the surgical world.

**Ethical Implications**

The most significant ethical issues raised by this study have been discussed above in the section on reflexivity and include the boundary between my roles as surgeon and researcher and the implications for patient safety. Other potential ethical issues were the use of incomplete disclosure for the observation phase, the presence of patients during the observation phase, and the safety of the participants. The study was approved by the institutional ethics board covering all sites.

The use of incomplete disclosure in this study was undertaken because of the possibility that participants would, knowingly or not, alter their activities and reactions associate with the ‘slowing down’ phenomenon. Participants were informed that the researcher was interested in
surgical judgment, but the details of the phenomenon were not completely described. Patients were not participants in the study, and thus were not required to provide informed consent. Researchers observed surgical activities whilst the patients were anaesthetized, although no data specific to the patients were recorded. Given the observational nature of the study, the research ethics board did not consider it necessary to obtain patient consent.

Ethical implications for participants included the impact of being interviewed or observed by a fellow surgical colleague. Surgeons are not used to being observed by other surgeons and so, depending on what is observed, might perceive this as having a potentially negative impact on their reputation. All surgeons were notified of the confidentiality of the data and were made aware of the option of declining participation in the study. Given that we were observing particularly the critical moments of procedures, there is an ethical concern that surgeons may act differently during these moments if they are being observed. Sensitive to this, the research team made an effort to be unobtrusive in the operating room, both in their note taking and in their presence. Questions were asked of the surgeon only when it was considered an appropriate time to do so.

Finally, the safety of participants with respect to their discussions of their own thoughts on judgment as well as any reference that might be made to their colleagues during interviews was protected by elimination of identifying information during data collection, analysis, and reporting. Participants were identified only by code in all field notes, transcripts, and manuscripts. Study documents are being held in a locked cabinet accessible only to the principal investigator and the research assistant for 5 years following the publication of the manuscripts related to the study, at which time they will be destroyed.
Chapter 4
Exploring the Role of ‘Slowing Down’ in Surgical Judgment

Before introducing the paper presented in this chapter, a brief description of the three results chapters will be provided. The following three chapters (Chapter 4-6) represent the results of data collected during Phase 1A (Chapter 4), Phase 1 (A & B) and 2 (Chapter 5 & 6) of the study. Figure 4A (page 64) outlines the conceptual framework of the phenomenon with four dimensions that will be elaborated on and explored in the remaining chapter. This figure can be referred back to as each chapter elaborates on and explores a different dimension of the framework. The first data paper (Chapter 4) represents a deconstruction of the phenomenon ‘slowing down when you should’ based on surgeons’ perceptions of this phenomenon in their practice. It presents two dimensions of the evolving framework: the initiators of the phenomenon and the influences of the phenomenon. The second data paper (Chapter 5) represents a third dimension of the framework – the manifestations of the phenomenon – and combines data from Phase 1 (A & B) and 2 exploring whether this phenomenon can be observed in the operating room. The final data paper (Chapter 6) represents a reanalysis of the dataset to explore an emergent theme – the surgeons’ reference to their experience of control during this transition in their academic operative practices. This final paper represents a fourth axis of the phenomenon – the surgeon’s experience of control during the phenomenon.
**Figure 4A:** Conceptual Framework of the ‘Slowing Down’ Phenomenon demonstrating the 4 dimensions discussed in Chapters 4-6
The paper presented in the current chapter explores surgeons’ perceptions and experiences of the transition from the ‘automatic’ to the ‘effortful’ in their operative practice and is based on results from Phase 1 (A & B) - a series of semi-structured interviews with surgeons across many sub-specialties. Surgeons were asked whether the transition was recognizable to them as part of their surgical operative practice and whether ‘slowing down’ was a description of it that resonated with them. Prior to being introduced to the term ‘slowing down’, surgeons often used this language in their descriptions of events during the interviews. An evolving framework from the interviews in Phase 1A included two dimensions that are presented in this paper – the initiators and the influences of the phenomenon (see Figure 4B, page 70). The phenomenon as it occurred intra-operatively was described by surgeons as being initiated by either anticipated events (labeled proactively planned ‘slowing down’ moments) or emergent and unexpected events (labeled situationally responsive ‘slowing down’ moments). Several influences on this phenomenon were recognized by the surgeons (see Table 4A; page 75) and these were briefly described in this paper. Two related phenomena – ‘speeding up’ and ‘plowing through’ – represent transitions from the ‘automatic’ to the ‘effortful’ in operative practice but were sufficiently distinct to be positioned separately within the paper. A need to gain more control was a common thread that was interwoven in the surgeons’ descriptions of the ‘slowing down’ moments and became the focus of the paper in Chapter 6 after further data emerged in Phase 2.

This paper was submitted to the Journal of Gastrointestinal Surgery, a journal with a readership of academic and community surgeons, and currently is in the hands of the reviewers. The discussion section provides some background theoretical knowledge for the surgeon who is unlikely to know of the relevant ‘external’ literatures. The focus of the discussion is on the practical implications that an understanding of this phenomenon might have for surgical practice. Issues related to these results are discussed at a more theoretical level in Chapter 7.
Exploring the Role of ‘Slowing Down When You Should’ in Surgical Judgment

Moulton, CA, Regehr G, Lingard L, Merritt CE, MacRae HM.
Submitted to Journal of Gastrointestinal Surgery

Introduction
Surgeons face many challenges and uncertainties in the course of their daily clinical activities. Medicine is not an exact science, and when clinicians find themselves in the ‘muddy zones’ of practice, they must be able detect, understand and respond effectively to essential, relevant, yet sometimes subtle cues in the environment (Schön, 1983). Effective responding often requires a transition from a relatively routine or ‘automatic’ mode of practice, whereby one is simply ‘doing what they know to do’ (Dreyfus & Dreyfus, 1986), into the more attentive mode of practice, requiring more cognitive effort and often intentional problem solving. We have argued previously that this transitional process of ‘slowing down when you should’ is a crucial part of expert surgical judgment, and failing to transition during critical moments may lead to medical error and patient harm (Moulton, Regehr, Mylopoulos, & MacRae, 2007). For example, an emergency physician may send a child home with a diagnosis of ‘gastroenteritis’ before eliciting and appreciating the signs and symptoms of intestinal intussusception; or a post-operative tachycardia may be explained as uncontrolled pain rather than considering and recognizing subtle cues for the life-threatening possibility of pulmonary emboli. An important step in minimizing medical error, therefore, is the exploration of factors that initiate and influence this transition from the routine to the effortful in the daily lives of clinicians. Until an understanding of this transition in surgical practice emerges, we are constrained in our ability to clearly understand the situations in which surgeons might fail to ‘slow down when they should’ and risk error and patient harm. This study was designed to explore expert surgeons’ perceptions of the transition from routine to more cognitively effortful clinical activity using the setting of surgical practice, with particular attention to the intra-operative environment. Our purpose was to deconstruct the phenomenon of ‘slowing down when you should’, to determine whether the phenomenon was recognizable to expert surgeons, to explore their perceptions of it and to understand the contexts in which it emerges and fails to emerge. Future study will explore the ‘slowing down’ phenomenon using observations of expert surgeons in the operating room.
Research Design and Methods

This interview-based study was designed using grounded theory methodology (Charmaz, 2000; Glaser & Strauss, 1967). Consistent with the key elements of grounded theory, the study utilized an iterative design, purposeful sampling and a constant comparison approach to data analysis (Glaser & Strauss, 1967; Strauss & Corbin, 1998).

The study took place with institutional review board approval at four tertiary care academic hospitals associated with a single large urban medical school. Semi-structured 60-minute interviews were conducted with 28 surgeons who, by reputation, had sound operative judgment and were considered experts in their field (9 general surgery, 4 neurosurgery, 3 orthopedics, 3 cardiac surgery, 3 vascular, 2 otolaryngology, 2 plastics, 1 thoracic, and 1 trauma surgeon). Each interview was conducted by the principal investigator (CAM) and a research assistant (CEM). Sampling continued until saturation of the key emergent themes was achieved (Morse, 1995).

Interviews explored surgeons’ general perceptions of expertise as it relates to operative judgment, as well as their perceptions and experiences of these transitions from the routine to the effortful in their operative practice. Elaboration of recent events and experiences was encouraged. Interviews were conducted individually (n = 10) or in pairs of surgeons (n = 9) within the same specialty. Both were valuable in exploring different aspects of this phenomenon, with paired interviews evoking a lively discussion of the details of recent operative experiences, and individual interviews capturing a more personal reflection of the surgeon’s individual experiences of this phenomenon.

All interviews were audiotaped and transcribed generating 458 pages of transcript. Themes emerged from a preliminary coding structure developed by two researchers (CAM and CEM) who read the entire data set, with data collection and analysis occurring in an iterative manner. This emerging coding structure was discussed, refined and confirmed by other members of the research team, consisting of a surgeon (HM), a qualitative researcher (LL) and a cognitive psychologist (GR). Confirmability was ensured by maintaining an audit trail of all analytical memos, minutes of the meetings, and revisions to the coding structure. The final coding structure
was applied to the complete data set using NVivo software (2007, QSR International Pty Ltd) to facilitate cross-referencing (Kelle, 2002).

**Results**

When introduced to the concept of a transition from a routine mode to an effortful mode during surgery, all participants recognized this as a phenomenon occurring in their operative practice and described details of related events. As one surgeon described, “The change to that sort of state usually goes along with where I stop talking to the resident and focus very intently on what’s going on and I may, again, ask for quiet in the room or to reduce distractions, that sort of thing.” Surgeons often used the term ‘slowing down’ as a description of their experience with this transition, even prior to the interviewers having suggested the term. For example, one surgeon spontaneously described the phenomenon in the following way: “... if I’m not in the right plane or if I haven’t got the right exposure, I might slow down, rethink where I am.”

One emergent theme from the data was the use of ‘slowing down’ as a control strategy to manage the environment in order to deal with these moments. As one surgeon indicated, “A surgeon essentially sets the tone for what he or she is doing at that point in time and communicates, sometimes overtly and other times subtly, with those around him or her, that this is a time when we all have to concentrate.” Ensuring that others focus on the task at hand appeared to be used as a mechanism of keeping control during critical or emerging situations. The more the surgeon felt out of control, the greater the need to regain control. Surgeons recognized that sometimes others in the room took control of the environment for the purposes of reducing distractions, acknowledging that the transition from the routine to the effortful can be obvious to others without verbalizing it. This was epitomized in one participant’s comment:

“I know there are times where I sort of recognize that it is serious in the room and what not, and I hear, ‘oh, now is not a good time’ - the nursing staff will send the visitor away, or ‘I’ll get back to you on that after we just go ahead with this part’. So there must be something that the nursing staff pick up on.”

This experience of control was further explored as a separate theme in the remaining interviews and observations and forms the subject for Chapter 6. Two further themes –
the initiators of the ‘slowing down’ phenomenon and the influences on the ‘slowing down’ phenomenon will be addressed in this paper.

Initiators of Slowing Down
Surgeons described their experiences of ‘slowing down’ intra-operatively as either planned (proactively planned) or unplanned (situationally responsive) (Figure 4B, page 70). Planned transitions occur at critical points that are flagged beforehand as requiring special attention – the proactively planned ‘slowing down’ transitions. Unplanned transitions were described as occurring in response to unexpected events caused by a variety of situations – the situationally responsive ‘slowing down’ transitions.

Proactively Planned ‘Slowing Down’ Transitions
Surgeons described critical points of operative procedures that were recognized and anticipated prior to commencing the operation. When these anticipated critical points were approaching, surgeons described themselves as becoming more focused, intentionally and proactively transitioning from the routine to the more effortful. These anticipated moments seemed to originate from cues that are either ‘procedural-specific’, occurring each and every time the surgeon performs that procedure, or ‘patient-specific’ (see Figure 4B, page 70), occurring as a result of pre-emptive planning for the unique intricacies and potential hazards of the particular patient.

Procedural-specific checkpoints: In most, if not all operations, the surgeons recognized critical points where they experienced a tendency to pay more attention. Even for routine operations and for very experienced surgeons, there were critical parts identified that elicited a transition in the surgeon from the routine to the effortful. As one example, a surgeon stated,

“If we’re doing a lung resection…dissecting pulmonary artery branches, that tends to be a quiet time, so we stop talking and just kind of focus on what we’re doing, because there is potential for getting into big trouble. So, when we’re at critical points where you could get into trouble, you know, the chatter stops.”
Showing ‘respect’ for these procedural-specific checkpoints and intentionally, proactively ‘slowing down’ every time these moments approach was recognized as a crucial component of judgment for every surgeon interviewed.

*Patient-specific checkpoints:* In addition to the procedural-specific checkpoints, surgeons indicated there were patient-specific checkpoints that they identified preoperatively. As one surgeon explained, “I try and think through - now, what are the parts of this case that are going to
be particularly difficult, if there are any, and try to think those through in advance.” A general surgeon described a recent procedure in which a patient had previous abdominal surgery and was requiring further surgery; “Like the game plan starts right when you open up the abdomen and say it’s a re-do, I say to the residents, ‘do not cut until I’m in the room’.” Recognizing the potential for injuring bowel upon entering the abdomen, the surgeon changed her routine. Rather than allowing the fellow to start the laparotomy without her supervision, which was her standard practice, she insisted on being present for it to ensure there was adequate care at that critical moment.

The participants often described this activity of identifying procedural-specific and patient-specific checkpoints as the development of the “game plan” (see Figure 4B, page 70). One surgeon stated that immediately prior to every case, he asks himself, “Where are the landmines? What’s going to prevent me from getting my usual good result?” Through the preparation of understanding where these “landmines” are for any given procedure, surgeons felt better prepared to not only manage them appropriately but to also, in some cases, avoid them altogether. This anticipation of the “landmines” or checkpoints – both procedural-specific and patient-specific – was considered key to expert judgment based on the model of a surgeon who avoids getting into trouble, rather than a surgeon who is forced to get out of trouble. As one participant said, “I have to say, you know, I think the people that I’ve worked with who have unbelievable judgment is because they’re unbelievable at anticipating what’s going to happen.”

**Situationally Responsive ‘Slowing Down’ Transitions**

Despite pre-planning, surgeons made reference to the experience of having to react to the unexpected – to deal with intra-operative ‘surprises’. Facing these situations, they become more focused – transitioning from the routine mode to the more effortful mode in response to the emerging conditions. These situationally responsive ‘slowing down’ transitions (see Figure 4B, page 70) were recognized and acknowledged by all surgeons and epitomized by one who said, “It’s when you’re looking at something you haven’t seen before or you weren’t expecting, then what do you do at that point? And so, obviously stopping to regroup and decide what to do.”
Participants used terms like “slowing down”, “stopping”, “regrouping”, and “reassessing” to describe their experience with this unanticipated transition. The uncertainty that shrouds the unexpected event seemed to evoke a need to stand back and reassess the situation, slowing the pace of the operation or even stopping to regain control. As one participant described, “…at those times when you’re uncertain, you do go back and forth. You’re tentative, you re-look at things, and you bring it down to a pace where I’m sure the residents are saying, well cut it and get on with it”. Regrouping seems to provide the ‘thinking space’ or freed up cognitive capacity to deal with the event that initiated the transition. It provides the ability to think – to gather, interpret, and understand the cues and information pertinent to the event – so that resolution of the uncertainty or the unexpected event can be achieved. As one surgeon stated, “I would take a time-out. You can think, look at the imaging again - sometimes you might even call one of your colleagues in, just to bounce the idea off someone.” The cognitive effort required at these moments seemed variable, depending on the situation, but when significant, was manifested with a stopping of the operation or asking that the music be turned off and chatter stop in the room. Unlike the proactively planned transitions, where much of the thinking takes place pre-operatively, situationally responsive ‘slowing down’ transitions seemed to involve a more elaborated intra-operative problem solving process, often leading to impromptu readjustments of the game plan.

This responsive transitional process is often subtle in its initiation and action. Some surgeons, for example, talked about the transition as being initiated by cues that only become obvious after time: “…there’s sometimes a series of cues and you know as sort of the captain of the ship you have to kind of decide when the cues have reached the level that you’ve got to, the frame shift occurs.” Others described an occasional sensation of recognizing the responsive transition only after the situation that caused it was over, having lacked awareness of actually being in a more effortful mode as it was unfolding. This was experienced as a ‘sense of relief’ after the fact, as with one surgeon’s description; “Sometimes you don’t even know you’re there until it’s over and you’ve done some stressful component to the operation, and as soon as it’s done everybody kind of breathes a sigh of relief.” The transition from the routine to the effortful, therefore, seems not always to be abrupt, intentional or consciously directed by the surgeon.
Contrasts to the Experience of Slowing Down

During the interviews, surgeons also described details of situations that were distinctly different from the experience of successfully ‘slowing down when they should’. Two such categories of experience were articulated in the interviews, categories we have labelled ‘plowing through’ and ‘speeding up’ (see Figure 4B, page 70).

Plowing Through

Surgeons described operative experiences that they felt, in retrospect, were moments where they perhaps should have slowed down, but did not. Two broad forms of this ‘plowing through’ phenomenon were suggested by the participants. First, surgeons described ‘plowing through’ as a result of being unaware, or not appreciating, all pertinent, available information in their surroundings. These situations were construed by participants as a ‘failure to slow down’, occurring because of a failure to obtain an accurate or complete picture of the environment, or a lack of situation awareness. As one surgeon described,

“...you'd be working along a structure and you don’t realize you were working with an anatomic variation and you hit something. Umm, and you say to yourself, geez, I didn’t think I’d get into that vein or that artery... I mean you’re sort of not listening to the anatomic cues that are presenting themselves to you...”

Although surgeons considered themselves to be paying attention to their environment, they recognized a failure to accurately read the cues that were available in an appropriate and timely manner. This became obvious to them in retrospect once the ‘plowing through’ had occurred.

A second form of ‘plowing through’ was associated with more simple cases where participants thought they became complacent, failing to pay due diligence when necessary. As explained by one surgeon,

"I think that's the other time you get burned. It's the easy ones, because the difficult ones you're going slow all the time. And that's exactly what happened here. It was an easy lobectomy - you're not going slow, you're maybe chit-chatting, you're maybe not paying as much attention."
Surgeons admitted that because of the routine nature of the particular case, or part thereof, they allowed their concentration to ‘drift’ and did not maintain the level of attention necessary to prevent a mishap from occurring.

Both of these forms of ‘plowing through’ were recognized causes not only of surgical mishaps (“injuring the facial nerve” or “compromising a tumour margin”), but also of ‘near misses’. As one participant described,

“There will be times where you take a needle and you stab the surface of the heart because you weren't looking...you burn too close to the aorta when you're cutting through the pericardium and, you'll not get into the aorta, but it leaves a little mark and I think ‘it's a good thing I didn't go deeper’...certainly there are times you say, ‘oh yeah, that wasn't sharp’”

Regardless of whether this resulted in a mishap or a ‘near miss’, surgeons acknowledged there was information available prior to the event that had been incorrectly interpreted or simply unattended and was therefore experienced by them as ‘plowing through’.

Several factors were recognized as having the potential to influence whether the surgeon appropriately ‘slows down’ (Table 4A, page 75 and Figure 4B, page 70). Some were transitory ‘internal’ factors, such as fatigue; “my decision making and judgment when I was tired or frustrated at one or two in the morning was not as crisp”. Others factors were perceived to be related more to personality factors such as a lack of adaptability, with those who had the ability “to change directions based on receiving new information or information in a way that they hadn’t considered it previously” being considered more likely to transition out of the routine when required, or over-confidence, which could often lead to surgeons “getting over their heads”. Other factors affecting this process were seen to be more situational, such as time pressures (“I think the pressure of the clock is distracting…”), hierarchical pressures (“even if it is my case...you let the person do something and you think, gee, I hope we didn’t do that… more out of respect for the surgeon, instead of respect for the patient.”), or social pressures to create a “fun” operating room (“There is a social environment that you find yourself in”).
| Fatigue                      | Adaptability                      | Time Pressure               |
| Endurance                   | Confidence                         | Hierarchical Pressure      |
| Physical Ailments           | Humility                           | Distractions               |
|                             | Fear of Doing Harm                 | Availability of Resources  |
|                             | Willingness to Learn               | Teaching Pressures         |
|                             | Fear of Losing Reputation          | Team Considerations        |
|                             | Mindfulness                        | Social Pressure            |
|                             | Ego                                |                            |
|                             | Greed                              |                            |

**Table 4A: Influences of the ‘Slowing Down’ Phenomenon**

*Speeding Up*

Another sharp contrast to the experience of ‘slowing down’ was the sudden presence of an immediate, emergent life threatening event such as a significant bleed or a cardiac arrest. This moment was described frequently by surgeons as a sense of ‘speeding up’, rather than ‘slowing down’. The urgency required of the situation and the stresses associated with it were identified as the reasons for this subjective experience of ‘speeding up’. Some participants recognized that sensing this urgency to act can lead to a cascade of errors and described an attempt to counteract this experience by purposefully slowing the pace and their movements down. As one surgeon stated,

“Your mind speeds up but you have to force yourself to slow down because I recognize in myself if I go faster I will make more mistakes.”

Thus, in these circumstances making a conscious effort to be more deliberate, slowing the pace of the operation down, seemed to be a mechanism used to prevent further trouble and regain control.

**Discussion**

Increasingly the research focus related to the prevention of medical error has been shifting away from factors and actions related to the individual, and toward an articulation of the systemic
pressures and factors that enable human fallibilities and undermine structural fail-safes (Carthey, de Leval, & Reason, 2001; Haynes, Weiser, Berry, Lipsitz, Breizat, Dellinger, Herbosa, Joseph, Kibatala, Lapitan, Merry, Moorthy, Reznick, Taylor, & Gawande, 2009; Lingard, Regehr, Orser, Reznick, Baker, Doran, Espin, Bohnen, & Whyte, 2008; Reason, 2005; Reason, Carthey, & de Leval, 2001). This refocusing of the field on sociological and environmental human factors has offered an important step forward in understanding how error occurs despite the best intentions of humans within the system. At the same time, this refocus has placed very little research emphasis on understanding the ways in which individual expert performance functions as an integral part of a robust error checking system. The results of this study, therefore, have the opportunity to provide an important supplement to the literature on systemic factors in medical error with our analysis of how experts effectively self-regulate their activities and (often) avoid errors through a process of appropriately increasing attention to a task when unusual or complicating circumstances are present.

Professional expertise and cognitive psychology literatures indicate that experts engage in two different types of thought processes during their daily activities. First, through an accumulation of automatic resources, such as pattern recognition and cognitive scripts and schemas, professional experts spend the majority of their time in a non-analytic, automatic or ‘routine’ mode (Custers et al., 1996; Dreyfus & Dreyfus, 1986; Ericsson, 2004; Regehr & Norman, 1996). Activities in this routine mode are carried out with little cognitive effort (Kahneman, 1973). In contrast, the analytic or effortful mode of processing is engaged when the expert is confronted with non-routine aspects of practice, requiring recruitment of cognitive resources to deliberatively deal with the issue at hand (Cowan et al., 2005; Rensink, Oregan, & Clark, 1997; Simons, 2000). Much attention in the judgment literature has focused on this dual-processing model, with researchers discussing the values of both the automatic and intentional processes (DeNeys & Glumicic, 2008; Evans, 2008). However, little effort has been directed towards understanding the transition from one mode to the other in professional expertise.

Through an exploration of surgical experiences, our study provides a taxonomy and framework for considering the transition from the routine to the effortful – ‘slowing down when you should’ – in surgical practice. This work is currently limited to interviews with surgeons in one
educational institution, so requires further research to explore its transferability to other venues or disciplines. Nonetheless the development of such a taxonomy has potential for guiding some important steps in improving practice and safety. It has been suggested that words not only allow us to express our thoughts but also shape them (Burke, 1969; Lingard & Haber, 1999). In this sense, our taxonomy has the potential to make explicit an activity that was, at best, implicit in experts’ practice, a way of thinking intentionally about these important aspects of safe and effective practice. Combined with an understanding of the various levels involved with attaining and maintaining situation awareness in dynamic environments (Endsley, 1995; Jones & Endsley, 1996), this framework may be a significant step towards developing a meaningful taxonomy for surgical error. Of note, many surgeons, following their interview, stopped the interviewer (CAM) in corridors to discuss subsequent ‘slowing down’ moments, their successes and their failures. This suggests not only that the taxonomy has resonance with the participants, but also that it offers a language for discussing such events that likely was not afforded our participants before their having participated in this reflective exercise. It also suggests having the language increases the likelihood of awareness and recognition of ‘slowing down’ moments (both successes and failures), creating opportunities to address such events explicitly - enhancing them where they are occurring and increasing their occurrence in situations where they may not have taken place. Finally it provides an important opportunity to teach about this critical skill set, moving such educational experiences from the implicit curriculum, where learners are expected to simply absorb these lessons over extended observation (Franzese & Stringer, 2007), to the explicit curriculum, with its attendant discussion and intentional efforts at improvement.

This study also generates a set of interesting opportunities for further exploration of the phenomenon. For example, several surgeons in this study noted that this transition can sometimes be recognized only through the ‘sense of relief’ felt after the events that initiated it are over. This raises the possibility that experts may not always be aware of the transition while it is occurring, forming the basis of our reference to this phenomenon as ‘slowing down when you should’, rather than ‘knowing when to slow down’. It is possible that surgeons respond to cues they perceive in their environment on a subliminal level without necessarily being aware of having done so (Koriat, 2000; Rosenthal, 2008). If so, we might wonder about the extent to which this transition is intentional and conscious, and the place of metacognitive theory in these
processes (Kentridge & Heywood, 2000). In the psychology literature, a ‘consciousness continuum’ has been described whereby thoughts arising from information stored in the unconscious (automatic processing) are brought to the subconscious, available for full construction by the conscious using more effortful and intentional processing (Mandler, 2005). Awareness of the information occurs at some stage along the continuum depending on available cognitive resources. Given our limited attention capacity, it is possible that information is processed from the unconscious and influences behaviour without us being aware prior to fully formed constructions of what that information means to us (Mandler, 2005). Complicating this issue, it is likely that many of these slowing down moments themselves become automated with repeated experience and therefore require a less fully formed construction of the process with growing expertise. Thus, the professional’s evolving ability to respond to these fluctuations as well as maintaining an ability to monitor both the situation and themselves is an interesting area for future research (Epstein, Siegel, & Silberman, 2008; Regehr & Eva, 2006).

As a first step in this program of research, the current study has provided a taxonomy for the phenomenon of ‘slowing down when you should’ as it relates to expert surgical judgment. With language to represent it, and an ability to recognize it in surgical practice, we have a valuable framework to begin to develop a better understanding of what is involved when the surgeon makes this transition from the routine to the effortful. This framework provides a method for studying factors related to a surgeon’s failing to ‘slow down when you should’ with its obvious implications for surgical error. From an educational perspective, this taxonomy and framework provides an opportunity to teach surgical judgment in a structured and explicit manner, taking advantage of the critical moments – both planned and unplanned – in every case. Making these ‘slowing down’ moments explicit, with an ability to recognize them in daily practice, provides opportunities for critical self-reflection, both ‘in the moment’ with implications for self-regulation and patient safety, and following the event, leading to continuing improvements in surgical practice.
Chapter 5
Manifestations of the ‘Slowing Down’ Phenomenon in the Operating Room

The paper presented in the previous chapter described two dimensions of the emergent framework that evolved from the interviews in Phase 1A (the initiators and the influences of the phenomenon). The following paper describes a third dimension that evolved from the interviews in Phase 1 (A&B) and was further elaborated and refined in the observational sessions of Phase 2 (refer to Figure 4A, page 64). These were the manifestations of the phenomenon as can be seen by an observer in the operating room. Throughout the interviews in Phase 1, several surgeons discussed manifestations of their own ‘slowing down’ moments. Many recounted having to “stop”, “remove distractions”, or “focus” when encountering critical aspects of the case. Surgeons also made reference to “slowing down” on a smaller scale numerous times throughout a case to avoid getting into trouble. This paper describes the manifestations of the phenomenon from the most obvious (stopping) to the most subtle (fine tuning).

Central to this paper is the acknowledgment that for a subset of surgeons the term ‘automaticity’ did not resonate well with them as a description of how they function in practice. While accepting the presence of the transition from the more routine to the more effortful, they could not accept that the word ‘automatic’ described any part of their surgical practice. Surgeons appeared to link the term ‘automaticity’ to something they actively tried to avoid, rather than accepting it as a state consistent with their level of expertise. This paper introduces a distinction between ‘attentive automaticity’ and ‘inattentive automaticity’ (refer to Figure 4A, page 64) and suggests that paying attention occurs along a spectrum even at the ‘automatic’ end of functioning for the expert. This construction of the metacognitive contribution of expert practice provides a means for probing further into previous questions raised through the course of this thesis. In the literature review paper of Chapter 2 we asked “how reflective is reflection” in expert practice, and “how effortful and consciously directed is the process of situation awareness”? During the discussion of the last paper we explored the experience of the ‘slowing down’ moment as a ‘sense of relief’ with the surgeon only aware of the tension once the moment had passed. This was the basis behind our description of the phenomenon as ‘slowing down when you should’
rather than ‘knowing when to slow down’, leaving the issue of intentionality of this transition to be explored with future research.

This paper will be submitted to Academic Medicine with a target audience comprising of medical educators and medical education researchers. It provides an opportunity to consider the well known educational theory - the automaticity of expertise – in a clinically relevant context and suggests incorporating the ideas of metacognition and mindfulness into this theory as an explanation of how the expert ‘stays out of trouble’ in clinical practice.
Introduction

Automaticity has been identified as an important component of expert performance (Dreyfus & Dreyfus, 1986). As the expert acquires experience and knowledge, he accumulates many automatic resources (e.g., pattern recognition) that provide him with the ability to ‘just know the right answer’ or ‘just know what to do’ - thinking and acting in a predominantly intuitive manner. While acknowledging the contribution of automaticity, experts cannot stay in automatic mode all the time and are required to transition into a more effortful state when the situation requires it (Bereiter & Scardamalia. 1993; DeNeys, 2006). Donald Schön (1987) observed experts from various domains in the context of their daily practices, and found that they engage in not only ‘automatic’ modes of thinking (termed ‘knowing-in-action’) but also more ‘effortful’ modes of thinking (termed ‘reflection-in-action’). Thus, he highlighted the ability to think on one’s feet during times of uncertainty as a central component in his model of expertise.

In previous work, we have argued that expert judgment in clinical practice is the effective and appropriate coordination of the automatic and the effortful – the ability of the expert to transition from the ‘automatic’ mode to the ‘effortful’ mode when the situation requires it, a process we referred to as ‘slowing down when you should’ (Moulton et al., 2007). For example, if an expert surgeon is faced with unusual anatomy when removing the gall bladder, she ‘slows down’ in response to that situation and focuses on the abnormality, rather than ‘plowing through’ and remaining in automatic mode. Similarly, when a surgeon recognizes pre-operatively that a colonic tumour might be invading the duodenum he proactively anticipates the need to ‘slow down’ during the dissection, approaching the tumour using alternate anatomic planes. This categorization into ‘slowing down’ moments that are situationally responsive to emergent intra-operative information and those that are proactively planned based on available pre-operative information was based on a qualitative study interviewing surgeons from a wide range of surgical specialties on their experiences with this phenomenon. During the interviews for that study, surgeons not only acknowledged the presence of ‘slowing down’ moments in their
operative practice but also suggested that other operating team personnel (i.e., nursing staff and surgical trainees) detected the surgeon’s ‘slowing down’ moments and responded appropriately by cutting out distractions.

Considering the phenomenon from a cognitive perspective, transitioning from a relatively ‘automatic’ mode to a more ‘effortful’ mode requires an increased level of cognitive resources or attention that needs to be recruited from a limited pool of resources (Kahneman, 1973). This redirection or focusing of attention seems to be an observable or, at least, a noticeable phenomenon. The purpose of this study was to enhance our understanding of the manifestations of this phenomenon in surgical operative practice by supplementing surgeons’ descriptions of these events with observations of the phenomena in intra- and peri-operative contexts.

Methods

This study was designed using grounded theory, a qualitative methodology intended to explore a social phenomenon for the purposes of generating a descriptive or explanatory theory that is ‘grounded in’ (i.e., derived from) naturalistic data (Charmaz, 2000; Glaser & Strauss, 1967; Kennedy & Lingard, 2006). As part of a larger study exploring the role of ‘slowing down when you should’ in the area of intra-operative surgical judgment (Moulton, Regehr, Lingard, Merritt, & MacRae, 2009) this study explored the manifestations of the phenomenon in the operating room. The research involved four tertiary care academic hospitals affiliated with a large urban university and took place over a 16-month period. Approval of institutional review boards at the involved hospitals was obtained. The study took place in two phases.

Phase One included 60-minute semi-structured interviews (audio-recorded and transcribed) with 28 surgeons across various specialties (general surgery n = 9, neurosurgery n = 4, orthopedics n = 3, cardiac surgery n = 3, vascular n = 3, head and neck n = 2, plastics n = 2, thoracics n = 1, trauma n = 1) selected for their reputation as having excellent surgical judgment (Moulton et al, 2009), Interviews were conducted by the principal investigator (a HPB surgeon) and a research assistant with a Masters in anthropology. Consistent with the iterative design of grounded theory, further interviews were conducted with 8 surgeons from the original group of interviewees to probe an emergent theme: these participants had denied quite vehemently in their original
interview they were ever in the ‘automatic’ mode when operating. This subset of surgeons was further questioned on their perceptions of ‘automaticity’ and their ideas about their ‘routine’ mode of functioning in their operative experience. Each interview was audio-recorded and transcribed.

The manifestations of the ‘slowing down’ phenomenon that emerged as a dominant theme from Phase 1 were iteratively explored, refined and elaborated in Phase 2. Phase 2 involved observations of 5 HPB surgeons over a 10 month period (29 cases, 147 hours) to expand, confirm and refine the preliminary framework developed from Phase 1 (Moulton et al, 2009). Surgeons in the observation phase were purposefully selected (Emerson et al., 2001) from the same specialty as the principal investigator to enhance the ability of the researcher to detect subtle nuances of the ‘slowing down’ phenomenon and to understand the intricate technical and cognitive operative details (Glaser & Strauss, 1967; Strauss & Corbin, 1998). Discussions during and after surgery were conducted with the operating surgeons to discuss the surgeon’s interpretations of operative events. Surgeons were asked to comment specifically on the researchers’ interpretations of the ‘slowing down’ moments.

Thematic analysis of the transcripts and field notes from Phase 2 was conducted by the lead investigator and research assistant and results of the identified preliminary categories compared and discrepant categories discussed and brought to the research team when required. The larger research team (consisting of the principal investigator, research assistant, a cognitive psychologist, a surgeon, and a qualitative researcher) met regularly to elaborate and refine the evolving framework as data collection progressed (Glaser & Strauss, 1967). As well, a key informant (a HPB surgeon that became interested in the phenomenon and was able to be reflective about the emergent ideas and themes) provided opportunities for additional discussions and interviews that helped refine the various categories.

Data collection continued until further interviews and observations ceased to inform the emergent thematic framework (Morse, 1995). Confirmability was ensured with the maintenance of an audit trail of all analytical memos, minutes of the meetings, and revisions to the coding structure. The final coding structure was applied to the complete data set, using NVivo software.
(2007, QSR International Pty Ltd) to facilitate cross-referencing (Kelle, 2002). At all stages of the research process, a reflexivity approach was adopted.

Results
As surgeons were observed in the operating room transitioning from the routine to the effortful, the range of phenomenological manifestations expressed during the original interviews became apparent and were able to be elaborated and refined. The various transitions that were described and observed are elaborated below, in order of the most phenomenologically extreme manifestation of ‘slowing down’ to the most subtle (see Figure 5A, page 84).

**Figure 5A:** Framework for Manifestations of the ‘Slowing Down’ Phenomenon (see discussion for description of ‘inattentive’ and ‘attentive’ automaticity)

*Transitions Manifested as ‘Stopping’*
The most extreme phenomenological account of ‘slowing down’ occurred when surgeons literally stopped the progression of the operation. Many surgeons interviewed described “stopping” the operation when confronted by critical aspects of surgery, regardless of whether
they were anticipated or unanticipated (Moulton et al., 2009) slowing down moments. The former is depicted in the following excerpt from the reflective field notes:

During the pre-operative interview the surgeon anticipated that he would need to make an intra-operative assessment of how extensive the pancreatic head tumour was before deciding whether to proceed. Having performed the relevant tissue dissections, the surgeon ‘stopped’ operating and entered into discussions with the fellow, looked again at the CT images, and called in a senior colleague for a second opinion.

*Field notes, HPB obs*

During the interviews, surgeons described critical moments intra-operatively where they knew more information was required before they could decide whether to proceed with a proposed “game plan” or consider an alternate “game plan”. This was observed in the operating room as a ‘stop’ in the procedure while surgeons sought further information in numerous ways. Surgeons often used words such as “regroup” and “reassess” to describe these situations, representative of the uncertainty that was so often linked to this critical event.

Additionally, planned ‘stops’ were sometimes described and observed for the purposes of setting up the surgeon’s environment in preparation for the more critical proactively planned ‘slowing down’ moments. Surgeons would stop and ensure all necessary team members were ready and had the required resources available. Some described engaging in a mental rehearsal to adequately focus themselves and the team on the task they were about to do. As one surgeon described in the interviews,

“It can be a situation where clamps are not on yet or about to put them on, stop, see that the contingency equipment is available, see the contingency blood products are available. I may even want to re-visualize where things are going to go and I’ll feel the vessels again…go over to the computer and look at the CAT scan again”.

*Transcript: phase one interview*
The criticality of these moments was appreciated by surgeons who understood that once the first step was initiated, the subsequent steps would necessarily follow in what might be a time pressured situation or a cascade difficult to control. To name a few, this ‘stopping’ was described by orthopaedic surgeons getting ready to divide the pelvis, vascular surgeons preparing to open an aneurysm, and observed with HPB surgeons about to clamp the portal vein. Surgeons used this ‘stopping’ mechanism to make sure equipment was ready and team members were prepared and focused on the task at hand as a forward planning process.

Surgeons also described ‘stopping’ unexpectedly as a *situationally responsive* ‘slowing down’ moment. An excerpt representative of a surgeon transitioning to more effortful cognitive activity from the reflective field notes follows:

> As the fellow was transecting the liver parenchyma, the surgeon, recognizing unusual anatomy said, “What the hell is that? Let’s just stop and see how we’re doing here”. The surgeon then placed his hand in the field to prevent the fellow from operating and looked up at the ceiling for a few seconds with his eyes closed. When the researcher asked what he was thinking, he (half) joked, “I am looking at the textbook on the ceiling”. He proceeded to explain that he needed a few seconds to visually consider what segment of the liver would be affected if he divided this particular structure and whether it was an essential structure that needed to be left in place. After deciding to go ahead he dissected it out further, and again became uncertain saying, “whoa, let’s stop again – we’re allowed to change our minds”.

*Field notes, HPB obs*

Given the teaching environment where this study was conducted, many trainees were the primary operators with the surgeons acting at various assistant levels. Surgeons, therefore, during their own ‘slowing down’ moments, needed to stop the proceedings of the operation by placing their own hand in the operative field to ensure the trainee also stopped. Sometimes surgeons responded to these moments by ‘taking over’ manual control of the case, often involving a change of who is holding the instruments or a change of positioning around the operating table.
Whether ‘stopping’ occurred as a result of a proactively planned ‘slowing down’ moment or whether it occurred as a function of an emergent issue, it was clearly a strategy that provided cognitive space for the surgeon to consider existing or gather new information.

*Transitions Manifested as ‘Removing Distractions’*

Some transitions into the effortful state were manifested by the operating team (often the surgeon) requesting that distractions in the operating room be removed. The surgeon, upon encountering a ‘slowing down’ moment, became irritated or distracted by various stimuli and needed them removed so that he or she could focus on the task at hand. Controlling the environment in this situation was not for the purposes of gathering new information or setting up the room as a forward planning initiative, but rather to recruit the additional attention or cognitive resources that were being used elsewhere to focus on the critical event. As one surgeon said when discussing his ‘slowing down’ moments,

“I think I notice the noise level. When things are going smoothly, you hardly notice it and when things get a little rough in there, you notice it much more…the anaesthetist doesn’t realize what’s going on and they’re still nattering away about what the Raptors did last night, so I usually have to just tell them, hold it a minute here until I see what we’re doing with this.

*Transcript: phase one interview*

This particular manifestation of eliminating distractions during the more critical ‘slowing down’ moments was also observed in the operating room with this representative excerpt from the reflective field notes:

The surgeon was assisting the fellow as the liver parenchyma was transected. The situation was relaxed and proceeding uneventfully. The resident, holding a retractor, was telling an unrelated story to the surgical team. In the operative field, a large hepatic vein was opened suddenly causing a moderate and steady flow of blood loss. Oblivious to this, the resident continued talking. The surgeon said, “Wait one minute (resident name). Let’s just see where we are” as the surgeon and fellow continued operating. Without the situation fully under control, the resident resumed talking. The surgeon said (with some
agitation), “Wait one minute (name), a bit too much bleeding here”. The surgeon verified this interpretation of the proceedings in the post-operative interview, admitting to being annoyed by her “chatter”. While she was talking, he felt distracted by her and was “unable to concentrate like I wanted to”.

Field notes, HPB obs

During another observational session a clinical fellow was overheard telling a junior resident after an operative case that “you take cues from the surgeon when to talk and not talk” demonstrating that this reverence or respect for these moments is not necessarily an intuitive skill found in all residents and may require acquiring with training over time.

It was not always the surgeon who actively removed distractions from the room. Other operative team members recognized the distracting potential of noise and conversations during these moments and eliminated distractions themselves. Nurses and surgical trainees, in such moments, were observed turning music down or off, turning away ‘visitors’ to the operating room, and requesting conversations be taken outside. Even when scrubbed, the same messages could be relayed with eye contact and head motioning. Many surgeons acknowledged this input from their surgical team, recognizing that “experienced” members of their team eliminate distractions on their behalf. As one surgeon proclaimed, “good nurses get it and residents may not”.

Transitions Manifested as ‘Focusing More Intently’

A somewhat more subtle manifestation of this phenomenon in the operating room was demonstrated when the surgeon allowed external distractions to continue but ceased to participate in these activities becoming exclusively focused on the procedure. As one surgeon said, “If you ask me to talk about my vacation or where I go take my car for repair, of course I can’t anymore. It becomes distracting to what am I doing”. Many surgeons recognized that because of the attention required during the critical ‘slowing down’ moments, they were unable to split their attention with another task (i.e., teaching or talking). As one surgeon described, “If it is a real critical part I’ll be the one that does that part and chances are there will be less teaching at that point in time, less talking at that point in time”.
During the observational sessions, this appeared to be a less intense manifestation of the transition, as surgeons were not appearing to be ‘distracted’ at conversations and noise around them as long as it was not directed at them. They simply appeared to be ‘dropping out’ of conversations or teaching interactions as they focused on the operative field. This was demonstrated in a reflective field note:

The surgical fellow had just divided the bile duct during a standard Whipple procedure and was engaged in an extraneous conversation with U2 playing in the background. The surgeon noticed some bleeding and dropped out of the conversation, focusing intently on what they had just divided. While he was inspecting the ligated bundle of tissue, feeling for pulses in the hilum, and tracing the pulse of the hepatic artery along its length, the fellow continued talking and the resident and medical student were literally nodding their heads to the music, oblivious to what the surgeon was concerned about. Once the surgeon had satisfied himself that they had not divided a replaced right hepatic artery (not a recommended step of this procedure!) he started back into the conversation. The researcher asked the surgeon whether he had heard what the fellow had said just seconds before. He had not.

Field notes, HPB obs

Some surgeons described particular ‘telling signs’ they were aware of, either with themselves or others they have worked with, that make it obvious to the outside observer they are in the midst of a ‘slowing down’ moment. As one said of himself, “And you’d also see me, maybe I’m starting to sweat a little bit, I’m just not as happy as I was, I’m not enjoying it as much as I was”. Another surgeon describing a colleague said, “…I get to work with everybody so I’ve seen everybody in that situation ...Dr (name) has an interesting one...he’ll start singing or humming La Vie En Rose. It’s, like, he sings a particular song, he hums a song and it’s always the same one, when he’s stressed”.

Transitions Manifested as ‘Fine Tuning’
During interviews that preceded the OR observational sessions, surgeons also discussed examples of what appeared to be ‘minor’ transitions from the routine to the effortful, that occurred numerous times throughout any given procedure. These transitions appeared to be
responsive but on a much smaller scale than those described above and seem to fit best under a separate category of ‘fine tuning’. As one surgeon stated, “I mean there are junction points during an operation during which you have to make a judgment, you have to make a decision but more than that there are multiple small nodal points where you have to go this way or that way, probably thousands.” Surgeons described engaging in this ‘fine tuning’ activity on a moment-to-moment basis, responding to emergent cues (e.g., readjusting angles, approaches and technique) for the purposes of staying out of trouble.

During the observational sessions, ‘fine tuning’ appeared to be momentary increases in attention or focus that occurred throughout the procedure. The surgeon appeared to be responding to or focusing on a technical issue (e.g., finding the correct dissection plane, tying off an important vessel), recruiting minimal effort to safely deal with the issue at hand. During these ‘minor’ transitions, surgeons could continue with other activities (e.g. talking, teaching, and listening to music) with very little, if any, interruptions. This was described in the following reflective field note:

The surgeon was encircling the portal vein at the hilum of the liver. He recognized the vein was bigger than anticipated and pulled the dissecting instrument out to then encircle the much larger vein. He was conversing throughout this maneuver with the fellow about the prognosis of the case and ‘paused’ momentarily as he corrected the angle of the right-angled instrument. 

Field notes, HPB obs

The event was largely unnoticed and did not seem to require an explicit or obvious transition from the routine to the effortful. In fact, the subtlety of many ‘fine tuning’ transitions prevented them from being noticed by the research assistant (non surgeon) who after some training detected some but not many ‘fine tuning’ activities. ‘Fine tuning’ appeared to represent the interplay between the finer aspects of the cognitive and technical components of surgery, and appeared to require, therefore, detailed content specific procedural knowledge of the surgery to be observed. The purpose of engaging in this ‘fine tuning’ activity appeared to be to avoid more dramatic reactive transitions (e.g., putting a hole in a vessel, compromising a tumor margin) not only responding to emergent cues as they arise, but also projecting forward to avoid unwanted events.
Failure to Slow Down: The State of ‘Drifting’

During the interviews, many surgeons described examples of ‘drifting’ dangerously into an inattentive state while operating. In fact, when surgeons considered the word ‘automatic’, this appeared to be the state they were thinking about, which may explain why a sub-set of surgeons vehemently objected to ever being in the ‘automatic’ mode. ‘Drifting’ was recognized as a consequence of complacency during the more routine, mundane, or “boring” parts of the procedure. Referring to a recent mishap, one surgeon explained the following: “…it’s the routine cases… it’s like the… bile duct injuries always happened in easy gall bladders, right? That’s what happened here. It was an easy case. We were chatting and obviously not being as diligent as we should have been”.

This was a common admission amongst the surgeons - when you allow yourself to ‘drift’ you fail to engage in the activities of ‘fine tuning’. This ‘drift’ was observed in the operating room, as described in the following excerpt from the observational field notes:

The senior surgeon was performing a Whipple procedure (resection of the head of the pancreas) on a patient with a replaced right hepatic artery. He carefully dissected this aberrant artery off the bile duct, as it was crucial to the procedure that it be preserved. Having completed this step, he continued to the usual next step, dividing the small bowel mesentery. While the surgeon assisted the fellow in this more mundane and routine part of the procedure the surgeon discussed ‘ward’ patients with the resident. The team returned to the porta hepatis and the surgeon placed the right angle around the bile duct, forgetting, for that moment, about the replaced right hepatic artery that had been delicately dissected out thirty minutes before. They proceeded to place the ligature around the bile duct as well as the replaced right artery, tying both together. In the post-operative interview, the surgeon explained that it was normally such a routine part of the procedure and admitted to being distracted by conversation. He appeared to have ‘drifted’ in a mode of ‘just tying off the bile duct’ forgetting the variation momentarily in this patient.  

Field notes, HPB obs
The transitions that did occur during this state of ‘drifting’ appeared to be prompted by the recognition of an error that occurred as a consequence of failing to appropriately ‘fine tune’ or in other words a failure to ‘slow down when you should’.

Discussion

The ‘slowing down when you should’ phenomenon has been proposed as an important marker for the display of intra-operative surgical judgment (Moulton et al., 2009; Moulton et al., 2007). ‘Slowing down’ represents the cognitive refocusing or increased attention onto a particular task and describes the surgeon’s experience during the critical moments of surgery. It is not meant to convey meaning about the speed of the surgeon’s hand movements during these times. While surgeons sometimes described a simultaneous decision to actively slow their movements down or make them more deliberate, this seemed to be a consequence of the surgeon wanting to regain or retain control during these critical moments (Moulton et al., 2009). This distinction has important ramifications when looking at manifestations of this phenomenon, as it is not the surgeons’ hands or movements that necessarily become slower but rather the focus of their attention that changes. This is consistent with the widely accepted ‘capacity model’ of attention, which suggests that humans work within a limited capacity of attention (Kahneman, 1973).

When the threshold is reached, further attention to a stimulus cannot be given without taking away attention from other stimuli. Using this model, we can begin to interpret the various manifestations of the ‘slowing down’ phenomenon seen in our study as representative of behaviors found along a spectrum of investment in cognitive effort. As more cognitive resources are required to carry out the physical and mental processes involved with a particular surgical task, more attention is taken away from other activities. As the surgeon transitions from a routine state to a more effortful state, various levels of recruitment are necessary to meet the demands of the task, manifesting itself in different ways. Generally speaking, the larger the amount of cognitive resource recruited for the task, the more dramatic is the manifestation (i.e., ‘stopping’) that accompanies it. This may not always be the case in situations where a life-threatening event forces a surgeon to continue operating. She might like to ‘stop’ and regroup but time does not allow it and therefore this transition might be observed as a less intense manifestation of ‘removing distractions’ or ‘focusing intently’. While this overlay of manifestations onto a framework of cognitive recruitment may not be a perfect match, the framework is nonetheless
useful for understanding the various manifestations that accompany this phenomenon. While it is useful to conceptualize the manifestations as occurring along a spectrum, this is not intended to imply that recruitment in cognitive activity occurs through stages, from one level to the next in a linear fashion. Rather, it is more appropriate to consider the various manifestations as fluctuations in discrete amounts of cognitive investment; a surgeon engaging in ‘fine tuning’ activities, for example, might recognize an abnormality and suddenly ‘stop’ the procedure, traversing no other ‘levels’ along the way.

Choosing to observe HPB surgeons was an intentional sampling strategy based on the fact that the principal investigator is a HPB surgeon (CAM). This decision was made for the explicit purposes of being able to detect subtle nuances of the ‘slowing down’ phenomenon as well as having the ability to understand and make informed attributions for what was going on surgically – weaving the story of both the phenomenon and the surgical relevance together. We believe this strategy enabled us to expand and refine the manifestations of this phenomenon in a way that would have been impossible otherwise. While it is a strength of this study that the primary researcher was from the same sub-specialty as the participants being studied, the subtleties of the phenomenon pose significant implications for future research. To start, it would be difficult, if not impossible, to place ‘naïve’ observers in the operating room and train them enough to detect the more subtle manifestations of ‘fine tuning’ and even ‘focusing more intently’. While the research assistant (masters student in anthropology) for this study was able to detect the range of manifestations including some instances of these more subtle manifestations with training, she missed many instances of them as well as the surgical details that were essential for adding meaning to the story. It is unclear whether even a trained surgeon in one specialty could detect the subtleties of a surgeon in another specialty.

Importantly, these subtleties also have implications both for the smooth functioning of the operating room and for the training of novice OR staff and residents. That is, surgeons recognized that not all members of the team detected their ‘slowing down’ moments, reflected in the surgeon who recounted that “good nurses get it and residents may not”. Knowledge of the cognitive fluctuations in members of the surgical team, particularly during the ‘slowing down’ moments, might provide sensitivity to this dynamic nature of the surgical environment and
improve the performance of the surgical and operating room team (Sevdalis, Lyons, Healey, Undre, Darzi, & Vincent, 2009). It is probable that trainees (medical or nursing) reach their ‘attentional threshold’ (Kahneman, 1973) when surgeons have not, making extraneous conversations, music or ‘noise’ distracting for one and not the other. If trainees lack the ‘right’ or ability to remove distractions they may be unable to dual-task effectively with negative consequences on performance (Hsu, Man, Gizicki, Feldman, & Fried, 2008). Further, if trainees are not detecting the more subtle transitions or ‘slowing down’ moments of the staff surgeon – manifested as ‘fine tuning’ or the ‘focusing more intently’ – they are less likely to appreciate the subtle nuances that require cognitive effort and minor readjustments in technique. This has obvious implications for teaching and training and may be found as a cause for trainees who fail to slow down when they should, or ‘plow through’ inappropriately (Moulton et al, 2009).

It is important to note, that some surgeons, while appreciating the phenomenon of the transition, felt less personal resonance with the construct of automatic activity. As one such surgeon described, “I don’t think we’re automatic. I don’t think we can be…but I guess there are levels, right?” Consistent with this position, during the observational sessions, the researcher began to notice that the surgeons studied rarely looked as if they were in a truly effortless mode, even during routine aspects of the procedures. Reading the expertise literatures, we might develop an image of surgeons’ movements in the operating room as unconscious, quick, fluid, and effortless for the majority of the time, only becoming effortful when the occasional situation requires it (Dreyfus & Dreyfus, 1986; Ericsson, 2004). This image of expert ‘automaticity’ as a sense of detachment from the activity was not regularly demonstrated in this study and, to the extent that it was it manifested as sufficiently different from the usual practice of constant fine tuning to be recognized as a separate phenomenon of ‘drifting’. More often, however, it appeared that even though surgeons’ hand movements demonstrated an economy of motion, lacking the clumsiness of novices for instance, some part of their cognitive processes were constantly engaged in and attentive to their environment. Some surgeons described this background monitoring activity as a “heightened sense of surveillance”. It is from this heightened baseline awareness that surgeons momentarily dip into their cognitive resource pool (or transition into a more effortful state) to engage in ‘fine tuning’ activities – numerous minor adjustments and technical maneuvering – to stay on course.
By contrast to this state of monitoring and “heightened surveillance”, the state of ‘drifting’ was described by surgeons in this study to as a negative by-product of automaticity, a state of inattention leading in some cases to error. This might explain why surgeons in this study were reluctant to consider this as their baseline level of functioning. This ‘cost of automaticity’ is discussed in the broader attention literature in procedures that are highly routinized but, at the same time, require close attention (Barshi & Healy, 1993; Toft & Gooderham, 2009). Errors in such systems, as those described by surgeons in this study, occur because routinization leads to automatic behaviours that are not accompanied by close attention (Barshi & Healy, 1993). Often the only evidence for ‘drifting’ in these situations is when errors occur. ‘Drifting’ has been suggested by some to be beyond the control of the subject working in such routine or ‘automatic’ conditions. In fact, Toft and Gooderham (2009) refer to this ‘drifting’ as ‘involuntary automaticity’ and go so far as to suggest it is a potential legal defence against allegations of clinical negligence in situations where organizations have not taken measures to counteract or consider the influence of ‘automaticity’ on the performance of their workers.

Given these two descriptions of ‘automaticity’ we propose that being in an automatic mode is not an ‘all or none’ phenomenon, but rather can be further characterized by how much attention is reinvested back into monitoring activities during the case. The distinction between the two states might be best described as: ‘attentive automaticity’ and ‘inattentive automaticity’. Being in a dynamic environment, surgeons are required to maintain some degree of situation awareness, requiring fluctuating levels of cognitive effort at a baseline level of functioning. This baseline level of cognitive effort appears to be directed towards metacognitive monitoring to “remain aware of the whole situation, to monitor events as they occur, to reflect on alternative possibilities should a decision need to be made” (Dunphy & Williamson, 2004), and to monitor processes that are happening “automatically” (Garofalo, 1986). When this monitoring activity fails, ‘drifting’ occurs. The importance of metacognitive monitoring in health professionals has been the recent focus of research programs in medical education (Epstein et al, 2008; Eva & Regehr, 2005; Regehr & Eva, 2006; Regehr & Mylopoulos, 2008) expanding our view of expertise beyond the ‘expertise as automaticity’ model. It is quite possible to consider that a true expert is one who reinvests freed up cognitive resources (a benefit of being automatic) into the
moment-by-moment monitoring of his or her clinical activities – a process that requires purposeful attention and effort. Knowledge of the ‘cost’ of automaticity with the potential for ‘drifting’ into an inattentive automatic state has important implications for patient safety and may help us in teaching the next generation the importance of remaining purposefully attentive (Epstein, 1999; Epstein et al., 2008) - reinvesting cognitive resources back into the case to function as a metacognitive self-monitoring and self-corrective feedback tool.
Chapter 6
The Control Dynamic of Educators in ‘Slowing Down’ Moments

This third data paper arose initially out of an interest to explore the teaching issues that surgeons alluded to in their discussions about their ‘slowing down’ experiences in the operating room. The main point of interest in the original versions of this paper revolved around how surgeons taught ‘judgment’ in the operating room, as represented by the critical events that initiated the ‘slowing down’ phenomenon. During the transitions into a more effortful state, surgeons described having to withdraw from activities such as teaching to focus their cognitive resources on the surgical event. How, then, do surgeons ensure trainees learn the critical aspects of judgment during these moments? Further, as surgeons described a frustration with trainees coming to the operating room ill-prepared, how do trainees learn the importance of the “game plan” and the consideration of the proactively planned ‘slowing down’ moments?

As interviews and data analysis continued, our analytical interest shifted away from evolving a set of ‘things we do well or poorly’ or ‘things we should do’ in surgical teaching practice to exploring an emergent dynamic about the balance between ‘managing the case’ and ‘managing the trainee’. This dynamic was overlaid by and led to an elaboration of the issue of control as surgeons experienced intra-operative ‘slowing down’ moments. This issue of control was mentioned briefly in the results of the paper in Chapter 4 as it was found to be a dominant theme expressed by surgeons in their discussions of their intra-operative ‘slowing down’ experiences. Given the academic environment this study was conducted in, the issue of control became magnified as surgeons described not only their own sense of needing more control during the ‘slowing down’ moments but also described a simultaneous process of having to negotiate control away from the trainee. This emergent theme was identified early in the course of Phase 1 and was explored through the remaining interviews of Phase 1 and the observations of Phase 2 (refer to Figure 4A, page 64). Surgeons were asked about their experiences as teachers and educators and how this interfered with or impacted on their own ‘slowing down’ moments intra-operatively. The following paper is a result of a separate analysis of the relevant data derived from both Phase 1 and 2.
The phenomenon of ‘slowing down’ occurs necessarily during moments of uncertainty or during moments that require more of the surgeon’s attention. This leads to the surgeon feeling a need to increase levels of control. Conducting this study in an academic teaching institution where trainees ‘perform’ the procedure while staff surgeons ‘assist’, provides a layer of complexity where priorities of education and patient safety sometimes compete. This paper therefore evolved into an exploration of how this control dynamic was perceived and managed by the surgeon. This paper has been submitted to the Journal of American College of Surgeons (JACS), a journal with a wide readership of surgeons and surgical educators. The discussion section focuses on the theoretical and practical implications of this explicit description of the ‘control dynamic’.
Operating from the Other Side of the Table: Control Dynamics and the Surgeon Educator
Moulton, CA, Regehr, G, Lingard, L, MacRae, HM.
*Accepted by JACS pending revisions*

**Introduction**

As with many clinical settings, the operating room is a complex and dynamic environment. At times the procedure is running according to plan requiring relatively little cognitive effort on the part of the surgeon beyond simply monitoring the progress of the case (Epstein et al., 2008; Flavell, 1979). Quite naturally and almost automatically surgeons in this setting will “do what they know how to do” (Dreyfus & Dreyfus, 1986; Ericsson, 2004). At other times the procedure requires more intensely effortful attention (Bereiter & Scardamalia, 1993; Schön, 1987) and regardless of whether such a moment is anticipated prior to the operation (i.e., is proactively planned) or whether it arises from an unanticipated emergent situation during the operation (i.e., requiring situational responsiveness on the part of the surgeon), these moments are often experienced by the surgeon as a sense of ‘slowing down’ (Moulton et al., 2009). It has been argued that the process of transitioning from the routine to the effortful, of “slowing down when you should,” is integral to the construct of expertise in the clinical setting (Moulton et al., 2007). Recent research suggests that, at least in the surgical setting, this process of ‘slowing down’ is, in part, an effort by the surgeon to maintain control over the evolving operative environment (Moulton et al., 2009).

The teaching context of the academic hospital setting contributes a further layer of complexity to this dynamic of control, as staff physicians must balance the need to maintain high standards of patient safety with the need to offer their trainees opportunities to gain experiences of “progressively independent” practice (Kennedy, Regehr, Baker, & Lingard, 2005). Because of this additional complexity, the teaching context provides a unique opportunity to explore more elaborately this issue of how, when and why physicians feel the need to exert control over the clinical situation, and the role of ‘slowing down when you should’ in this process. In the context of a larger, multi-phase study of intra-operative surgical judgment, during which we interviewed academic surgeons regarding their experiences of slowing down and observed this phenomenon in the operating room, the importance of the control dynamic as a factor in the ‘slowing down’
process emerged as a dominant theme. The current paper describes our explorations and elaborations of the control dynamic in the academic teaching environment within the framework of our model of ‘slowing down when you should’.

Methods

This study was designed using grounded theory methodology (Charmaz 2000; Glaser & Strauss, 1967; Kennedy & Lingard, 2006b). The research took place over a 16-month period at four tertiary care academic teaching hospitals affiliated with a large urban university. Approval of institutional review boards at the involved hospitals was obtained. The larger study took place in two phases. Phase 1 included semi-structured interviews (audio-recorded and transcribed) with 28 surgeons from various specialties (general surgery n = 9, neurosurgery n = 4, orthopedics n = 3, cardiac surgery n = 3, vascular n = 3, head and neck n = 2, plastics n = 2, thoracics n = 1, trauma n = 1) selected for their reputation as having excellent surgical judgment (Moulton et al., 2009). Phase 2 involved observations of 5 surgeons over a 10 month period to expand, confirm and refine the preliminary framework developed from Phase 1. Surgeons in the observation phase were purposefully selected (Emerson et al, 2001; Strauss & Corbin, 1998) from the same specialty as the principal investigator (HPB surgery) to enhance the ability of the researcher to detect subtle nuances of the ‘slowing down’ phenomenon. The emergent theme of control in this teaching environment was explored in both phases of this study. A reflexive approach was adopted throughout the research process.

Thematic analysis of the transcripts and field notes was conducted primarily by the lead investigator, with preliminary categories identified, iteratively elaborated and refined in conjunction with other members of the research team as data collection progressed (Glaser & Strauss, 1967). Data collection continued until further interviews and observations ceased to inform the emergent thematic framework – the point at which ‘saturation’ is reached (Morse, 1995). Confirmability was ensured by maintaining an audit trail of all analytical memos, minutes of the meetings, and revisions to the coding structure. The final coding structure was applied to the complete data set, using NVivo software (2007, QSR International Pty Ltd) to facilitate cross-referencing (Kelle, 2002).
Results

Although minor contextual differences between specialties were identified, broad thematic issues were representative of participants in both phases of the study, with the issue of control manifesting as a dominant theme in surgeon’s supervisory practices in relation to the ‘slowing down’ phenomenon. That is, surgeons regularly described how the teaching environment in surgery, in which trainees perform the procedure while the surgeon supervises from the other side of the table, set up an interesting control dynamic between surgeon and trainee and demonstrated these phenomena in the operating room (Figure 6A, page 102; Table 6A, page 109).

The Control Dynamic

Control issues appeared magnified when surgeons described their experiences of the ‘slowing down’ phenomenon in the supervisory setting, because they had to control the operation through the medium of a trainee. The dual responsibilities to education and patient safety seemed to set up a dynamic that required constant monitoring on the part of the surgeon.

One aspect of this dynamic involved the educational perspective. Surgeons felt the need to give some manual control (i.e., control of the moment to moment actions and decisions) to the trainee, believing that the best way of learning how to operate is to actually operate. Surgeons sensed a pressure to be ‘hands off’ – providing the trainee space to develop the necessary skills to become an independent surgeon. As one surgeon said, “there is a sense of that need to let them exercise their own judgment and their own decision making, and that’s important…I feel an obligation to allow them to do that, provided they’re not going to do anything harmful.” This necessarily requires the surgeon to give up some degree of manual control, as the operating instruments are held and controlled by the trainee in these situations.
The educational responsibility of letting trainees operate was not straightforward, and was tempered by a perceived need to protect the trainees’ sense of well-being, or confidence in themselves as evolving surgeons. As one surgeon noted,

“There is a certain level of operation that I will let a resident or fellow do but then there is a certain level of complexity to an operation I won’t let the fellow do. And the reason is not because I don’t necessarily feel that he or she can’t do it but because if something
happens I don’t want them to have that on their conscience. I would rather, if something
goes awry, that I’m the one who takes the blame, not them.”

Transcript: phase one interview

This position was echoed by many surgeons interviewed, highlighting the complexity of these
decisions, even when considering only the educational aspect of the dynamic. As a general rule,
the desire to let trainees operate at the edge of their ability was a strongly held educational
mandate among our participants.

At the same time, surgeons were aware of their responsibility to ensure patient safety at all times,
and understood that they needed to be prepared to “take over” when the situation required it. As
one surgeon stated, “…often I will take over … because I don’t like the way it looks, I don’t like
the way it’s going….”. Thus, there was a general feeling among the surgeons that they needed to
constantly monitor the situation to gauge how involved they were required to be on a moment-
by-moment basis. This monitoring of the situation provided them with a sense of control over a
case, even when they had given up manual control through the medium of the trainee. Surgeons
outlined a complicated relationship between maintaining a sense of control over a case regardless
of how much manual control of the case they had. That is, despite surgeons sometimes handing
over manual control of the operative case to the hands of the trainee, surgeons were reluctant to
say they ever felt ‘out of control’ (even in the extreme situation where they described leaving the
OR for periods of time). This balance was achieved in numerous ways as described below.

The Negotiation of Control

The dual responsibility to education and patient safety, with its competing pressures to give up
manual control on the one hand and take it back on the other, seemed to set up an implicit
negotiating process between surgeon and trainee. They understood that trainees might feel they
deserve a different level of manual control than surgeons are prepared to give up in order to
maintain their sense of control. At any given moment, they may find themselves needing to
negotiate manual control away from a trainee who is trying to tightly guard it. As one surgeon
stated:
“There’s an expectation, especially for senior trainees, that they’re doing operations and we have to appropriately utilize them because there’s a balance…Once they’re no longer doing it you need them there as an effective assistant and you certainly don’t want them to sabotage the operation. You do get the occasional person that disengages when they’re no longer in charge and that’s problematic too.”

Transcript: phase one interview

This negotiation of giving and taking *manual control* appeared to be a process that was in a constant state of flux with surgeons varying their level of involvement in a case based on assessments of trainee ability and patient safety. Patient safety factors appeared to ‘trump’ any other factor, taking precedence over any decision to give control to the trainee. As one surgeon said, “if I think they’re doing it differently than I would, but it’s safe, then I’m okay with that. But if I think that they’re not being safe, I would take over”.

These implicit negotiations began prior to the operation, a time during which surgeons were establishing the level of *manual control*. This included a general assessment of the trainee’s knowledge and skill level, often assessed by previous experience with the trainee. As one surgeon said, “It would be highly unusual for me to leave a resident alone in their first week of their rotation with us”. Surgeons also considered the trainee’s awareness of their limitations and how likely they would be to call for help, again based on past experiences and reputation: “I need to know that they know where to slow down, will be uncertain when they need to be and will call for help when they need to”. Further, surgeons made assessments of how well trainees carry out instructions, essential for the surgeon to trust the trainee, especially when operating independently. As one surgeon said, “there are those (trainees) where, after the first few cases I know I can tell them what I would like to do and they’ll do it…And others, I basically have to watch them the entire time for the length of the rotation, to make sure they don’t exercise their own free will too much.” Having confidence that the trainee will carry out instructions enabled the surgeon to relinquish a greater degree of *manual control* in the case. Finally, surgeons considered how the preparedness of the trainee for that particular case. Surgeons felt confidence in the trainee who had invested in the case, had considered the critical moments of the case, and had a similar “game plan” to the surgeon’s own. As one surgeon said, “I need to know the fellow
or resident is on the same page as I am. Otherwise I don’t trust them to start the case.” Thus, this process of establishing a level of manual control between surgeon and trainee pre-operatively influenced how “hands-on” the surgeon would be at the beginning of the case.

Negotiation of control was also described during the procedure, with the surgeon maintaining his or her sense of control over the operation through fluctuating levels of direct involvement or manual control during the case, moving between two ends of a spectrum from being a fully “hands-off” observer to being the primary “hands-on” surgeon (taking over the operating instruments). The sense of need to gain additional manual control over the operative environment was often triggered by the surgeons’ own intra-operative ‘slowing down’ moments when their sense of control was potentially threatened. That is, when the procedure was at a ‘delicate’ stage or when an unexpected situation arose, surgeons described the desire to slow the operation down, which required the exertion of additional control over the situation. In addition to their own ‘slowing down’ moments, supervising surgeons had to monitor the trainees ‘slowing down’ moments, keeping them on track and ensuring they ‘slowed down when they should’. This recognized need to ‘slow down’ not only according to the surgeon’s own internal cues, but also in response to what the trainee was doing required an elaborated monitoring process and a constantly fluctuating level of involvement with the case: “…usually I just let them operate. I assist them, but there are times when I can see they are going off track. I need to take over operating sometimes to get them back on track and then give it back to them”.

There were various strategies surgeons used to negotiate fluctuating levels of manual control in order to maintain their sense of control intra-operatively. Surgeons recounted how increasing their own level of manual control did not always appear as taking over control of the instruments. There were various other tactics they used to manipulate control from the trainee that were much more subtle and implicit. One particular strategy was to get control of the operative team, without necessarily having to take manual control of the case. This strategy was usually described in the context of surgeons’ proactively planned ‘slowing down’ moments when they did not necessarily feel the need to take manual control away from the trainee but needed to increase their sense of control at that moment. As one surgeon described, “A surgeon essentially sets the tone for what he or she is doing at that point in time and communicates, sometimes
overtly and other times subtly, with those around him or her, that this is a time when we all have to concentrate.” Another strategy described to negotiate additional control was to manipulate the exposure of the operative field, altering what is presented to the trainee. One surgeon described, “… a resident has control of the operation and, one way or the other, I’ll intervene to make sure I have control, not necessarily because I’m physically doing all the maneuvers but I can set the pace, I can control what everyone is looking at and stuff like that.” Again, this implicit intra-operative negotiation of giving and taking away some degree of manual control appeared to be a fairly fluid process throughout the procedure according to what was occurring in the operative field and how competent the surgeon judged the trainee to be in dealing with the particular task at hand; more critical moments that threatened their sense of control required more manual control and more “hands-on” intervention.

There were some surgeons that described giving up manual control to the trainee completely by leaving the room for short periods of time. Though the surgeons acknowledged they gave up complete manual control they were reluctant to say they felt out of control even in these moments. They maintained their sense of control during these situations by making an assessment (or as some termed it, a “calculated risk”) that they were handing over a ‘controlled’ situation and the risk to patient safety was minimal. As one surgeon stated, “There are going to be moments of surgery where it’s routine, where the risk is low, those are areas of the surgery that a resident or fellow is doing it by themselves…and that’s part of the expertise, to recognize those areas when the delicate aspects of surgery [are].” Surgeons seemed to hand over complete manual control of the operation to the trainee only when they sensed the situation was routine with minimal risk and in doing so, maintained their sense of control over the situation. As one surgeon stated, remembering their trainee days, “it was intriguing to me that my staff knew exactly when to come back to the operating room, they would leave for a while, but always seemed to walk in exactly at the right time”.

Through the discussions of negotiating control, surgeons acknowledged being able to give trainees the ‘illusion of having control’, while keeping control from the other side of the table. This was more than having a sense of control of the operation; surgeons acknowledged they could have almost complete manual control of the operation from the other side of the table.
through the hands of the trainee, utilizing various strategies, some of which are outlined above. As one surgeon described, “I can set the operation up and control it so that the resident virtually cuts from A to B”. Though this may have benefits from an educational perspective (providing self-efficacy for the junior trainee and providing an opportunity to keep trainees operating with time constraints) some surgeons warned that it might give undue confidence to the trainee. As one surgeon stated,

“I think most of them in their own mind they think they’re sort of doing this big operation even though we’re leading them point to point and they sometimes get to a point where they think they can just go do the whole thing and they’re not really listening to the plan, they’re not doing what you want them to. They think they can do it.”

*Transcript: phase one interview*

Surgeons believed that residents who were given the illusion of control were prone to underestimate the actual contribution from the staff surgeon. Without appreciating the intricate details (e.g., exposure techniques, forward planning) necessary to perform the procedure safely, surgeons feared it could make trainees over-confident, giving them a false sense of ‘competence’.

**The Complications of Control**

When discussing their experiences with ‘slowing down’ moments within the teaching context of their workplace, surgeons described instances when this balance of control became especially complicated. When things were going well between the surgeon and trainee, surgeons described a flow that occurred from being “in sync” with the trainee. As one surgeon described, “it’s a pleasure to operate with trainees when you both are on the same page. You think about the case in the same way, and anticipate the same issues”. The surgeon and trainee ‘slowed down’ at the same moments providing a synchronicity that the surgeon found pleasurable and helpful. Alternatively, surgeons describe trainees who, in their opinion ‘slow down’ too much, “substituting meticulousness for knowledge or experience”. Here surgeons felt the need to ‘speed up’ the trainee, giving them confidence with statements such as “there is nothing you can do here that I can’t get you out of”. On the other side, surgeons describe trainees who appear to “plough
through” everything; “I think there’s a lot of protection for trainees and I think that’s why a lot of them just don’t really slow down until you force them to.”

A further complication of the control dynamic was described when surgeons found themselves at the edge of control – taking over too late or taking over too quickly. On one side of this edge, surgeons described a ‘skidding’ sensation whereby they believed they took control of an evolving issue too late, failing to ‘slow down’ or stop the trainee in a timely fashion. ‘Skidding’ was epitomized by one surgeon who said, “…by the time I opened my mouth to stay “stop” it was too late. A second later there was a big hole in the cava. It’s almost like we skidded. From the time it got from my brain to my mouth and then from his brain to his hands it was too late.” This was illustrated in a reflective note from the observational sessions:

During a liver resection, the surgeon operating from the other side of the table, shouted to the fellow who had manual control of the procedure, “Stop. Stay. Still.” When questioned about this following the operation, he said “they don’t always stop when you want them to, or when you feel they need to. You have to be forceful sometimes if you feel they aren’t listening”.

Field notes, HPB obs

The potential the trainee had for putting the patient at risk, because of his manual control of the case, seemed to threaten the surgeon’s sense of control. In delicate situations, trainees are sometimes required to respond effectively and swiftly in order for the surgeon to be able to negotiate manual control from the trainee. If this fails, surgeons perceive this as ‘skidding’. Not all surgeons resonated with the ‘skidding’ phenomenon, stating their problem was often the opposite. As one surgeon described, “I have to say I have a very short trigger to take over…I know I have a pretty low threshold for giving into that feeling and not letting them [operate]…I am not sure it is helping them too much”. These surgeons felt they supervised with a different style, never giving enough manual control to the trainee to do harm, appearing apologetic for its possible negative effects on education.

A third complication of the ‘control dynamic’ involved the bargaining arrangement that gets established between surgeon and trainee. If trainees prepared for a case, surgeons more willingly
invested in the trainee; if trainees didn’t prepare for a case, surgeons were less prepared to invest in them. As one surgeon stated, “She’ll go through the charts and if she has some questions, she’ll come and talk with me. And I find that very, very good, which is why, even though I’m not sure she’s up to doing the entire case, I’ll let her get started on them because I can see she’s making an effort to be a good surgeon.” While some described a reward for what they perceived as “good behaviour”, many described the opposite with a punitive system for “bad behaviour”, a situation they perceived as “much more common”: “I expect that they have analyzed the case before they get there. That’s my expectation…if they haven’t done that, they can just take off and they’re not doing the case at all, which I actually think is a very fair assessment.” This bargaining arrangement appeared, for most surgeons, to be an implicit overlay to the issue of balancing learning and patient safety, and was often carried out, not with active communication to the trainee, but as a tacit reaction to their perceived assessment of the trainee’s investment into the case.

Table 6A: Emergent Theme of Control

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<tr>
<th>Themes and Definitions</th>
<th>Representative transcript excerpts</th>
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<td><strong>A. Control Dynamic</strong></td>
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<tr>
<td>Refers to the fluctuation of control that is negotiated by surgeons in the operating room as they 1) manage the dual responsibility to education and patient care, and 2) negotiate control through the medium of a trainee.</td>
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**Dual Responsibility to Education and Patient Safety**

- Refers to the balance the surgeon strives for between his supervisory role - interested in education - and his surgeon role interested in patient safety.

“there is a sense of that need to let them exercise their own judgment and their own decision making, and that’s important…I feel an obligation to allow them to do that, provided they’re not going to do anything harmful.”

*Interview 3, A05*
Negotiate Control Through Trainee

• Refers to the maintenance of control through the medium of a third person – the trainee – handing over and taking back *direct control* to achieve *overall control*.

“… a resident has control of the operation and, one way or the other, I’ll intervene to make sure I have control, not necessarily because I’m physically doing all the maneuvers but I can set the pace, I can control what everyone is looking at and stuff like that.”

*Interview 2, A03*

B. Negotiation of Control

Refers to how surgeons negotiate control throughout the course of an operation – both general issues and specific strategies.

General Issues in Establishing Control

• Refers to general issues considered by surgeons when deciding the level of direct control necessary to achieve overall control.

“I need to know the fellow or resident is on the same page as I am. Otherwise I don’t trust them to start the case.” *Interview 8, KI01*

Specific Strategies in Maintenance of Control

• Refers to specific strategies surgeons have to negotiate *direct control* with the trainee in order to achieve *overall control* intra-operatively.

“I can set the operation up and control it so that the resident virtually cuts from A to B.” *Interview pre, B01*

C. Complications of Control

Refers to the challenges surgeons face as a result of the control dynamic
Out of Sync
• Refers to instances where the trainee is not ‘slowing down’ appropriately according to the surgeon; either the trainee is ‘slowing down’ too much or too little.

“…there’s nothing worse than the trainee being ‘out of sync’ with your rhythm; they are either too slow and careful, not seeing the big picture, or too quick, not appreciating the details and nuances of the case.”
Interview 9, KI01

Skidding
• Refers to instances where a surgeon supervisor takes control too late.

“…by the time I opened my mouth to stay “stop” it was too late. A second later there was a big hole in the cava. It’s almost like we skidded. From the time it got from my brain to my mouth and then from his brain to his hands it was too late.” Interview 4, KI01

Too much control
• Refers to instances where a surgeon supervisor feels he retains too much control.

“I have to say I have a very short trigger to take over…I know I have a pretty low threshold for giving into that feeling and not letting them [operate]…I am not sure it is helping them too much.” Interview 4, A08

Bargaining
• Refers to instances where direct control is given to a trainee (reward) or taken away from a trainee (punishment) based on trainee investment and understanding of a case.

“She’ll go through the charts and if she has some questions, she’ll come and talk with me. And I find that very, very good, which is why, even though I’m not sure she’s up to doing the entire case, I’ll let her get started on them because I can see she’s making an effort to be a good surgeon.” Interview 3, A05

“I expect that they have analyzed the case before they get there. That’s my expectation…if they haven’t done that, they can just take off and they’re not doing the case at all, which I actually think is a very fair assessment.”
Interview 3, A05
Discussion

The control dynamic investigated in this study describes the surgeon’s struggle with balancing the dual responsibility of education and patient care through the medium of the trainee. Particularly during the critical ‘slowing down’ moments, these two mandates might appear as two opposing responsibilities. Surgical training relies on a model of progressive independence, where supervision of trainees is progressively withdrawn as their skill level increases. This model has its roots in the Halstedian apprenticeship style of teaching medicine, where trainees spend many years under direct supervision of a teacher learning the skills, knowledge and art of medicine (Halsted, 1904). Gradually, if the training works, supervision is withdrawn until trainees are autonomous and independent operators. Certainly, surgeons in this study considered supervision an important aspect of training for the purposes of developing particular skills considered necessary to function independently. In other studies, medical trainees also perceived this progressive independence to be necessary for learning to take responsibility and “stand on your own feet” (McKee & Black, 1992). In the expertise literature, Bereiter and Scardamalia (1993) define an expert as one who chooses to work at the upper echelons of their profession – progressively advancing their field by working at the highest limits of complexity. Expertise, in this way, defines an approach to practice that should be learned and adopted early in a career. Surgical trainees, in this model, would be given the opportunity to ‘stand on their own feet’ and work at the upper limits of their competence without the overprotection of a supervisor. This would provide opportunity for them to develop into true experts.

However, as identified by surgeons in this study, a particular challenge arises when allowing trainees to become independent in the clinical arena because of the need to maintain patient safety from the ‘other side of the table’. Kennedy (2008) referred to this challenge in emergency and internal medicine practices as a ‘double bind’, where two competing priorities (education and patient safety) were difficult to attend to at all times resulting in one taking temporary priority over the other. The continuous negotiation of control in this study could be perceived as a means of managing this ‘double bind’ (Bateson, 1972), handing over as much control to the trainee as possible, but taking it back in various forms when necessary, all the while maintaining an overall sense of control. This requires an assessment and constant monitoring of the situation and trainee, with control for the surgeon appearing along a spectrum of supervisory activities.
from ‘hands-off’ on one hand to ‘taking-over’ on the other, with many subtle and not-so subtle strategies in between.

Participants in Kennedy’s study (2008) made ‘point-of-care’ assessments of trainees’ competence to provide independent patient care, moving beyond simple assessments of knowledge and skill to a multi-dimensional construct of ‘trustworthiness’ (Kennedy, Regehr, Baker, & Lingard, 2008). This construct appears to be consistent with how surgeons made assessments of surgical trainees’ abilities to operate independently, with knowledge and skill level, discernment (referring to a trainee’s awareness of their limits of skill and when to call for help) and conscientiousness (referring to a trainee’s dependability in following through assigned tasks) featuring prominently in their appraisals. Surgeons in this study made a further assessment of how prepared the trainee was for each particular case. As with previous work, surgeons believed that pre-operative preparation, with the creation of a ‘game plan’ and consideration of proactively planned ‘slowing down’ moments, was a crucial aspect of their own construct of intra-operative judgment (Moulton et al., 2009), applying the same metric for assessments of trainees in this study. In order for them to feel comfortable in ‘handing over’ control to the trainee, the trainee’s ‘game plan’ and proactively planned ‘slowing down’ moments needed to be consistent, or ‘in sync’, with theirs. In the context of the ‘slowing down’ framework then (Moulton et al., 2009), surgeons appear more likely to ‘hand over’ control when trainees have the same ‘game plan’, have considered the same proactively planned ‘slowing down’ moments, can be trusted to recognize the intra-operative cues requiring a situationally responsive ‘slowing down’ moment, and can be trusted to call for help when necessary.

When the challenging aspects of surgical supervision are appreciated alongside an awareness of how surgeons make assessments of trainees, we can begin to construct a framework that highlights more explicitly our expectations of trainees. At the same time, an understanding of the strategies surgeons use in negotiating control, alongside an awareness of the ‘illusion of control’, can provide surgeons with tools to be more explicit in their efforts to authentically hand over control when appropriate. This will provide trainees opportunity to develop their own situation awareness - to perceive for themselves the important ‘cues’ in their operative field, to construct a meaning for what these ‘cues’ represent, and to project how these ‘cues’ will impact the future
state in relation to their operational goals (Endsley, 1995). Until trainees learn to develop their own situation awareness, they are unlikely to appropriately ‘slow down when they should’. An understanding of the dynamics of surgical supervision will assist us in our efforts of training independent, ‘true expert’ (Bereiter & Scardamalia, 1993) surgeons while simultaneously providing expert clinical care, fulfilling our dual responsibility of education and patient safety.
Chapter 7
Implications

Potentially critical moments in practice move the expert physician from an ‘automatic’ or routine mode to a more ‘effortful’ or attentive mode of practicing. The recognition that this transition occurs at critical or uncertain points of practice and the appreciation that this transition was observable led the researchers to the central tenet of this thesis – that exploring this transition in clinical practice will shed light upon the construct of judgment. The naming of the phenomenon as ‘slowing down when you should’ was a result of the cognitive lens through which this phenomenon was viewed; as experts transition from a routine state where freed up cognitive resources can be invested in several activities, to a more effortful state, where cognitive resources focus on one activity, it can be viewed cognitively as ‘slowing down’. Surgeons often used words like, “Whoa, wait a minute”, “Slow down”, “Let’s regroup”, when confronted by cues that caused the transition to the more effortful. It appeared to the observer that the pace or the progression of the operation was ‘slowing down’ as surgeons allowed space for focusing and contemplating. During discussions with the interviewer about the transition from the routine to the effortful and prior to being introduced to the term ‘slowing down’, surgeons used similar words to describe their experiences with this transition. In the days following the interviews, participant surgeons would stop the researcher in the hospital corridors to discuss their recent “slowing down” experiences, providing further evidence that the phenomenon was often experienced in this way and that the term ‘slowing down’ resonated with surgeons.

Whilst recognizing that many individuals (e.g., trainees, nurses, anaesthetists) and ‘systems’ factors contribute to the display of expert performance, this thesis focuses on the cognitive contributions of the individual in a system (in this case, the surgeon). Other ways of ‘seeing’ this phenomenon would lend themselves to different questions, different methodologies, and different study designs and might refer to the issue of expert performance in the operating room as ‘collective competence’ (Lingard, 2008), team performance (Sevdalis et al, 2009) or ‘distributed cognition’ (Hutchins & Klausen, 1996). Consistent with the cognitive perspective of the principal researcher as well as the primary supervisor, this study considered the effects of external factors and interactions only to the extent that they had potential to directly influence the
cognition of the surgeon. The theory developed in this study, therefore, is a product of the conceptual framework of the phenomenon that emerged from the data and the individual cognitive perspective with which it was explored.

The studies within this thesis were designed to explore the transition from the routine to the effortful in surgical practice for the purposes of developing a greater understanding of the construct of surgical judgment (objective #4, page 4). Recognizing the unclear existing definitions for judgment and the confusing terminology that surround what experts do in practice, the researchers felt that prior to being able to study ‘judgment’, a more precise definition for judgment needed to be provided. After a review of the literature, a definition was provided and presented in paper in Chapter 2: “we would propose that expert judgment be considered as an expert’s ability to respond effectively in the moment to the limits of her automatic resources and to transition appropriately to a greater reliance on effortful processes when needed” (page 31). In this study, an interest in surgical judgment led the researchers to explore the phenomenon ‘slowing down’ in clinical practice – a phenomenon that was observable and associated with expert surgical judgment. Exploring this phenomenon would, therefore, lead to a better understanding of the construct of surgical judgment. As a result, the researchers attempted to draw conclusions from the study that informed the construct of judgment, as this was the preliminary goal of this study. Through the discussion sections of the results chapters, attempts were made to explain how judgment was being made more explicit through the results of the research study in this thesis. However, the term ‘judgment’ constantly required qualification for how it was being used in this particular study and still appeared open to interpretation in the wider community. In other words, the term ‘judgment’ remained elusive and confusing despite having provided an explicit framework for the phenomenon of ‘slowing down when you should’. Although the study within this thesis sheds light on expert surgical performance and informs what it is experts do in practice, attempts at informing the construct of ‘judgment’ appeared unhelpful; trying to hold on to the term ‘judgment’ did not seem to provide any benefit in terms of deconstructing, exploring and understanding expert performance.

The evolution of thinking in this regard, developed through the course of this study, has important theoretical implications for future research in expertise. Rather than trying to
understand the nature of expertise through studies that attempt to develop elaborations of theory that *should* be seen, such as judgment, reasoning, and problem-solving, perhaps the study of expertise could develop theories based on elaborations of phenomena that are *actually* seen, such as ‘slowing down when you should’. In this way, a framework that begins to deconstruct and understand expert performance can be created. Take for example another theoretical construct commonly pursued as an avenue towards understanding expertise – ‘problem-solving’. If a researcher with an interest in ‘problem-solving’ sets out to understand the nature of expert ‘problem-solving’ they risk bringing their assumptions about ‘problem-solving’ to their research. Assumptions might be made about what experts are actually doing in real-world activities when in fact they may not be ‘problem-solving’ at all. Through the process of developing automatic resources to deal with issues that are confronted in professional practice, the professional may simply know the answer. A simple illustration of this can be made when one considers the every day act of opening a door. A child, who is not yet an ‘expert’ door-opener, needs to ‘problem-solve’ when confronted by a door. Does the handle need to be twisted or pulled? Does the door go in or out? An adult, an ‘expert’ door opener on the other hand, simply goes to the door and opens it. There is no ‘problem-solving’ in this situation and so approaching expert practice with this in mind may not be useful. Until one understands and studies what is occurring in real-life expert settings, assumptions and preconceived ideas about what *might be or should be* occurring need to be examined.

The framework provided in this study creates a taxonomy for the phenomenon of ‘slowing down when you should’ (figure 4A, page 64), a transition that captures a part of what experts do in practice that contributes to expert performance. To this end, this study begins to make explicit this aspect of expert practice, developing a framework that can be further added to and elaborated on in future research studies to deconstruct and understand what contributes to expert performance in surgery. The first two dimensions of the phenomenon, the *initiators* and the *influences*, formed the basis for the paper presented in Chapter 4. There are two initiating categories of this phenomenon – the *proactively planned* ‘slowing down’ moments anticipated by the surgeon pre-operatively and the *situationally responsive* ‘slowing down’ moments to emergent intra-operative events. Surgeons stressed the creation of the ‘game plan’ as providing a crucial map of their intra-operative ‘slowing down’ moments where they consider the proposed
procedure in light of potential ‘landmines’. Several *influences* were identified by the surgeons in the study as having the potential to either help or hinder the appropriate transitioning of the surgeon and are captured in the framework.

The third dimension, the *manifestations* of this phenomenon in practice is presented in Chapter 5 (Figure 4A, page 64; Figure 5A, page 84). This chapter captures a range of manifestations of this phenomenon as it occurs in its natural setting from the subtle manifestations to the most obvious. The appearance of surgeons transitioning from the routine to the effortful in practice can be very different, from ‘fine tuning’ – dipping into cognitive resources momentarily – to ‘stopping’ – recruiting all additional resources to *focus on the performance* at hand. The appearance of surgeons in their routine mode of practice – traditionally thought of as being ‘automatic’ – can also be very different depending on how much attention is being reinvested at a *meta-cognitive level back into the activity*. This paper problematized the term ‘automaticity’. Automaticity, in the expertise literature, develops as a result of the accumulation of automatic resources, such as pattern recognition and cognitive scripts and schemas, enabling the expert to function in an intuitive manner, free of effortful activity or thinking. In this study, when surgeons were observed in the ‘automatic’ mode, it appeared that cognitive effort was being re-invested back into the case in most situations as a form of self-monitoring. Being in this ‘automatic’ mode, in other words, was not an ‘all-or-none’ phenomenon, but rather included multiple potential states depending on how much attention and how much freed up cognitive resources were being reinvested back into these metacognitive activities. The terms ‘inattentive’ and ‘attentive’ automaticity were introduced to capture the differences identified in the ‘automatic’ functioning of the expert, with ‘inattentive’ automaticity as being an unwanted state characterized as ‘drifting’ and therefore prone to error. The assumption in the expertise literature is that experts become automatic (Dreyfus & Dreyfus, 1986; Ericsson, 2004) and therefore more intuitive and effortless, able to engage in their routine activities without thought. This conceptualization of an expert appears to be more consistent with the expert who is in a state of ‘inattentive’ automaticity, going about his daily activities with little effort. Participants in this study appeared to be more in a state of ‘attentive automaticity’ when observed in the operating room, even during routine parts of cases or during routine cases. The conceptualization of automaticity as ‘attentive automaticity’ provides an alternative form of automaticity and challenges health care
professionals in expert clinical practice to be effortful even in the automatic state, recruiting freed up cognitive resources to be engaged in some sort of ‘monitoring’ activity at all times. This monitoring activity might prevent the drifting state discussed by surgeons and witnessed by the researcher in the operating room.

And finally, the experience of the phenomenon as an issue of control within academic practice is the central theme in Chapter 6, creating the fourth dimension (Figure 4A, page 64; Figure 6A, page 102). How do surgeons feel during these moments in academic practice? How do they remain in control during these critical moments and how do they negotiate their dual responsibilities to patient care and education? In this chapter we provide a language for studying the ‘surgeon as supervisor’ and highlight some of the tensions and potential failures of this rather implicit negotiation process during the operative ‘slowing down’ moments.

Taken together, this framework provides a structured way of thinking and talking about the various aspects of this phenomenon in an operative setting, and offers several theoretical and practical implications for the nature of expert performance in surgical operative practice. With the provision of a framework that deconstructs the phenomenon of ‘slowing down when you should’ one can consider what is involved during this important transition in expert practice. With an understanding of other important literatures and with further observational studies of experts in surgical practice, one can begin to build a more elaborate framework of what is involved in expert practice. To this end, expert performance can be restructured as a series of activities or phenomena that experts engage in.

Once these activities are better understood with a vocabulary that helps identify them, a further implication of this research program may lead to a taxonomy for human error. Once we are able to understand what it is experts do ‘right’ we may be in a better position to understand what it is they do ‘wrong’ when errors occur.
Towards a Taxonomy for Surgical Error

This study deconstructs the phenomenon of ‘slowing down when you should’, an activity involved in expert performance. Through the addition or consideration of other aspects of expert performance, a more elaborate network or framework can be established. This in turn can lead to a greater understanding of where error occurs providing the potential in future research endeavours to create a useful taxonomy for human error. Currently, the research communities exploring surgical error are doing so independently, unable to ‘talk’ to one another in a common, recognizable language.

As well as the usual definitional dilemma common to all aspects of medical practice with terms such as judgment, acumen, and decision-making, surgery has another distinction between what is often dichotomized as judgment and technical skill. Judgment has long been considered a key component of safe practice and is often differentiated from technical skill. However, the boundaries between judgment, cognitive ability and technique are blurred and provide additional support, perhaps, to the notion that the term ‘judgment’ is ineffective at capturing clear aspects of expert performance and should therefore be abandoned. As an example, what is the difference between a technical error and a judgment error? If a surgeon severs a structure inadvertently, is this a judgment or a technical error? In a recent publication of surgical error, the authors attempted to identify patterns of technical error among surgical malpractice claims (Regenbogen, Greenberg, Studdert, Lipsitz, Zinner, & Gawande, 2007). They categorized them as either ‘manual’ errors or ‘judgment/ knowledge’ errors. ‘Manual’ errors included ‘peripheral nerve injury’, ‘incidental injury to viscera’, and ‘haemorrhage’; ‘judgment/ knowledge’ errors included “error of planning such as wrong timing or selection of procedure, failure to diagnose complications, or wrong site surgery” (pp.706). To truly appreciate the cause or root of the error, one needs to consider the thought processes of the surgeon and the influences of the environment at that point in time. Rather than grouping errors under the vague category of ‘judgment’ it might prove more useful to consider the error within the context of the framework described thus far for the phenomenon ‘slowing down when you should’. Was the surgeon distracted? Did the surgeon not appreciate the anatomy? Did the surgeon not prepare adequately? In other words, diagnosing and classifying errors into categories - technical, judgment or otherwise - without
having knowledge of other cognitive information is futile if one wants to understand why the error occurred, let alone implement changes to decrease the error rate. We need a taxonomy for error that is designed around a theoretical human-error framework and this can only be achieved if we understand the components of expertise (Weigmann & Shappell, 1997).

Weigmann and Shappell (1997), from the aviation and human factors literature, recognized that it was an onerous task to infer specific causes of human error when an error database was not built upon a theoretical framework and therefore set out to create such a framework. Rather than develop a new framework, they initially examined the utility of organizing and analyzing human factors data by applying pre-existing theoretical frameworks to existing post-accident databases. They used three popular frameworks to do so: a four stage model of information processing as described by Wickens and Flach (1988), a model of internal human malfunction derived from Rasmussen’s (1982) Skills-Rules-Knowledge model, and a model of unsafe acts as proposed by Reason (1990). Though some data were lost, over three-quarters of the data were effectively categorized using each taxonomy. This was considered an academic success but from an applied viewpoint was considered a failure in that several human factors remained unclassified. Factors that did not fit cleanly within the frameworks were ‘planning for the flight’, ‘social variables’, and ‘physiological or mental condition of the pilot’, including loss of situation awareness. To increase the practicality of the framework for the aviation industry, Shappell and Weigmann (2001) adapted Reason’s (1990) ‘Swiss cheese’ model of accident causation to the aviation industry, filling in many of the missing “holes in the cheese” to become applicable to the field of aviation. Their research led to the creation of a comprehensive tool for capturing human error in the human factors analysis and classification system (HFACS) and they continue to broaden its applicability (Shappell, Detwiler, Holcomb, Hackworth, Boquet, & Weigmann, 2007) and test its completeness.

In a similar way, the classification of surgical error could benefit from such an overhaul whereby errors are classified according to a theoretically based framework developed from an understanding of what contributes to expert surgical practice. This study provides a framework that can be further built upon, or incorporated into existing frameworks, to consider and classify the individual surgeon’s contribution to human error. By deconstructing the phenomenon of
‘slowing down when you should’, that is, the transition from the routine mode to the effortful mode of functioning, this study provides a language to consider this key component of expert practice. Through the study of expert surgeons in their naturalistic environment, the research community can begin to develop a common language with which to study and better understand the respective contributions of various phenomena to safe practice and medical error.

As an example of how this research can contribute towards a better understanding of expert performance and ultimately error, we present a series of diagrams that begin to tease the activities of expert performance apart, highlighting the contributions of the current research program. Starting with the basic premise that with expertise comes automaticity, experts can be expected to spend the majority of time in this routine mode. However, they cannot stay in this mode at all times and will be required to transition into the more effortful, deliberate mode when particular situations arise. This transition occurs through two initiating mechanisms: proactively planned ‘slowing down’ moments and situationally responsive ‘slowing down’ moments (refer to Figure 7A, page 123). If this transition did not occur appropriately, one could ask whether this was something that should have been anticipated through evaluation of information available pre-operatively (during the creation of the game plan) or whether this was a failure to transition to an emergent cue. In addition, one could ask whether any of the recognized influencing factors as listed in Chapter 4 had any role to play in the failure to transition. Many of the potential influences (i.e., time stressors, ego, etc) could be studied in their own right to determine how they influence surgeons’ judgment and behaviour. One such study in the recent medical error literature considered how ‘overconfidence’ led to diagnostic error (Berner & Graber, 2008). Further research conducted within the surgical context exploring each influence may provide valuable insights into surgical error.
The appropriate transitioning in practice requires a certain level of ‘situation awareness’ – an accurate picture and account of what is going on in the expert’s environment. For the most part, maintaining situation awareness requires very little effort as the scope of what the expert engages in falls within the realm of routine practice. Looking at the human factors literature (Endsley, 1995), there are three different levels to attaining and maintaining situation awareness: 1) perception of the relevant stimuli, 2) comprehension of what the stimuli mean, and 3) projection of what the stimuli mean for future operational goals (refer to Figure 7B, page 125).

Previously this was considered a linear process whereby a stimulus is perceived, comprehended and then appreciated in light of future operational goals. More recently, researchers have considered and appreciated the potential influences of both the ‘top-down’ and the ‘bottom-up’ processes; a stimulus might be perceived de novo and then processed (bottom-up) or an understanding of the environment might cause the expert to anticipate and actively look for the

**Figure 7A:** The framework developed from this study as presented in Chapter 4 with initiators and influences as potential sources of error
presence of a ‘stimulus’ (top-down) (Endsley, Bolté, & Jones, 2003). Within the aviation industry, each level of situation awareness can be further sub-divided into categories to delineate the exact source of human error (Jones & Endsley, 1996). This requires an understanding of the pilot’s awareness and thought processes as well as knowledge of the mental models of understanding the pilot should have had. To consider this in the surgical domain, a surgeon failing to appreciate that a ureter is in tissue he is about to divide could be committing a level 1 error (error in perception). Alternately, if one considers that the surgeon should be aware of the proximity of the ureter, taking steps to protect it, one would classify it instead as a level 2 error (error in understanding). Similarly, if a surgeon fails to identify that a colonic tumour is adherent to the pancreas on the pre-operative CT scan, or fails to read the pre-operative CT report stating the same, and then damages the pancreas at its removal intra-operatively, this could also be perceived as either a level 1 or 2 error depending on what the surgeon should have understood.

This distinction is vital for understanding and remediating the root of human error. One could apply this taxonomy for situation awareness onto the framework of this current study, for further analysis of why a surgeon either fails to proactively plan a ‘slowing down’ moment or fails to situationally respond to an emergent cue intra-operatively. These considerations illustrate the complexity involved when dealing with human error and the essential need to understand cognitively what is occurring ‘in the head of the surgeon’ as well as what is occurring in the environment that might affect what is happening ‘in the head of the surgeon’. Further research into understanding the processes involved in attaining and maintaining situation awareness in surgery and their role in error could provide important insights into the human contribution to surgical error. Identifying what this process of maintaining situation awareness looks like in practice may contribute further to our understanding of expert surgical performance.
Further to exploring the phenomenon of ‘slowing down’ in this study, the researchers were able to identify other related phenomena that occurred after the transition, creating a distinction between the act of ‘slowing down’ and other recognized constructs of problem solving, decision-
making and action execution. As an example, if uncertainty was identified as a component of the ‘slowing down’ moment, surgeons would often enter into another mode of ‘information gathering’ to acquire the necessary data to resolve the uncertainty. This ‘data gathering’ phase might involve a ‘decision-making’ phase where several options needed to be considered and an ‘action execution’ phase where a specific action needs to be carried out (Figure 7B, page 125). The process of identifying independent activities of expert performance serves to isolate phenomena that can be further studied in the context of expert performance, reframing expertise as elaborations of phenomena we see in expert performance, rather than elaborations of theory that we should see. Like the different levels of situation awareness, these activities are unlikely to be linear but for the purposes of considering and observing expert performance, they can be identified as separate activities phenomenologically.

To build upon this, utilizing the data analysis from Chapter 5, one could introduce a metacognitive level to this framework (Figure 7C, page 127). If one considers the notion put forward in Chapter 5, that freed up cognitive resources made available through the process of automaticity can be reinvested back into the present situation, one could wonder whether this was taking place at the time the error occurred and if not, why not? If cognitive resources were being reinvested back in the case, how were they being invested? The recent movement towards a systematic approach to error in the health industry should not take light off the individual physician’s responsibility to minimizing their contribution to error. Metacognition and self-monitoring are crucial components that make up the self-regulating professional. Their role in attaining and maintaining situation awareness during all aspects of practice – routine and non-routine – have direct implications towards a more mindful approach to practice.

As explored in the figures above, the central framework provided in this study can be further elaborated on to create, with the help of future research, a more inclusive framework made up of a series of activities that can be identified phenomenologically to better understand expert performance and error.
Figure 7C: Slowing down framework adding ‘Metacognitive Monitoring’ as a potential source of error
Towards a More Mindful Approach to Practice

Metacognitive monitoring and reflective practice have recently occupied an increasing amount of space in the medical education and error literature (Borrell-Carri & Epstein, 2004; Graber, 2003; Mamede, Schmidt, Rikers, Penaforte, & Coelho-Filho, 2007; Mann, 2008). Calls for physicians to be held accountable by remaining vigilant and reflective at all times are rising. This study presents some evidence to support these calls in surgery. As was discussed in Chapter 5, experts seem to vary in how much of their freed up attention in routine and ‘automatic’ parts of procedures gets invested back into the case. Although surgeons were reluctant to think of themselves as automatons, they acknowledged fluctuating levels of ‘paying attention’ during their cases. As one surgeon said, “I don’t think we’re automatic. I don’t think we can be…but I guess there are levels, right?” Many surgeons described examples of ‘drifting’ leading to error or ‘near misses’ in their recent practice, linking this state to routine cases. This is supported in the wider literature with a recent paper by Regenbogen and colleagues (2007) suggesting after a review of malpractice claims that the majority of surgical errors occur in routine cases with experienced surgeons. Apart from categorizing the manifestations of the ‘slowing down’ phenomenon, this thesis demonstrates that even at the routine or ‘automatic’ end of the ‘cognitive’ spectrum there can be a varied level of attention invested into the case. This has been captured in the paper as ‘attentive’ and ‘inattentive’ automaticity. Recognizing the distinction, many surgeons were adamant they remained “hypervigilant” in the routine mode at all times, preferring to think of this “hypervigilant” state as their routine or ‘automatic’ mode. Many equated the state of being ‘automatic’ with the state of ‘drifting’ and therefore preferred to consider their ‘routine’ state of operating as being more attentive than the term ‘automatic’ suggests.

The introduction in this study to the terms ‘attentive’ and ‘inattentive’ automaticity challenges the ways in which experts are envisioned functioning during the routine aspects of their practice, and challenges to some degree the theory of automaticity and expertise in professional practice. According to many cognitive theories of expertise, experts develop automatic resources that enable them to carry out their ‘routine’ activities effortlessly and intuitively, conjuring up an image of an expert who acts and talks with very little effort or thinking (Dreyfus & Dreyfus, 1986; Ericsson & Smith, 1991). This study proposes that expert practice could be viewed more
in terms of what the expert chooses to do with her freed up cognitive resources afforded through the process of automaticity. Recent views of expertise support these ideas with researchers proposing a juxtaposition of two different types of experts; Bereiter and Scardamalia (1993) distinguish between the ‘true expert’ and the ‘experienced non-expert’, Hatano and Inagaki (1986) compare the ‘adaptive expert’ with the ‘routine expert’, and Epstein (1999) describes the ‘mindful practitioner’ and the ‘mindless practitioner’. The important consideration in all of these models of expertise is not how automatic, routine or intuitive the expert has become but rather how they allocate and reinvest their freed up attention. How aware are they at any given moment of their thoughts and actions? Further, how aware are they of the influences on their thoughts and actions? Are they purposefully paying attention to their environment or surgical field, looking out for cues that may alter their plan? Are they examining their assumptions, applying a ‘beginner’s mind’ to the situation when necessary? This reinvestment of attention and cognitive resources requires effort and offers a challenge to the expert to approach their practice in a ‘mindful’ way.

Jon Kabat-Zinn (1994), a contemporary advocate of mindfulness, describes mindfulness as a means of paying attention on purpose in the present moment leading to greater awareness and clarity. Epstein (1999) defines ‘mindful practice’ in the professional setting as a “purposeful, nonanxious, reflective presence that can be applied to any aspect of practice”. Epstein has characterized mindful practice as demonstrating four ‘habits’. Firstly, attentive observation includes looking for the unexpected, both in details pertaining to the external world, e.g., the surgical field, the patient, or the CT, and within ourselves, e.g., our perception and responses to cues in our environment and in our own emotions. In surgery, how are the time pressures affecting the progress of the case, or, how is the desire to preserve ego getting in the way of calling for help? The second habit is critical curiosity, or “seeing the world as it is and not as we would like it to be”. Here, doubt and uncertainty has to be tolerated and welcomed into practice; seeing a tubular structure alongside the gall bladder may well be the common duct and not the cystic duct and therefore require a change in mindset or plan. Thirdly, he describes adopting a beginner’s mind – to see a situation freshly - with a willingness to set aside assumptions that have previously been made. In some ways it is a healthy state of paranoia or uncertainty that allows for ‘contradictory ideas to be held simultaneously’. For a surgeon, this might mean that
the diagnosis of benign chronic pancreatitis needs revisiting, or the tumour that he thought was resectable is not. Finally, the habit of presence means avoiding preoccupation and distraction and being ‘in the moment’. Cognitive resources are invested back into the situation. When this is achieved, clinicians may be more likely to appropriately ‘respond’ to the slowing down moments - gathering the necessary cognitive resources to focus and remain purposeful in a productive manner - rather than miss the cue altogether or inappropriately ‘react’ with unproductive anxiety (Asher & Epstein, 2005).

The research presented in this thesis not only challenges the theory of expertise and automaticity in professional practice on a theoretical level, but also provides practical tools that help to enable change in practice. Providing a language to the surgical and medical community that will allow them to consider, reflect on, discuss and research critical moments of judgment in a more explicit way has the potential to change their experience with these critical moments. As Lingard (1999) stated following Burke (1969), “The language people use both makes possible and constrains the thoughts they can have. More than just a vehicle for ideas, language shapes ideas – and the practices that follow from them”

Recognizing that an important aspect of research in applied domains is the ability to change practice, Lather (1986) coined the term ‘catalytic validity’ to describe a change experienced by a researcher or key informant as a result of being involved with a research process. Through involvement with the research process, the informant begins to think about his or her world in a different way, invoking a change in practice. In the present study, the key informant, a colleague of the primary researcher and a participant in this study, with newfound awareness of the ‘slowing down’ phenomenon began to think about and approach his practice differently. The key informant wrote the following excerpt about some of the changes he was experiencing in his practice, changes that he credited to a newfound understanding of the phenomenon ‘slowing down when you should’.
Journey Towards a Mindful Surgical Practice

Key Informant Reflections

As a senior surgeon caring for complex cancer patients for over 15 years, I have often thought about my reaction to unexpected crises before, during and after surgery. Moreover, as a ‘hard-core’ cancer researcher, my training and approach to practice and research has naturally been most in line with the more traditional positivist paradigm. The ultimate search for truth and ‘fact’ overshadow any effort to understand the emotional or subjective elements of practice. My innate restriction to ‘objective reality’, common to many surgeons of my generation, has been difficult to reconcile since there are many emotions, feelings and reactions ignored in the course of a busy day ‘at the office, or in the operating room’. We are taught to be confident and decisive, with an apparent lack of regard for our behaviour or feelings in times of stress or crisis during surgery. Any recognition of our limitations is actually contradictory to the archetypal surgeon that is fostered by the media and the public we care for.

Though I have been aware of heightened moments of tension that occur in the operating room and elsewhere, I have not had words to describe or discuss my reactions to such events. With a basic understanding that I now have of the attention literature and the implications of our limited cognitive capacity, I can now identify and recognize when my own ‘multi-tasking’ skills are taxed to their maximum. The simple act of giving words to this phenomenon – ‘slowing down’ – seems to have altered my subjective reaction while I am in this transition. I feel a sense of comfort knowing that this phenomenon – and all of its associated subjective emotions and reactions individual to the surgeon – is not only a common component of surgical practice but also an essential one. This awareness that has been developed after many conversations with my junior colleague about her research has provided me with ‘security in my insecurities’.

Previously, without awareness of what I was experiencing, my efforts during these moments of crises were consumed with the anxiety I was feeling, and like the story suggests above, intermixed with feelings of inadequacy, uncertainty, reputation and ego. Perhaps it is best explained by saying that I no longer feel anxious about being anxious and I can now focus my
efforts appropriately on the immediate task at hand. The awareness of this phenomenon has evolved into a challenge in every case to not only ‘slow down’ but to slow down when I should – appropriately marshalling the cognitive resources in a timely manner. I now ‘look for the traps’ and have found myself being more mindful ‘in the moment’ to avoid injury and error should I ‘fail to slow down when I should’.

As illustrated in the reflective excerpt above, and echoed by participants stopping the researcher in the corridors to discuss their recent ‘slowing down’ moments in surgery, knowledge of the phenomenon of ‘slowing down’ seems to make this phenomenon a more recognizable activity in their practice. This recognition can lead the clinician to ‘flag’ metacognitively the more critical or uncertain moments of practice, providing an opportunity to hold these moments up to self analysis and reflection – both in the moment or ‘reflection-in-action’ and after the moment or ‘reflection-on-action’ (Schön, 1987). During interviews the key informant discussed changes to both types of reflection – made possible through an awareness of the ‘slowing down’ phenomenon and the issues of ‘mindful practice’. As he said,

“I’m more, I think I’m more careful in the operating room, things that I do, or that other people do. I think that I’m concentrating more as opposed to my mind was often wandering in the old days. I don’t think I’ve made as many mistakes as I have made before and I don’t know if this is sort of a paranoia about everybody else is making mistakes, so I don’t want to make any mistakes; and this slowing down thing is funny. It’s comical to me because I kind of joke around to myself. When those moments happen, there’s no one to tell but usually I can tell that I’ve slowed down and there’s a good reason for it and I’m comfortable with it and in fact it’s intentional. We better slow down here and they laugh and so I think that part is kind of cool. So maybe I’m just being more careful or I’m better. I don’t know, I’m not really sure…But I think what’s cool about it is I’ve noticed a kind of a shift in my own behaviour of taking it more seriously and being there more.”
The key informant felt that through an awareness of the ‘slowing down’ phenomenon and the associated framework presented in this thesis (Figure 4A, page 64) his behaviour ‘in the moment’ changed. He was better able to reflect on the situation and take due care ‘in the moment’ once he recognized that the ‘slowing down’ moments were potentially critical and could affect the outcome of the case. He was able to drop his ‘ego’ and insecurity about being uncertain and ask for help when necessary. As he said during an interview,

“…and I realize that there’s no way any of us can know everything, so we’re kind of life long learners, so you better just admit it that you’re going to be in there once a month or two and you’re going to have a problem and it’s okay to have a problem. It’s okay not to know the answer. Recognizing that ‘slowing down’ is part of mine and everybody’s practice gives you a license to be uncertain and if you can drop your ego and everything else which is the hard part, and not worry about what a resident or a fellow thinks about you then it probably is better and it is kind of the way the world is working and it’s kind of what patients expect. I think the slowing down thing, all it’s done for me in a real way has sort of opened my eyes to a way of thinking or operating. It kind of justifies being careful and turning the insecurity into something else, which it was before.”

Similarly, he discussed being able to reflect on the events once they had passed, having metacognitively flagged them as important intra-operatively through an awareness of the ‘slowing down’ phenomenon. As he stated in an interview,

“In the old days you’d probably do your thing and go home and probably never think about it again but now because we talked and I’ve thought about it, there’s definitely a kind of rethinking…I wouldn’t have had this rethinking experience yesterday and today where I thought ‘I should tell Carol-Anne about it’… I felt differently.”

Introducing a recognizable phenomenon that serves to flag potential critical aspects of practice with a framework to consider them encourages a more explicit approach to critical self-reflection in practice. The ability to engage in critical self reflection is considered a cornerstone in
professional competence essential to self-regulation, self-assessment and self-monitoring (Mann 2008, Mamede & Schmidt, 2004). In this regard, an important contribution of this research agenda is the isolation of a demonstrable, recognizable phenomenon that can be held up as an object for critical evaluation, assessment and reflection.

**Towards An Explicit Model for Teaching**

Given that ‘slowing down’ moments flag many of the more critical or potentially critical aspects of practice, teaching during these moments might be an important activity in academic practice. Paradoxically, however, in this study, it became apparent that surgeons considered these to be precisely the moments where teaching opportunities could be missed or not fully realized. Due to the very nature of the increased cognitive load on the expert during these moments, this paradox can be understood. With the lack of a clear definition or framework with which to consider the activities of expert performance, surgical training has largely adopted an implicit model of ‘learning through osmosis’. This apprenticeship model has its roots in the Halstedian style of teaching medicine, where trainees spend many years under direct supervision of a teacher learning the skills, knowledge and art of medicine (Halsted, 1904). In recent years, for the first time, the surgical community is seeing a move away from this model towards a more structured, competency-based program, one that enables individual trainees to move through training at their own pace according to certain criteria and competencies (Grantcharov & Reznick, 2009; Reznick & MacRae, 2006) Training in this model is much more structured and modular-based and therefore focuses on components of training that can be taught and assessed satisfactorily in this way. The results of this research might help surgical teachers and trainees to consider what constitutes expert surgical practice in a more explicit manner.

Apart from the practical teaching implications of this research, there are also implications for considering the supervisory practices of training, again through the provision of a language and framework with which to consider this in practice. Chapter 6 described the surgeon’s struggle with balancing the dual responsibility of teaching and patient care during the ‘slowing down’ moments where control becomes a necessity. It was considered important by the participants in this study for trainees to have exposure to increasing levels of independence during their training – it gives trainees a sense of responsibility and forces them to take seriously their role in patient
care. In other studies, medical trainees perceived this progressive independence to be a necessary part of training for similar reasons of learning to take responsibility and “stand on your own feet” (McKee & Black, 1992). Some evidence that supports the notion of increased responsibility can be found in the expertise literature with Bereiter and Scardamalia’s (1993) concept of an expert as being one who chooses to work at the upper echelons of their profession – progressively advancing their field by working at the upper limits of complexity. Using this model of expertise, then, surgical trainees could be encouraged to approach practice in this way. As Kennedy (2005) suggests, the implication of this for training is that trainees should be given the opportunity to work at the upper edge of their competence, without being ‘overprotected’ or shielded by a supervisor, in order for them to develop into ‘true’ experts.

However, a struggle arises when allowing trainees to become independent in the medical arena because of the need to maintain patient safety, as acknowledged by surgeons in this study. There may exist a compromise of one or the other as surgeons move along this spectrum of supervision – from ‘hands-off’ to ‘taking-over’. Surgeons in this study felt a need to control the operation from a patient safety perspective during the potentially critical moments of a case – the ‘slowing down’ moments. This study deconstructs this ‘control dynamic’ and provides a framework that can be used to explore this aspect of surgical teaching further, providing an opportunity to more explicitly consider expectations of trainees and how assessments are made informally on a day-to-day basis. At the same time, an understanding of the strategies surgeons might use in negotiating control, alongside an awareness of the ‘illusion of control’, can provide surgeons with tools to be more explicit in their efforts to authentically hand over control when appropriate. An understanding of the dynamics of surgical supervision can assist efforts for training independent, ‘true expert’ (Bereiter & Scardamalia, 1993) surgeons while simultaneously providing expert clinical care, fulfilling the dual responsibility of education and patient safety.

The metacognitive contribution to surgery has been highlighted in this thesis as being a key component of expert practice. The ability to remain mindful, or as Mann and colleagues (2007) stated, “to achieve and maintain control over the more intuitive aspects of their experience”, is an important component of expert performance. Mindfulness has its roots in the philosophical-religious tradition yet the underlying philosophy is essentially pragmatic and based on the
interdependence between cognition, emotions, memory and action (Epstein, 1999; Kabat-Zinn, 1994; Langer, 1989). Whether this metacognitive self-monitoring is something that can be taught is a matter for debate, though personal anecdotes after this study from the participants and key informant suggest that change to practice is possible. In a recent systematic review of reflective practices in the health professions, there were four studies found that explored the question of whether reflective thinking can be developed (Mann, Gordon, & Macleod, 2007). Three were studies involving students and one involved faculty members. The author’s conclusions suggested that reflective thinking may be developed in association with certain interventions. However, caution was noted in that reflection was stimulated by the educational context the studies were conducted in. Whether the same stimulation for reflection would occur in natural professional settings would require further demonstration.

This debate over how much cognitive or metacognitive training can alter an expert’s performance has been carried out in the medical education literature (Croskerry, 2003; Graber, 2003; Graber, Gordon, & Franklin, 2002). Predominantly this debate relates to diagnostic errors in relation to ‘automatic’ thinking – the so called ‘cognitive dispositions to respond’ or the heuristics and biases that are inherent in such non-analytic systems. Croskerry (2003) discusses the ‘cognitive debiasing strategies to reduce diagnostic error’ focusing on ways of reducing the errors experts make on the “front line, when resources are in short supply, when time constraints apply, and when shortcuts are being sought”. He calls more rational, normative models of decision-making deserving of “a prominent place in Plato’s heaven of ideas” but are irrational at the sharp end of patient care, acquiescing that cognitive diagnostic failure is inevitable in the real world of medicine. Borrell-Carrió and Epstein (2004) call for self-awareness on the part of physicians to prevent errors in clinical practice, focusing the spotlight on individual factors, such as emotional and cognitive capacities, that can lead to error. They propose a ‘rational-emotive’ model that may help develop physician’s insight and self-awareness. An important aspect of this training is the development of a tolerance to ambiguity and uncertainty and a cultivation of certain ‘habits’ that enable this to occur, such as the ‘habit of self-questioning’ or the ‘habit of reframing’. This mindful approach appears not to be focused on any particular aspect of practice, such as diagnostics, and does not appear to be related only to the ‘automatic’ functioning of an expert. Rather, it stresses the importance of an alternative way of practicing, one that emphasizes
a ‘mindful’ approach to practice through developing ‘habits of the mind’ that can be applied to all aspects of practice, and includes overriding automatic behaviours (Borrell-Carri, Suchman, & Epstein, 2004; Epstein, 1999; Epstein et al., 2008).

Further evidence supporting the theories that mindful practice can be taught comes from the neuroscience literature. In recent years, researchers in neuroscience have demonstrated increases in cortical thickness after meditative practice (Lazar, Kerr, Wasserman, Gray, Greve, Treadway, McGarvey, Quinn, Dusek, Benson, Rauch, Moore, & Fischl, 2005). With the introduction of functional magnetic resonance imaging, other researchers have revealed changes in neural pathways that accompany mindfulness training (Farb, Segal, Mayberg, Bean, McKeon, Fatima, & Anderson, 2007). Researchers propose that mindful awareness can be developed that will disentangle set pathways of automatic responses, engaging some activities and disengaging others so that information flow is altered. This has been proposed to offer benefits of personal well-being (Siegel, 2007) and benefits for mindful professional practice (Epstein et al., 2008).

With increasing evidence from outside literatures and an increased awareness and interest in self-regulation, self-assessment, critical self-reflection, and self-monitoring in medical education, it may be timely to consider realigning our efforts in surgical and medical education towards a different model of expertise – one that focuses not on the fast and efficient expert, but rather on the mindful and thoughtful expert. The experts in this model require certain ‘habits of the mind’ – a tolerance of uncertainty, a critical curiosity, a beginner’s mind, a purposeful attentiveness and an ability to critically reflect on one’s thought processes and actions. This expert approach to practice can be modeled and identified in all aspects of professional practice – patient care, teaching, research and learning.

**Implications for Future Research**

The medical research community has for decades explored the more cognitive elements of clinical practice by applying theory to what they believe occurred or should occur in the practical setting (LeBlanc et al., 2002; Norman et al., 1983; Patel & Groen, 1986). The theoretical models have often been tested in laboratory-based experimental research designs to make conclusions
about what occurs in real-life. Recent interest in surgical decision-making seems to be following the same path with Flin, Youngson and Yule (2007) describing various theoretical models of decision-making that might be identified in the intra-operative setting. The research presented in this thesis provides an alternative means for considering the cognitive elements of practice. With an understanding of the theoretical frameworks as a guide researchers can enter the clinical setting and through qualitative methods identify and explore various phenomenona of importance in expert performance. In this way, performance will be described as elaborations of phenomenologically identified activities experts engage in, instead of elaborations of theoretically derived constructs. Rather than asking questions like, “What model of decision-making do surgeons use intra-operatively?”, one might ask instead, “What does it look like when surgeons face uncertainty in the operating room?” or “What are the factors that cause uncertainty in the operating room and what does the information-gathering process look like?”.

The development of a comprehensive framework that elaborates a series of activities experts engage in can then be used to identify points of error. With these phenomenologically identified activities as a focus and with an understanding of how they relate to each other, one might better pinpoint the source and cause of error. With an exploration of the sociological as well as psychological influences on the expert and a better understanding of how the clinical environment interacts with the expert during the performance of each activity, one can begin to understand more comprehensively the source of and contribution to medical error. Rather than asking questions like, “Was this error a technical or judgment error?”, one might ask instead, “Why did the surgeon fail to slow down at that moment?” or “Should this have been a ‘proactively planned’ slowing down moment and if so, why was it not anticipated?” As the activities of expert performance are elaborated on and a framework is developed, the multitude of factors affecting the activities can be used to inform error.

Further elaborations of the factors that influence the ‘slowing down’ phenomenon as identified in this study would lead to many potential avenues of research. One example is to ask how the feeling of confidence influences the ‘slowing down’ phenomenon – either under-confidence that may lead to what some have described as ‘slowing down’ too much, or over-confidence that may lead to not ‘slowing down’ enough. And where does ‘ego’ fit in to the construct of confidence
and how does it affect the appropriate transition between the routine and the effortful? Are there
gender differences with the perception, recognition or response to the ‘slowing down’
phenomenon? Another possible influence that could be explored further is the construct of
mindfulness. Some surgeons described activities of being purposefully attentive at all times and
not allowing themselves to ‘drift’ into the ‘mindless’ state of ‘inattentive automaticity’. Are there
consistencies in behaviour intra-operatively amongst the surgeons who describe being effortfully
attentive at all times? Does the operative team, i.e., scrub and circulating nurse, resident staff,
fellow and anesthetist, recognize differences in the behaviours or standards of surgeons who
appear ‘mindful’? Does the surgeon’s approach to their practice influence the team’s approach
to their practice? Is there a basis behind the term ‘elite’ surgical teams and if so, what does this
team look like? Further expansion of this methodology and line of inquiry into other members of
the operative team might shed light on who make up this ‘elite’ team and why. For example, how
do ‘good’ nurses manage their environment? What are the cues from the surgeon that they pick
up on that cause them to ‘slow down when they should’. Ultimately, one might ask whether this
‘mindful’ approach of the surgeon or the surgical team leads to better surgical outcomes?

Practical questions of whether surgeons can be taught about the various phenomena of expert
performance and what impact this might have on practice need exploration. A more systematic
inquiry into what happens to people once they are introduced to the phenomenon of ‘slowing
down’ and the framework associated with it is required. Will the surgeon who is taught about the
‘slowing down’ phenomenon have greater awareness of it in their practice and if so, does this
alter their ability to ‘slow down’ appropriately? Can we teach surgeons to be ‘mindful’
purposefully remaining in an attentive state during the routine aspects of practice and will this
reduce the propensity for error caused by the inattentive state of ‘drifting’? In academic settings,
what is the resident’s perspective on the ‘slowing down’ phenomenon and what does the
progression to expertise look like? How do the ‘slowing down’ moments become automated or
routinized so they are no longer ‘slowing down’ moments for the expert? What impact does a
teaching curriculum structured around the ‘slowing down’ framework have on resident
performance? What impact can a faculty development workshop on surgeons’ supervisory
practices and the ‘control dynamic’ have on their effectiveness of intra-operative teaching?
The methodologies used in this research opens up the potential to explore various phenomena of interest in clinical practice through qualitative means. In this way, experts can be observed in the course of their daily activities within the complexity of their natural environment. The interest in expert performance is not in discovering what the expert does with well-packaged ‘problems’, but rather to observe how the expert identifies and manages the non routine aspects of practice. Such work might best be accomplished with ethnographic observational studies of clinicians in their workplace to examine the ‘in-vivo’ recruitment of additional cognitive resources, such as the one presented in this thesis. Expansion into other health care domains a framework might be developed for the activities of expert clinical performance.

Viewing expertise as a series of activities or phenomena experts engage in and pursuing the lines of research described above to elaborate on these activities may help the health professions align their educational research efforts towards a goal of expertise that is consistent with Bereiter and Scardamalia’s (1993) notion of expertise - to ensure health professionals develop into experts rather than experienced non-experts. By understanding further what the activities of expert performance are and how these are coordinated and managed by the expert, students may acquire the tools that are necessary to pursue their job as an expert – “addressing and readdressing, with cumulative skill and wisdom, the constitutive problems of the job, rather than reducing the dimensions of the job to what one is already accustomed to doing” (Scardamalia & Bereiter 1991, pp. 18).

Concluding Statement

This study offers an important theoretical advancement from the current vague conceptualization of surgical judgment to a more explicit framework built upon a naturally-occurring phenomenon in surgical practice, ‘slowing down when you should’. Through the creation of a framework, developed using a grounded theory approach, expert surgical performance is made more explicit. An elaboration of this framework with future research will continue to forge new depth and understanding of what expert surgeons do in practice. A vocabulary is offered that will enhance the ways we teach, supervise, and critically evaluate ourselves and others. It will enable us, as a surgical community, to be united in our research endeavours to develop a larger theoretical
framework for expert practice, one that is built up from the solid foundations of this current framework. This will contribute to our ability to define more clearly and reflect more accurately and meaningfully on the human contribution to surgical error.


Harris, I. (2003). What does "the discovery of grounded theory" have to say to medical education? Advances in Health Sciences Education, 49-61.


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thetical taxonomies of human error. *The International Journal of Aviation Psychology, 
7, 67-81.*


Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-
formation. *Journal of Comparative Neurology of Psychology, 18, 459-482.*
# Appendix A

First Iteration of Questions for Phase 1A Interviews

<table>
<thead>
<tr>
<th>Introduction</th>
<th>What is judgment? Explanation of phenomenon of interest with examples</th>
</tr>
</thead>
</table>

**Theme 1: Recognition of the phenomenon**
- Is the description of this phenomenon recognizable to you?
- Can you describe a recent account of slowing down?
- Can you describe when a resident fails to slow down? How does it make you feel? Why does it make you nervous?
- What are your telling signs?
- Do you notice it in others?

**Theme 2: Understanding the phenomenon**
- What causes the slowing down phenomenon to occur?
- Cues?
- Personal accounts of what you do to ensure a successful outcome.
  - Pre-operatively (proactively anticipate things)
  - Operatively
  - Post-operatively (learn for next time)
- When is this developed in residents and fellows?

**Theme 3: Teaching the phenomenon**
- How do you teach judgment?
- Think back to the last time you had a slowing down moment
  - Was there teaching?
  - How?
  - When?
  - Could it have been improved?
- Do you think these moments are good teaching moments?

**Theme 4: Other aspects of judgment important but overlooked here?**
### Appendix B

**Final Iteration of Questions for Phase 1A Interviews**

<table>
<thead>
<tr>
<th><strong>Introduction</strong></th>
<th>Very general statement of surgical judgment and approach to operation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Theme 1: General thoughts on judgment</strong></td>
<td>Pre-op, Op, Post-op</td>
</tr>
</tbody>
</table>
| **Theme 2: Approach to surgery** | • Some talk of ‘game plan’  
• Visual Imagery/ mental rehearsal  
• Take me through your routine preparation for a case  
• How does it help? |
| **Theme 3: Mistakes** | Tell me last time you did something stupid |
| **Transition from Automatic to Effortful** | |
| **Theme 1: Recognition of the phenomenon** | • Is the description of this phenomenon recognizable to you?  
• Can you describe a recent account of slowing down?  
• Failure to slow down?  
• What are your telling signs?  
• Do you notice it in others?  
• Some say they ‘stop’ |
| **Theme 2: Understanding the phenomenon** | • What causes the slowing down phenomenon to occur?  
• Cues?  
• What might prevent it from occurring?  
• Personal accounts of what they do to ensure a successful outcome.  
   Pre, peri and post-operatively  
• Pushing the limits – cowboy, call for help |
| **Theme 3: Teaching the phenomenon** | • Think back to the last time you had a slowing down moment  
   • Was there teaching?  
   • How?  
   • When?  
   • Could it have been improved?  
• Do you think these moments are good teaching moments?  
• Supervising the fellow/resident.  
   • Feeling uncomfortable |
| **Theme 4: Anything other aspect of judgment important but not talked about?** | |

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