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Clinical Affordances: Towards an Ecological Account of Health Affordance and Design of Clinical Learning Spaces

Daniel R Schweitzer
Mater Health
University of Queensland

E-Liisa Laakso
Mater Research Institute, University of Queensland
Menzies Health Institute Queensland, Griffith University

Joseph Ting
Mater Misericordiae Hospital
Queensland University of Technology

Eric Brymer
Southern Cross University

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Daniel R Schweitzer,[*] **E-Liisa Laakso,**[+] **Joseph Ting,**[^] **Eric Brymer**[**]

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[*]   Neurology, Mater Health and Faculty of Medicine, University of Queensland
[+]   Mater Research Institute, University of Queensland and Menzies Health Institute Queensland, Griffith University
[^]   Emergency Department, Mater Misericordiae Hospital and School of Public Health and Social Work, Queensland University of Technology
[**] Faculty of Health, Southern Cross University, Gold Coast

Abstract

In this article, we address the following question: how should clinical environments be designed to promote learning opportunities for clinicians? We develop an ecologically-informed account of learning opportunities informed by Gibson's influential ecological theory of perception (Gibson, 1977, 1979). The so-called 'push-pull' account is proposed as a framework in which we can conceptualise how affordances are formed and actioned across different areas of clinical practice. We develop an account of health-care-related affordances that is discussed in relation to surgical training with a particular emphasis in terms of how skills are acquired in the use of robotic surgical techniques. Our primary focus is on the performative aspects of surgical performative process. We situate the current discussion in relation to a broader discussion about skills development in the context of healthcare as well as the future design of clinical spaces.

I   INTRODUCTION

The problem that this article seeks to address is: how should clinical environments be designed to promote learning opportunities for clinicians in hospital settings? We argue that the design of hospital-based spaces depends on important affordances that need to be perceived and actioned to promote effective clinical decisions that lead to good patient care and healthcare outcomes. At the same time, other affordances need to be perceived and avoided to promote good clinical care.

We outline an ecologically informed account of the performative aspect of surgery. The acquisition of surgical skills in relation to the design of learning environments is informed by Gibson's ecological account of perception (Bruineberg & van den Herik, 2021; Gibson, 1977, 1979; Shaw et al., 1982). We discuss learning in the context of acquiring procedural skills in relation to recent technological developments in surgical practice, including the increasing use of robotic surgery. In contrast to previous accounts which have distinguished 'positive' and 'negative' affordances in surgery (Kim et al., 2020), we propose a 'Push-Pull' framework of healthcare affordances to inform the future design of clinical spaces. This framework implies that an affordance cannot simply be defined in terms of the objective properties of a piece of medical equipment, but rather, there is a landscape of different healthcare-related affordances that may include surgical equipment, robotic systems, other technology as well as the operating theatre and other people, which offer a range of different purposes. The focus of this article is to conceptualise an account of health-related affordances for learning skills across the course of clinical training with a particular focus on skill acquisition concerning the performative aspects of surgery.

II   ECOLOGICAL APPROACHES AND FACILITATING SKILLED PERFORMANCE

There has been considerable interest in the ecological approach to facilitating skilled performance across a variety of fields including sport (Brymer & Davids, 2014), information technology (Conole & Dyke, 2016; Norman, 1999), education (Hammond, 2010), health (Menatti & Rocha, 2016), arts (Leduc, 2013), and medicine (Onyura et al., 2015; van der Niet, 2007; Kim et al., 2020). A key principle of the ecological approach is that behaviour emerges from the person-environment (physical and social) relationship. One of the important implications of this approach from a skill acquisition perspective is that we may need to reconceptualise how we design clinical spaces to facilitate the effective acquisition of skills required across different domains of healthcare.

We propose that undertaking clinical tasks is best conceptualised in terms of performer-environment systems, particularly the notion of affordances. An account of healthcare affordances draws attention to the multifaceted nature of affordances, how affordances can influence a range of actions across different healthcare environments, and how healthcare affordances can lead to different actions and are situation dependent. In particular, the account of clinical affordances has several important implications for understanding of the interactions between clinicians and the different components of the healthcare workplace, including the various items that clinicians interact with as part of their clinical responsibilities. Skilled performance is not limited by internal processes but is a function of the performer-environment system. A skilled performer can functionally adapt behaviours "to the dynamics of complex performance environments by continuously perceiving information to regulate goal-directed actions" (Davids et al., 2015, p.130). Undertaking specialised surgical procedures relies on a range of highly specialised skills that are gradually acquired during medical training and subsequent surgical training. This requires the integration of both sensory information and motor skills.

Healthcare affordances can be further conceptualised as part of the broader affordance framework (McClelland, 2020) as, in the case of surgery, an action that has the potential to improve (or be detrimental for) the health and wellbeing of a patient. Healthcare practitioners work within specific contexts and we must understand the environmental factors that contribute to the successful performance of clinical tasks in order to completely understand how clinicians undertake tasks.

III   AN ECOLOGICAL PERSPECTIVE ON LEARNING EXPERT SKILLS

From an ecological perspective, the learner (e.g., surgical registrar) may be considered as a goal directed system that needs to adapt to a range of different demands that occur in the setting of providing good evidence-based care. A learner consists of a range of different sub-systems that support actions, thinking and effective clinical decision-making. Learners have dispositional characteristics and may be influenced by a range of physical, psychological, emotional, and social factors that can constrain the acquisition of new skills across different areas of clinical practice (Davids et al., 2008; Flores et al., 2019). Generally, it will take some time for residents and registrars over the course of clinical training and clinical practice to find various ways to address clinical problems to achieve a range of treatment goals.

The types of learning and transitions that are required to go from being a novice to a skilful clinician are a process which requires the acquisition of the necessary skills to achieve a specific clinical goal. It is important to appreciate that each learner will begin the learning journey from a unique starting point and will follow an individual path and that learning is an open-ended process. For this reason, the time and approach taken by each individual to acquire the appropriate attitudes, qualities and behaviours necessary to achieve specific goal-directed behaviours and outcomes across clinical contexts may differ considerably. This also depends, in part, on the background knowledge and skills that each learner brings to the task.

An ecological account of perception (Gibson, 1966, 1977, 1979) has important implications on how we develop clinical environments conducive to the acquisition of clinical skills, including surgical techniques. Traditionally, medical education has focused on individual factors related to the trainee. We broaden this framework to consider how the learner-environment relationship within the context of healthcare systems may promote opportunities for the acquisition of clinical skills.

A   *Affordances*

A central tenet of the ecological approach in contrast to traditional approaches is that it emphasises the person-environment (including physical and social) relationship as fundamental to the learning journey. Although some approaches have considered the person and the environment as separate entities, the ecological approach emphasises the relational concept. This is well captured by Gibson's account of affordances:

> The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. It implies the complementarity of the animal and the environment (Gibson 1979, p. 127).

Affordances are not material entities but functional relationships that occur between an individual and an environment (Gibson, 1966, 1979, 1977). According to this account, affordances regulate human behaviours, either for good or ill. In the case of clinical performance, this means that the trainee will need to determine which affordances are supportive of good clinical practice.

The notion of affordances is considered fundamental to human behaviour and changes behavioural environments (learning and performance) from ones which are described by form (e.g., colour, attractiveness, shape) to ones that are inherently meaningful and described by function (e.g., climb-on-able, graspable, walk-on-able) (Withagen et al., 2017). Properties of a performance or learning environment, including what an object, surface, or another individual offers an individual in terms of opportunities for actions, are fundamental to behaviour (Chemero, 2003). For example, a step stool when placed next to a resuscitation bed offers a useful affordance for chest compressions for a patient presenting with cardiac arrest. On the other hand, the step stool may be a hazard if it is located where a person is unaware of it and trips. The relationship between affordances to achieve clinical milestones (e.g., acquisition of a certain set of skills as part of surgical training) and clinical environments is important. This will be explored further in the next section.

B *Affordances in Clinical Practice*

An affordance-based framework is important to the design of clinical environments as well as providing a framework to understand how clinical skills are acquired over the course of clinical training including how healthcare workers adapt to workplace change (Wood, Bruner & Ross, 1976). An affordance-based framework provides a structure in which to understand how clinical tasks and procedures are undertaken by training doctors. This includes surgical registrars who are increasingly expected to be able to develop clinical expertise across a range of clinical skills, including more recently, experiences in robotic surgical techniques. Although sporting activities and musical productions are commonly recognised as a type of performance, there has been little discussion around medicine as a type of performance, understood within an ecologically based framework (McCaskie et al., 2011). We suggest that the process of transitioning from a surgical registrar to a consultant surgeon may be informed by other areas of practice, such as music and sport, which also require the deliberate performance of complex fine motor movements.

The 'push-pull' framework has important implications in so far as it provides a basis to guide the design of learning environments in the wider context of the landscape of affordances. The 'push-pull' framework implies that items within the clinical environment, including beds and other medical based equipment, could be strategically placed to ensure that they are associated with a positive outcome (pushing one towards actions that could lead to positive patient outcomes) while at the same time, avoiding actions that are associated with adverse outcomes (pulling one away from actions that could lead to adverse patient outcomes). By designing hospitals with a 'push-pull' framework in mind, we may begin to design clinical environments that enhance good patient outcomes and minimise the risk of adverse patient outcomes.

Greater attention should be given to investigating the kinds of affordances important for effective clinical practice and how clinicians perceive such affordances within complex hospital-based environments. An affordance-based framework may inform future clinical education practices, including the training of surgical registrars in the ability to recognise and respond effectively to affordances conducive to good medical practice across diverse hospital environments. Workplace design, from an affordance-based perspective, should ensure that hospital environments allow for the detection of clinical affordances that lead to clinically appropriate actions within a landscape of possible healthcare-related affordances.

The capacity to appreciate different components of the workplace, including different items and other aspects of the hospital environment, is important to the process of adapting to an often complex and unpredictable workplace environment and a range of competing demands. Clinicians are literally attuned to information in the workplace environment, including the various items in the workplace, in terms of opportunities for clinical actions. The concept of affordances broadens our understanding of the process of learning throughout a healthcare career and contributes to a more nuanced understanding of how clinical skills are acquired. We further suggest that healthcare educators need to reconsider the strategies that enable clinicians to perceive and act appropriately in response to the different kinds of affordance in clinical practice.

C *Affordances and Clinical Excellence*

Gibson's account of affordances (Gibson, 1979) has been extended to encompass a range of opportunities for a variety of human behaviours across multiple dimensions (Araújo et al., 2004; Warren, 2006). Furthermore, affordances have been recognised as *invitations* for action (Withagen et al., 2012, 2017). In the case of healthcare, this perspective emphasises the resourcefulness of different environments and the opportunities that different environments afford for a range of different clinical actions. This, in turn, has implications for how healthcare environments may be designed, including to enhance opportunities for learning and acquiring effective clinical skills. An affordance-based account of behaviour is predicated on the person's capacity to perceive and action affordances which suggests the need for a user-centred design of learning environments to facilitate clinical skill development across a broad range of hospital environments (Gangopadhyay & Kiverstein, 2009; Rietveld & Kiverstein, 2014). Behavioural

interactions across clinical environments involve an active process of searching for, picking up, and actioning affordances available through interactions with features, objects, materials, surfaces, and other people in the environment that are relevant for specific goal-directed behaviours.

Hospital environments offer a rich landscape of affordances that are perceived and actioned by clinicians. An ineffectively designed learning environment is not neutral and can hinder learning. Technically, this notion where environmental factors work against effective learning is known as a rate limiter. It is an empirical question as to which components of a particular environment are most likely to invite good clinical decisions for most learners and which are most likely to act as rate limiters. These ideas establish the notion of embodied agency and selective engagement with a rich landscape of affordances as a function of learning, experience and development, which has considerable implications for learning behaviour within clinical contexts.

D *Towards a User Account of Healthcare Design*

Within hospital settings, affordances can be considered as possibilities for particular types of clinical actions within particular clinical settings. One way of understanding this is outlined by what we have proposed as the 'push-pull' account of clinical affordances, where hospital environments are described in terms of their potential to promote effective clinical practice, i) push me to undertake good clinical actions and ii) pull me away from taking clinical actions that lead to patient harm. The proposed 'push-pull' account of clinical affordances recognises the sensitivity of the training doctors to a range of environmental affordances that are potentially beneficial in terms of supporting health-promoting actions. Relevant affordances will need to be recognised and either acted upon (e.g., supporting the repair of a bleeding vessel during a cardiac procedure) if they address a health-related issue and result in a beneficial outcome or avoided if they afford harm (e.g., avoiding injuring a major blood vessel during a cardiac procedure).

A particular item or feature within a hospital space has the potential to lead to a range of affordances depending on its purpose within a particular clinical setting depending on the clinical context and the user of the affordance. In the case of clinical environments, both the type of clinician (e.g., surgeon, physician or anaesthetist) as well the years into clinical training are important in terms of influencing the types of clinically related affordances that are effective across different clinical contexts. For example, the electrocardiogram (ECG) machine can offer a range of affordances and most of these clinical affordances would be perceived by appropriately trained and experienced clinicians and actioned as necessary. However, a junior clinician in their early days may not recognise its capacity for clinical use in the management of acute cardiac ischemia or myocardial infarction. In some cases, if they do recognise its capacity (e.g., they may have seen it used on a TV program), the training clinicians may simply not have the required skills to effectively utilise the ECG. The incorrect interpretation of the ECG by a junior and inexperienced clinician has the potential to cause harm to patients, and it is only through engaging with ECGs across clinical environments that clinicians can become acquainted with the different affordances of ECGs.

A fundamental goal of medical education is ensuring that clinicians acquire effectiveness in particular sets of skills that are required to achieve key clinical milestones across different environmental contexts. In view of the increasing complexity of medicine, it is increasingly important that clinicians can perceive and action a range of affordances that promote good clinical care.

To design effective clinical learning environments, it is important for the learning designer to identify and put in place environmental based factors that ensure that clinically helpful affordances are perceived from the available landscape of affordances and actioned appropriately when indicated (Rietveld & Kiverstein, 2014). Therefore, an aspect of good hospital design is also about ensuring that the clinically helpful affordances are easily perceivable and actionable.

E *The Landscape of Clinical Affordances*

Hospital environments can be considered as having a rich landscape of affordances and clinicians need appropriate skills to perceive and action clinically helpful affordances. The ecological framework recognises that perception and action are coupled and inseparable. While at times perception might lead to action at other times action leads to perception. Clinicians develop skills and capabilities by working within particular clinical environments which in turn lead to new affordances. For example, like holding a pen, there are multiple ways of holding a scalpel for effective use, predicated on individual and environmental factors. Robotic surgery affords greater precision for the appropriately experienced surgeon but potential affordances for ill for the inexperienced surgeon, especially in the setting of stress and technically difficult procedures or because the robotic device interferes with the 'feel' of the surgery.

The account of clinical affordances relevant for the learner as well as its clinical implications can be summarised in terms of the following components:

1. The process of acquiring effective clinical skills is not purely an internal process within the learner but is dependent on the person-environment relationship where the learner, as the embodied agent, actively searches the environment for affordances.
2. There is a broad landscape of clinical affordances available for the learner.
3. Poorly designed learning environments are likely to invite behaviours that are not conducive to good clinical practice.
4. A range of potentially different types of clinical affordances can be perceived and the clinician needs to determine which affordances to action. Once an affordance for good clinical action is perceived, the clinician needs the skills and capabilities to action the affordance. Perception and action are coupled according to the ecological perspective.
5. Being able to perceive and action affordances is linked to the capacity to perceive, as well as the experience of being able to take the necessary actions to facilitate the action.
6. Being able to act upon affordances is predicated on goal intentions and the goal intentions which will vary across a range of areas of healthcare contexts.
7. Clinical learning occurs when the clinician has both the capacity to perceive affordances (including recognition of helpful/unhelpful affordances) as well as being aware of the capabilities to action the helpful affordances that lead to good clinical outcomes (as well as avoiding the affordances that have the potential to lead to clinical decisions resulting in poorer healthcare outcomes and which in some cases, may result in harm).
8. When designing clinical environments, it is important to consider the design of clinical spaces that are conducive to the acquisition of the types of affordances that promote good clinical decisions and patient outcomes.

In summary, what constitutes a good or effective clinical action varies and is in part, influenced by the goals of clinical care, clinical expertise, and capabilities of the clinician, as well as the clinical environment. According to the ecological account of perception introduced in this article, perception and action are coupled. To identify the affordance, it is important that the clinical goal is clear. A clinician will typically engage across the different areas of the hospital, including the emergency department, intensive care unit, and medical and surgical wards. When and how these affordances are formed and actioned in response to different clinical situations is complicated and developing a clinically informed account of affordances will clearly be important as part of future interdisciplinary studies.

F *Affordances in Context: Dispositions for Clinical Actions and the Role of Technology*

There has been little research examining affordances within the context of clinical settings (Clapper et al., 2018). The concept of affordance highlights the types of processes that occur prior to perception including the interrelationship between the 'thing perceived' and the goals of the perceiver (Scarantino, 2003). Healthcare affordances occur in response to the different aspects

of the hospital environment and can be considered as a type of clinical disposition for clinical decisions and actions. Traditionally, healthcare educators have avoided referring to the goals of the perceiver. However, we argue that this is an important but under-recognised concept in healthcare pedagogy, given the widespread differences in the goals of clinical care across the range of healthcare (McLaren & Hawe, 2005).

The items and medical equipment located within the hospital environment have a range of possible 'dispositions' (or properties) that are only instantiated across some clinical contexts. A particular item or feature of the hospital environment does not need to instantiate all these dispositions at any one time in so far as an item may have a range of different dispositional features across clinical contexts in terms of how they can be used to manage a wide range of health-related conditions. We examine the case of robotic-assisted surgery (RAS) which is increasingly being used across multiple areas of clinical practice (Ashrafian et al., 2017) to highlight the features of the i) push-pull me account of robotic surgery as well as highlighting the ii) distribution of affordances across networks of structures including the biological (e.g., patient's knee) and affordance-based biomechanical surgical device design (Kim et al., 2020).

Designing effective joint and ligament-related reconstructions and surgical-based interventions requires an appreciation of the action possibilities that take place in the context of both the knee (biological environment) as well as the biomechanical artefacts and the need to appreciate the aspects related to the anatomy of the knee as well as the potential interactions with the biomechanical artefacts introduced at the time of surgery (Kim et al., 2020). In this case, an affordance-based approach has been used to understand artificial-based design, including surgical-based settings. Our proposal goes beyond a surgical-based intervention to the interaction between the operator and robotic equipment. RAS offers novel surgery-specific affordances (Sergeeva et al., 2015). RAS allows surgeons to undertake complex procedures more precisely and with a greater level of flexibility than can be achieved through conventional surgical techniques. RAS is deployed through small incisions and is sometimes used as part of other traditional open surgical procedures.

The distinctive affordance offered by RAS is the capacity to operate remotely from a console situated some distance away from the patient. However, RAS devices offer affordances that challenge the way in which surgery has been traditionally practiced. Finding space for a large RAS device may potentially alter the position of the surgery table and may have an impact on the traditional idea of space use by specialists and nurses undertaking a particular surgical procedure. Hence, RAS may even transform traditional notions of how surgical teams comprising of surgeons, nurses, anaesthetists and porters work together. Robotic-assisted surgery changes traditional surgery practice and roles. Sergeeva et al. (2015, 2016) found that the adoption of RAS may also have an impact on the responsibilities of nurses and surgeons including the ways in which nurses may engage in new roles, which may, in turn, be associated with enhanced work satisfaction. RAS may also have an impact on the peripheral vision of surgeons, which, in turn may affect the visual access to the actions of other team members, which is not generally an issue that is encountered in surgery relying on traditional techniques. Furthermore, RAS may also potentially be associated with reduced learning and teaching opportunities for residents and training surgeons (Sergeeva et al., 2015, 2016) although this question requires further empirical studies.

For a training surgical registrar acquiring skills over the course of clinical training, there are differences in the type of clinical affordances that are offered in terms of i) intervening without a robotic surgical technique and ii) intervening with the assistance of a robotic surgical technique. Acquiring surgical skills is highly dependent on environmental features, which not only include a detailed understanding of anatomy, but also other factors related to environmental design, including various robotic surgical based techniques. The advent of technology, including robotic surgery, has led to a number of changes in how people i) experience and ii) adapt to learning across clinical environments. A surgeon relying on robotic surgery has to appropriately select the right sorts of actions using robotic surgical-based techniques within a particular clinical context that can accomplish a particular desired treatment goal.

Effective surgery requires the integration of sensory and motor-based information to accomplish highly deliberate actions. Robotic surgery has introduced challenges for residents learning surgery. The skills that are needed to successfully undertake surgical interventions with the assistance of robotic-based techniques are different to the types of skills that are needed to undertake traditional non-robotic surgical-based surgery. A surgical-based affordance refers to the interaction between the surgeon and the surgical equipment. Before robotic-based surgical techniques, affordances between the surgeon and the surgical equipment (e.g., scalpel blade), were relatively straightforward. It is important to distinguish affordance in relation to the acquisition of i) knowledge-based skills and ii) skills-based procedural skills. The learning that takes place across surgical specialties is a particularly dynamic process and does not rely on the sequential acquisition of skills. The types of skills required for successful surgery depend on the recognition of a range of affordances needed to perform effective surgical procedures with robotic assistance. These skills eventually become automatic.

The structure of affordances will differ across different training environments. Effective surgical skills training will need to take place in a clinical environment that is most clearly representative of the performance environment. Robotics (and Artificial Intelligence (AI)) will continue to transform many areas of medicine (Hammond, 2010; Kim et al., 2020). Learning and acquiring the skills as part of surgical training requires that the learner recognises health-promoting affordances specific to robotic-assisted techniques.

Based on the ecological account, the skills that are developed during clinical training are not often clearly transferable across different clinical environments. In the future, there will need to be a greater emphasis in terms of developing training environments more closely representative of the actual operating theatre environment where a robot or a piece of technological equipment will be deployed as well as thinking about the design of clinical spaces based on the 'push-pull' framework. For the trainee surgeon to advance from novice to an experienced surgeon, they will need to recognise and respond appropriately to the landscape of affordances across the patient-robotic system. An affordance-based account emphasises the way in which the acquisition of skills in the area of robotic surgery may hinder the acquisition of skills across more traditional areas of surgery (e.g., suturing). Instead of operating on a patient, robotic-assisted techniques invite the surgeon to undertake procedures that are physically removed from the patient. A surgical trainee undertaking a surgical-based intervention with the assistance of a particular robotic-based intervention is required to i) understand and ii) utilise affordances that may include both patient-related and technology-related factors. Robotic-assisted surgery introduces a different dimension through which clinicians can interact with the surgical team and a patient and undertake a surgical procedure that has the potential to improve patient outcomes.

The introduction of new experimental techniques as well as technology has the potential to inform our understanding of learning as well enhancing the design of clinical environments that enhance the recognition of affordances that help promote effective clinical actions. An account of clinical affordances provides a framework in which to understand how experienced clinicians differ from less experienced clinicians. A more experienced clinician may be able to perceive and act in response to a more expansive field of affordances than a less experienced clinician and have the capacity to use that information to make more effective clinical decisions. Further research is required to define the types of healthcare affordances as well as how healthcare-related affordances can inform educational practices with this view. This can, in turn, be used to inform the development of clinical spaces that help train clinicians to acquire the capacity to recognise and act in response to clinically important affordances which, in turn, will lead to clinicians making effective clinical actions.

G   *The 'Push Pull' Framework and Implications for the Design of Clinical Environments*

Aspects of the clinical environment may become integrated into the landscape of healthcare affordances, and this may include different items of technology, including robotic-assisted surgery equipment. The 'push-pull' framework assumes that there are different healthcare affordances that can enhance patient care and lead to positive patient outcomes in contrast to other

affordances that can result in harm. However, there is no *a priori* way of deciding which affordances will result in clinically helpful actions as opposed to actions which have the potential to result in harm. It is possible that some affordances may be clinically meaningful for some clinicians but not for others.

Based on this account, there will be a need to reorganise healthcare spaces to accommodate and promote the opportunity to recognise the healthcare-promoting affordances that are important for the successful completion of a range of different medical and surgical procedures, including surgical interventions. In the case of a robotic-assisted appendicectomy, a surgeon needs to perform an intricate procedure in which the affordances in relation to achieving a particular desired clinical outcome require an intricate understanding of the relationship between the patient, including their abdominal anatomy and the robotic-assisted equipment. In this case, the healthcare affordance literally takes place at the level of the relationship between the patient and the robotic surgical equipment. Developing surgical skills can, in part, be accounted for in terms of developing the ability to recognise and understand the relationships between the biological and technological systems in relation to particular surgical outcomes.

This account implies that we may need to reorganise healthcare spaces that promote affordances that are important for the successful completion of different clinical tasks and procedures. To become an expert surgeon, the trainee surgeon needs to learn how to perform complex skills in response to affordances as well as ways in which one can optimise performance over the course of clinical training. An affordance-based framework focuses on elements of physical space including the interactions between the surgeon, robotic surgical equipment and layout of the theatre that are conducive to achieving clinical goals and outcomes that result in a good clinical outcome.

IV   CONCLUSION

An ecologically informed approach has important implications for medical pedagogy as well as the design of healthcare spaces. The 'push-pull' account of affordances provides a framework for user-centred hospital designs that enhance affordances conducive to good clinical decisions and actions. In this article, we have suggested that it will be important to design the landscape of hospital environments in which the kinds of affordances that are conducive to good clinical decisions are recognised and responded to at the correct time and place, leading to effective clinical decisions and actions.

The concept of a landscape of affordances (Rietveld & Kiverstein, 2014) provides a useful framework to understand how affordances are perceived and actioned in clinical practice. Trainees at various stages of training, including surgical training need to recognise and respond to a range of healthcare affordances congruent with both their capabilities at their stage of training and their clinical goals. Developing an integrated account of healthcare affordances based on the clinician's goals, and which also acknowledges the central role of environmental factors has the potential to lead to the design of enhanced clinical spaces and training environments which promote good clinical actions. This has the potential to lead to improved clinical training which in turn may lead to enhanced healthcare services and improved patient outcomes. Affordances have a complex structure, and the substrate for the clinical affordances takes place at the level of the relationship between the patient, robotic surgical equipment, and other technological devices, as well as the clinician. Moreover, an ecological account of learning in clinical environments provides a novel theoretical framework with a range of important implications for further discussions about how learning could be enhanced across clinical contexts.

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