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**Designing affordances for health enhancing physical activity and exercise in sedentary individuals**

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## **Abstract**

Ideas in ecological dynamics have profound implications for designing environments that offer opportunities for physical activity, exercise and play in sedentary individuals. They imply how exercise scientists, health professionals, planners, designers and engineers, and psychologists, can collaborate in co-designing environments and playscapes that facilitate physical activity and exercise behaviours in different population sub-groups. Here, we discuss how concepts in ecological dynamics emphasise the person-environment scale of analysis indicating how physical activity environments might be (re)designed into qualitative regions of functional significance (*affordances*) that invite health enhancing behaviours according to individuals' capacities and skills (*effectivities*).

### **Key Points:**

1. Exercise uptake and adherence is influenced by thoughtful design of environments.
2. A multidisciplinary approach to physical activity is best able to initiate the required design features.
3. Designers for physical activity must understand the relationship between functional aspects of the environment and individual characteristics.

## 1. Introduction

Data from existing research in ecological dynamics imply how informational variables emerging during ongoing interpersonal interactions of individuals with their environments (e.g., negotiating gaps, stepping on and off objects, locomoting on different surfaces) inform about health-enhancing *affordances* (invitations for action) which can be perceived and realised by people during sedentary behaviours and during physical activity (PA). In this paper, we discuss how the key concept of affordances can be used to regulate environmental interactions (see Gibson [1]), providing a basis for (re)designing PA and exercise contexts.

## 2. Affordances

James Gibson [1] proposed that affordances are available in every performance environment to regulate human behaviours. Affordances are not *material entities* that are perceived, but functional *relationships*, or *relational entities*, formed between an individual and an environment. This definition emphasises the functional, rather than structural, relational, rather than material, properties of a performance environment, i.e., what an object, surface, or another individual, *offers* an individual in terms of opportunities for actions. For example, a puddle can afford jumping over or jumping in by young children and adults, depending on what it offers each individual. For an adult, or perhaps a child on the way to school, a large muddy, brown puddle might signify something that ought to be avoided, however for a child at play the same puddle might signify a place to sail their boat, drive their toy car or sit and splash. This emphasis on an affordance being a relational property between an individual and a performance environment, suggests that it simultaneously has both an objective/public (they exist in a performance environment) and a subjective/particular (they need an actor with specific capabilities to utilise them) dimension [1, 2]. Thus an affordance can invite behaviours from specific individuals since Gibson [1] argued that an affordance ‘is neither an objective property nor a subjective property; or it is both if you like’ (p129).

This implied particularity of affordance utilisation by different individuals was captured by Rietveld and Kiverstein [3] who, after Gibson [1], proposed that affordances offered by an individual's relationship with an environment are always predicated on a capacity to *utilise* them. This perspective emphasises the resourcefulness of different environments and has implications for how they can be (re)designed for different purposes, including for enhancing opportunities for the uptake of PA and exercise in specific population groupings. The suggestion is a rich landscape of affordances, dependent on people's capabilities and expertise, which can be designed to invite or attract PA and exercise behaviours. These ideas predicating a 'selective engagement' with a rich landscape of affordances, as a function of learning, experience and development, have implications for health promotion groups and healthcare planners, amongst others.

Gibson [1] focused on the person-environment relationship as the appropriate scale of analysis for understanding human behaviours, advocating that the environment contains qualitative regions of functional significance for interactions that are perceivable to individuals with complementary capacities and skills. Following Gibson, Shaw and colleagues [4] introduced the concept of *effectivities* to complement the concept of affordances. Functionally defined, an effectivity set constitutes those complementary capabilities of an individual that can realize affordances in coherent forms of behaviour. With a particular effectivity, individuals can perceive and interact with the world in certain ways—even noticing certain affordances that may be imperceptible to other people. For example, parkour participants or BASE jumpers [5,6] tend to view urban environments as a means to PA, and what would normally be considered barriers to locomotion in other groups, such as walls or fences at the top of high buildings, are perceived as invitations to engage in acts like climbing, balancing and jumping.

A niche is a set of affordances, according to Gibson [1], which offers an organism a specific *way of life*, an important idea for considering how to encourage people to take up and maintain a physically active lifestyle. Predicated on Gibsonian ideas, Rietveld and Kiverstein [3] proposed that a 'form of life' is important for implying how human socio-cultural practices can constrain the emergence of specific behavioural patterns. A 'form of life' comprises patterns of behaviour that become regular and stable over time, and is a significant concept for understanding how to design environments that encourage individuals to regularly partake in PA and exercise. For example, a more active 'form of life' might be possible to people who live in nature or close to parks, countryside or rural landscapes. For those who do not have this proximity, designers of urban environments and health promotion programmes can create affordances for PA to help urban dwellers to avoid a sedentary lifestyle, inviting variations in use of perception and action during behavioural interactions with an environment.

These ideas suggest how behavioural interactions with different PA landscapes involves searching for, and picking up affordances, which support interactions with relevant features, objects, materials, surfaces, and other people in these environments, during goal-directed activities. The role of PA planners and exercise practitioners is to educate individuals' attention to the specific affordances for PA. For example, negotiating environments in nature involves becoming perceptually attuned to affordances for support and locomotion offered by different surfaces and terrains such as a sand dune, flat grassy area or rocky trail. These ideas are supported by research on effects of exercise environments on psychological health, for example. Rogerson et al. [7] investigated psychological outcomes of people exercising in four different nature-based PA environments and reported that all were capable of inducing positive effects such as enhanced self-esteem, reduced stress and elevated mood. They noted

that different nature-based environments facilitated psychological health and wellbeing through a range of varied affordances to be utilised by individuals engaged in PA.

Therefore, changing sedentary behaviours involves people becoming more attuned to varied aspects of an active form of life which potentiates social interactions with other exercisers and psychological health and wellbeing. Affordances for PA and exercise in different individuals are dependent on their physical, cognitive and perceptual capacities to help them utilise these affordances. Their capacities are shaped by the form of life (the social and cultural practices of the community, including beliefs and attitudes). A form of life only exists because cultural and material aspects of an environment offer opportunities for action. For example, at a population level, while still at an early stage of development, cities such as Toronto, Copenhagen and Portland have begun redesigning streets and communities to emphasise nature (e.g. small parks and tree lined streets), street connectivity and public transport in an attempt to counteract a traditional, sedentary, car-focused culture. Preliminary evidence suggests that these redesigns have been linked to increased PA at a community level because the affordances for PA in these new environments are more attractive than the traditional car-focused lifestyle [8]. In the UK, the city of Sheffield has the highest number of trees per capita than any other city in the country and a large proportion of the city is located in the Peak District national park, offering inhabitants constant contact with nature. Here, public access to footpaths merely needs to be maintained. However, more work needs to be done to determine the benefits of existing or re-designed affordances for PA at an individual level. These ideas imply that artists, designers, urban planners, developmental psychologists, pedagogists, exercise scientists and architects, for example, could collaborate to research the invitational characteristic of affordances to design healthier habitats for different people to continuously move around. An affordance can create a readiness for play, exercise and PA, or for sedentary behaviours [8]. Relevant affordances can invite these behaviours and their

associated psychological and physical responses and social interactions. This approach could result in an environment overflowing with affordances, allowing people to selectively interact with a relevant few that enhance their functional behaviours. An important aspect of affordance design is for some PA and sports participation programmes to be specifically targeted at different population sub-groups, depending on age, sex, cultural and social groupings. Accordingly, designers need to better understand how to design a form of life that drives different sub-groups of people to accept invitations to be active.

### **2.1 How Affordances can enhance opportunities for Physical Activity and Exercise**

Withagen et al. [9] also proposed that affordances provide behavioural invitations which are individual-specific and time-based, dependent on past experience, learning and development for their realization. They suggested that the specific motivations and intentions should be seen at the individual-environment level, not specifically generated inside an individual.

These motivations and intentions are embedded in the utilisation of affordances in a particular environment. At a more general level, however, the key tenets of psychological theories emphasising affiliation, autonomy and competencies, offer a platform for designing affordances for PA participation in different community groupings [11].

In this regard, Gibson [1] conceived that affordances 'do not cause behavior but constrain or control it', laying the foundation for considering affordances as constraints on emergent behaviours [10, 12]. In fields like industrial architecture and planning, there has been a strong tradition of understanding how to exploit affordances in edifice properties to constrain human interactions with built environments (e.g. the width of entrances and exits, the flow of walking areas and properties of objects for pushing and pulling doors) [9]. This tradition prompts the notion that exercise scientists, health promotion specialists and physical educators should be considered as *physical activity designers* with the role of creating multiple, specific affordances into different environments such as urban areas, parks,

shopping malls, residential complexes, industrial centres, universities and even travel centres such as railway stations and airports to ensure that there are numerous affordances designed into location sites for people with different capacities to utilise. In this way design can consider the needs of different groups such as (male/female) young children, adults and elderly people, as well those with specific diseases and disabilities, or those from different cultural backgrounds, facilitating their capacity to remain active. For example, from a transit perspective, individuals might realise affordances for PA if roads were restricted and local areas redesigned to include more user-friendly and wider walk ways with separate cycleways that facilitate movement for walkers, cyclists and wheelers. This could be combined with quality, accessible public transport and local amenities such as places to socialise, dance, swim and purchase everyday groceries. From a recreational perspective these same design features could also incorporate a richer array of potential affordances such as wider areas of various nature-based or soft features to encourage exploration, jumping or climbing in children. They might include water features and foliage for playing in that are accessible and safe for all users, or trees planted in all areas not just neatly planted along the sides. Socio-cultural constraints such as traditions, customs and practices can also be understood as constraining affordances for PA, exemplified by clothing typically worn by specific groups. A landscape of affordances can facilitate the emergence of functional relations between different individuals and a specific environment such as a park area or an urban street [3, 13-15]. Design can incorporate affordances for PA as integral to people and the community as opposed to an afterthought that gets fitted ineffectively to a community designed around the presence of cars. Design around affordances for PA might also suggest to individuals that their community recognises the importance of PA, instead of admonishing people to be more active, while designing environments that afford sedentary behaviours.

During interactions with an affordance landscape in a park or nature trail, for example, individuals need to be able to explore a surface and its texture, an object or feature and discover invitations for specific behaviours. A manifold of affordances represents a perceptual-motor workspace that PA designers could create for different individuals by manipulating task constraints [16]. It is important to design invitations for variable actions to emerge under different task and environmental constraints in workspaces because of the role of movement variability in enhancing skill acquisition and children's motor learning and development [12]. These ideas suggest how schools could be designed to take into account how classrooms, gymnasiums, playgrounds and open spaces could facilitate PA in children with different abilities and effectivities. For example, interacting with grass, ledges, surfaces and trees can help children become and remain active whilst they are engaged in learning, even in subjects like mathematics which have been traditionally associated with static, classroom-based learning environments [17, 18].

Variability in a play environment is a key property which can invite adaptive movements, as Withagen and co-workers have pointed out [9, 19]. So why are some environments too symmetrical: for example playscapes for children? These exercise and play environments are built by adults in a standardised fashion, despite the evidence from children that they prefer (i.e. will design games incorporating) non-standard, varying environmental features for play [19]. The work of Jongeneel et al. [19] critiqued the 'omnipresent standardisation of playgrounds' (p 45), which may have been built and designed by adults, to create a 'risk free' area, without consideration of children's developmental needs. Well-designed play environments contain many variable opportunities to achieve the same movement goal, giving people experience in adapting their behaviours to dynamic contexts. To become more skilful in adaptive behaviours, people need to be exposed to more variability in a perceptual-motor workspace to gain experience such as managing potential dangers, so that they can

experience a 'gradient of risks' when playing and exercising, rather than seeking to eliminate it completely from their environments [20]. Cordovil et al. [20] pointed out that a safe environment is not the same as a risk-free one. A risk-free environment, without any element of danger, is almost impossible to design. But it is also undesirable because there are positive developmental outcomes which can emerge when people actualise affordances that have a certain gradient of risk, related to their effectivities and psychological state of development [21, 22] Indeed, these ideas reflect the need to involve children as participants in the co-design of affordances to enhance variability in play areas, given their specific characteristics. This is a mode of operating that planners and designers could include with different sub-groupings according to age, gender and culture.

According to insights in ecological psychology: “The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or for ill” [1]. Variable environments should seek to allow learners to utilise affordances, which have consequences for 'good or ill' to paraphrase Gibson [1]. These Gibsonian ideas suggest that our understanding of what constitutes risky play environments could benefit from analysis of how different individuals (e.g., children, adults, elderly people, people with disabilities) behave in those environments. Cordovil et al. [20] proposed that “risk” is not an entity in a specific play environment, but is a relationship that emerges from continuous interactions between a specific individual (with particular action capabilities) and an environmental context. Gibsonian ideas imply that some affordances may have negative consequences for individuals. People need to be able to utilise these affordances to regulate their behaviours, perhaps in managing or avoiding possible dangers. The environment is not a manifold of *neutral* action possibilities that an active person intentionally chooses from. Rather, affordances can attract or repel an individual and impact on particular behavioural outcomes [9]. The effectivities of individuals channel them to discover and utilise such invitations.

To exemplify, people actively exploring an inclined surface or narrow pathway in their behavioural environment are likely to manage inherent risks through discovering different ways to achieve the task goal of locomoting. Accordingly, exercise designers can provide flexible opportunities for locomotion, perhaps by co-creating affordances for young children, young adults and elderly or disabled people to negotiate a particular environmental feature (e.g., a route across a parkland area), in variable ways, based on their effectivities.

Opportunities for simple transitions of a pathway, can co-exist with challenging negotiations of the trail in a well-designed area, facilitating PA which suits effectivities of each person, involving different modes of transport (e.g. stepping, walking, climbing, and exploiting coordination modes in upper and lower limbs separately or together). Through experience and learning, people can perceive and realise the most functional affordances available in a landscape of opportunities for actions [23]. The enormous adaptability of human beings and a large number of affordances inviting action provide a platform for functional negotiation of PA landscapes. Facilitating peoples' capacity to explore variable environments can even impact on brain function. Voelcker-Rehage, et al. [24] found that when older adults were exposed to a period of cardiovascular training in stable environments, brain changes mainly involved volume in white and grey matter. However, in participants who were asked to undertake coordination training, synaptic connections between different parts of the brain improved significantly. These data suggest that affordances designed for older adults to provide opportunities for physical activities which enhance cardio-respiratory capacity and coordinative skills can result in changes in brain volume as well as synaptic connectivity.

These ideas and data imply that manipulating task constraints in specific environments can co-create affordances to help different population groups gain what they need when regulating their activities. Designing affordances into exercise and PA environments can 'nudge' individuals towards particular outcomes. As they emerge, behaviours can underpin

each individual's structural (physical conditioning, agility, flexibility, strength and speed) and functional needs (cognitions, emotions and fatigue reduction) in a specific performance environment (e.g., an aquatic environment with different depths, objects and surfaces to climb upon and dive off and slide down from). Some affordances might suit highly skilled swimmers, while less skilled swimmers can explore other ways of locomoting through shallow still water areas which are calm and inviting. Although differing, affordances should have a common theme of continually inviting physical interactions, psychological and emotional engagement and dynamic exercise. Even affordances for static or sedentary behaviours should be available for a limited few individuals who need to remain stable in PA environments. As Withagen and Caljouw [25] suggest in this issue, even astute work space design can mean that people remain static for only temporary periods. The study found that creative design such as exemplified by Rietveld Architecture Art Affordances (RAAAF) and visual artist Barbara Visser [25] generates many opportunities to get up, move around, change posture and location, and engage with different objects, surfaces and environmental features to promote an ongoing, cyclical relationship between action and information.

### **3. Conclusion**

Ecological dynamics emphasises continuous interactions between an individual and a behavioural environment and is ideally suited to explaining how PA and exercise experiences might improve physical and psychological health and wellbeing. Based on these ideas, as part of a multidisciplinary team exercise scientists need to consider themselves as designers who focus on informational constraints or *affordances* constructed into environments by PA designers to facilitate exploratory behaviours and interactions of individuals with surfaces, objects, features and terrains, as well as other individuals. They can achieve these aims by a multi-disciplined approach to gain a more nuanced understanding of affordances for PA in specific contexts and then applying this knowledge in the design process.

## Compliance with Ethical Standards

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## Conflicts of Interest

Keith Davids, Duarte Araújo and Eric Brymer declare that they have no conflicts of interest relevant to the content of this review.

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