

Research Statement

Medical Diagnoses: When and How to Prompt Uncertainty

“Problems in diagnosis have...been heavily dominated by physicians with little input from the cognitive sciences. What is missing...is foundational work aimed at understanding how clinicians in actual situations take a complex, tangled stream of phenomena...to create an understanding of them as a problem.” (Wears, 2014)

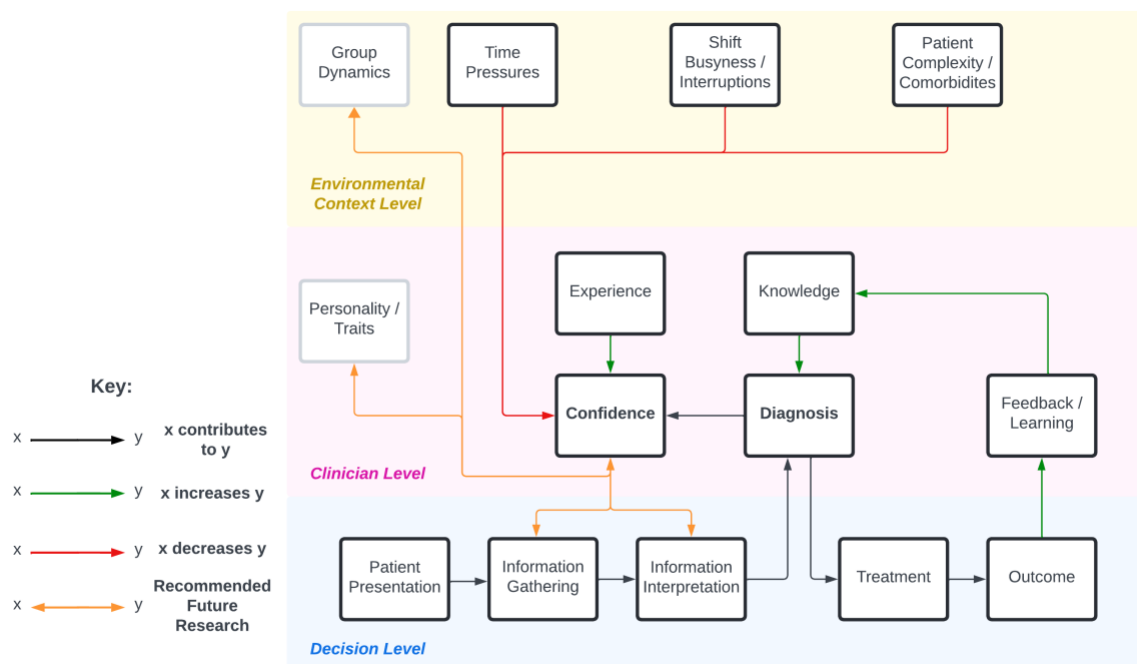
The scale of the diagnostic error is substantial and results in differences to treatment of patients, as they have been found to lead to longer hospital stays and even increased patient mortality (Hautz et al., 2019). An Australian study found that 20% of adverse events were due to delayed diagnosis (Wilson et al., 2019). Around 32% of clinical errors have also been found to be caused by the clinician's failure to weigh up competing diagnoses (Schiff et al., 2019). What these studies indicate is that diagnostic error is associated with factors pertaining to how clinicians make diagnostic decisions. By studying diagnosis from a cognitive psychology perspective, we are able to develop our foundational understanding of where diagnostic errors stem from.

My PhD in Experimental Psychology at the University of Oxford (co-supervised by Professor Nick Yeung and Professor Helen Higham) aimed to improve our understanding of the cognitive mechanisms of diagnoses. I especially studied the relationship between confidence and information seeking during diagnoses, as overconfidence has been found to be associated with inadequate patient management and lower clinical effort (i.e. clinicians seek less information on the patient from their medical history and from physical examinations). Hence, my empirical work aimed to understand how the process of seeking information during diagnostic decisions influences the confidence that participants (who in my studies were final year medical students) had in their diagnosis. I used a mixture of dynamic, evolving patient vignettes and virtual reality (VR) in my experiments. Building on past work, I moved towards more naturalistic decision making paradigms that reflect the evolving nature of diagnoses over time (rather than representing diagnoses as single decisions at single points in time). As such, medical students were able to freely seek patient information (e.g. tests, physical examinations) before recording their suspected diagnoses and the confidence they have in their diagnoses. I found that the amount of information seeking (i.e. physical examinations, testing) was associated with increases in confidence, even if some information was not supportive of their decision. This association was also found in the opposite direction, such that higher initial confidence then resulted in more tests being requested for patients. Diagnostic accuracy, however, was associated with selectivity in information seeking. In a study where participants verbalised their thought process out loud as they were making diagnoses, I found that participants used different reasoning strategies for generating diagnostic hypotheses and then seeking information to support or rule out these hypotheses. When moving to the more realistic VR paradigm, I found that confidence was linked to patient treatment, which changed the way that medical students made diagnoses when compared to the controlled environment of the vignette paradigms. My work was also grounded within in-situ observations in A&E and Intensive Care to ensure its applicability to real medical contexts.

Taken together, my work expands our foundational understanding of the cognitive mechanisms underpinning diagnoses, as well as informing avenues for improving medical education. Design of educational and cognitive interventions should focus on prompting appropriate information seeking, as well as prompting uses of different reasoning strategies based on the properties of the patient case (such as how much diagnostic uncertainty there is associated with the patient). Whilst this work has revealed interesting results, there is still follow-up work to be done to elucidate how interventions can prompt accurate diagnostic decisions with appropriate levels of confidence. In addition, there is still limited

understanding of how clinicians deal with uncertainty in their clinical practice. Uncertainty, and tolerance of uncertainty/ambiguity, is considered a key part of medical practice and education but is also a source of stress for medical students and clinicians (Stephens, Rees & Lazarus, 2021). This necessitates the study of uncertainty during medical decisions to understand how it can be mitigated or supported appropriately. This follow-up work is what I intend to pursue during my research fellowship.

Based on a systematic scoping review conducted on the extant literature, I identified key gaps that future research should focus on.



In the conceptual model above (developed from my systematic scoping review of the literature), I depict the various factors that impact the course of a diagnostic process, with links established between concepts based on findings from this systematic scoping review. Factors are categorised in three levels: the level of the diagnostic decision process (bottom box, blue, where the course of the decision proceeds from left to right), the level of the clinician (middle box, pink) and the level of the environmental context within which the clinician operates (top box, yellow). Black arrows represent a progression from one concept to another. Green arrows indicate positive impacts between concepts; red arrows indicate the opposite (i.e. a negative relationship). Orange arrows represent links between concepts that are areas for future research. Light grey boxes represent factors that are known to affect decisions and confidence within the psychology literature but are currently less understood in the context of medical decisions.

One recommendation was for future work to investigate the association between the ongoing receipt of information and confidence. We recommended future work on the implications of diagnosis as a dynamic process where confidence and information seeking interact. Past work has tended to frame information seeking as a further action after diagnosis, rather than information seeking as a process that forms the diagnosis in the first place. Hence, we should prioritise examining how to prompt appropriate information seeking (i.e., neither overtesting nor undertesting) via educational tools or cognitive interventions, as this has not been explored in previous literature. Understanding can help us teach and train clinicians on cognitive biases and clinical reasoning.

The themes for the planned research are as follows:

Theme 1 - Normative Diagnostic Strategies: whilst my work has uncovered differences in how medical students approach diagnoses (despite being educated at the same university), it does not delve into how doctors (especially those who are more experienced) approach medical decisions broadly. This strand will aim to understand how clinicians think they should make decisions from a normative perspective. To understand this, I will develop a survey to distribute to clinicians, whilst also collecting information about their experience and speciality (e.g. surgery, emergency medicine, pathology). This survey will ask clinicians whether they use more structured/analytical decision strategies in their practice or rely primarily on intuition, primary types of decisions they face during their practice (e.g. diagnosis, admitting/discharging patients, administering medication etc.) and how they tend to mitigate uncertainty during their practice. The survey's outputs will guide the subsequent research, particularly around emulating decisions that are both frequently encountered by clinicians in their practice and frequently result in situations of uncertainty. The survey results will also be used to look at differences between medical specialities, which will be used to focus subsequent on a specific speciality and its context.

Theme 2 – Exposure to Ambiguity: this strand will use experimental methods that build on the paradigm I developed during my PhD to investigate how the diagnostic decisional process develops with more information. Specifically, I will build on this paradigm by considering an aspect of real medical decisions (and indeed, other non-medical decisions): ambiguity. Information, such as test results may sometimes be neutral (and could be interpreted in multiple ways) or inconclusive. How do clinicians proceed with their decisions in the face of ambiguity? Do they ask for help from seniors or colleagues early on? Past work has shown that less experienced clinicians are more prone to interpreting ambiguous information as supportive of their decisions (Kostopolou et al, 2012). My hypothesis is that clinicians who see more ambiguous information reduce their confidence and seek more information as a result, but that more accurate clinicians will seek help early on in the diagnostic process.

Theme 3 – Timing Prompts of Uncertainty: this strand will build on previous work (Eva & Cunningham, 2006, Sibbald et al., 2012) looking at the optimal time during a diagnostic decision to 'prompt' uncertainty. When is the best time for clinicians to reconsider their diagnosis during a patient case? If prompted at the wrong time, clinicians may either ignore important information (if prompted too late) or proceed down an erroneous line of thinking (if prompted too early). These prompts will take the form of a cognitive intervention taken from existing literature: guided reflection to consider of alternative diagnoses (Hess et al., 2015) (such that participants are asked if they think they missed any possibilities). Participants will either be instructed to do this throughout at the start of the task, will be prompted early on during a decision or prompted later on. We will also look at the effects of framing the cognitive intervention/prompt as advice coming from a Large Language Model (LLM, e.g. ChatGPT), which is important to study given AI's ever-growing usage within healthcare. My hypothesis is that clinicians with higher confidence will be less susceptible to prompts of uncertainty when provided later.

During my PhD, I have developed research collaborations in Oxford with medical professionals who can assist with ensuring the ecological validity of my experimental designs. I also intend to work with a wide range of collaborators in my network who can assist with the practical aspects of my research, including design of experiment materials, participant recruitment and engagement of stakeholders within the medical community, all of which I gained experience with during my PhD and will help greatly with delivering this research. During my past work, I worked very closely with clinicians and researchers

associated with the OxSTaR centre, based at John Radcliffe Hospital. Where possible, I will make use of existing materials (e.g. sample patient cases for experiments) and clinician recruitment opportunities (e.g. conferences, training sessions, workshops). Early engagement with healthcare professionals is important for ensuring that the study of medical diagnoses is grounded in real practice and can have a tangible impact on the work that clinicians do. Hence, I would have an advantageous position of already being able to utilise my existing network in Oxford to actually deliver this research.

Clinical reasoning and diagnostic uncertainty are important non-technical 'soft skills' for doctors. My goal is to use this research to better understand when and how clinicians experience uncertainty, how this manifests in day-to-day medical practice and how uncertainty can be cultivated appropriately to reduce instances of error. For instance, when do clinicians ask for help? Can diagnostic errors be reduced by prompting uncertainty at the right time (i.e. when clinicians do not have information to make a decision on a patient)? This represents an example of important cross-disciplinary work, where cognitive psychology has a potential to have a tangible impact on real-world decision making. This is an exciting and important space for future research and one that Oxford, and St John's, has an opportunity to help in cultivating.

References

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Statement on Research Culture at the University of Oxford

I would be expected to be associated primarily with the Department of Experimental Psychology, but will also be integrated within the Department of Clinical Neurosciences as part of my ongoing collaboration with the OxSTaR centre (based at the John Radcliffe Hospital, Oxford). I will also work alongside other medical specialities during my research, such as with Department of Primary Care, who is a potential speciality to focus any future cognitive interventions toward given the importance of diagnosis to their day-to-day work. Engagement with stakeholders and clinicians is crucial for research that studies real-world decisions to ensure there is appropriate naturalism and applicability.

I also intend to continue my association with the Department of Experimental Psychology fruitfully by disseminating and promoting my research both within Oxford and at conferences. During my PhD, I have presented my research at the Society of Medical Decision and the Association for the Study of Medical Education, and I intend to continue presenting my work at relevant venues to promote this research and the University of Oxford. Within the department, I know that my research is very unique given both its basis in cognitive psychology and its study of impactful real-world decisions. Medical decision making is an area that demands more attention for psychology, as demonstrated by the quote at the start of this document. I intend them to promote this line of research within the department to foster more of a research culture with common interests. I also intend to be an active member of St John's College by contributing to college life, engaging with teaching for Psychology (where possible) and building a network of other academics within the college.