

Original Contributions - Originalbeiträge

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Extension and the Ground in Motion's Gestalt: Literal and metaphoric

Introduction

In pictures, extended limbs, limbs curled, limbs touching the ground and limbs in air suggest the motion of the actor. To explain the effects, we extend Gibson's ecological theory of the ground in perception (Gibson, 1950, 1979; Kennedy, 1974). We suggest some limb poses are literal and others metaphoric. In air, we suggest, the more extended the limbs the faster the motion, a claim that can be applied to literal and metaphoric pictures. In the cases of curled-up limbs of an actor in-air and the splits with the actor's limbs on the ground, a key factor may be departure from a norm (Arnheim, 1954, 1974). The information that the actor is in-air or on the ground can come from shadows, literal and metaphoric.

By way of introduction, an example of extended and curled-up postures in a metaphoric image may be useful. In publicity photographs the athlete, Usain Bolt strikes a *Lightning Bolt* pose, one arm highly extended and pointing at 45° upwards and to one side, and the other arm parallel to the first but fully folded at the elbow. Bolt implies action *metaphorically*, we suggest, since he is standing still on the ground. In contrast, pictures of running horses and dogs show them in-air, legs extended. In quite the opposite pose, the Ford Mustang airborne running-pony's legs are tightly curled under.

Our goal is to consider limb-extensions in literal or metaphoric pictures and to propose the ground is part of Gestalts of movement. The ground – key to the Gibson (1950) theory of distance and shape perception – needs to become a part of a Gestalt theory of movement perception. It is obviously relevant to perception of water tumbling down a waterfall, and is just as pertinent to actions of animals.

Limb poses to do with motion have long been an art subject. For example, in a volume on ice-age art, Cook (2013, Figure 21, p. 196) presents a picture of a wolverine one foreleg out in front of the chest, the other vertically below. Flying-gallop portrayals are common in art from many eras and regions and attracted lively dispute in the mid-19th century, as Muybridge photographs of galloping horses (Gombrich, 1960; Cutting, 2002) helped to determine whether the gallop entailed leaving the ground. Muybridge's work allows us to ask if poses like the

flying gallop that are not physically real are successful psychologically. Do they suggest fast motion? Are they taken to be unreal? Are they pleasing? We will touch on these questions.

Cutting (2002) listed as indicators of movement in pictures broken symmetry, multiple images, forward lean, blur and action lines. As in flying-gallops, we add here, highly extended limbs may also indicate fast motion. Further, some limb-extensions are literal but some may be metaphoric. Also, in dance in particular, poses may imply motion has taken place, the Gestalt theorist Arnheim argued, since “we perceive the pose as a deviation from a normal or key position” (Arnheim, 1954, p. 330). Legs are pictured reaching the ground, pushing off from it, or elevated above it and so the ground should play a role in theories of the whole including Gestalt and Gibsonian theories of perception of movement.

Arnheim (1954) gave extensive accounts of the studies by Wertheimer (1922, 2012) on apparent movement induced by pairs of flashes and Duncker’s observation that the moon could be seen as moving when clouds scud across its face. He concluded “the experience of visual motion presupposes that two systems are seen as displaced in relation to each other” (Arnheim, 1954, p. 309). For Arnheim (1954,1974), we observe a landscape within which action takes place. “The organization of the field assigns to certain objects the role of a framework on which others depend” (Arnheim, 1954, p. 310). Further, “Duncker’s rule indicates that in displacement the framework tends to remain immobile whereas the dependent object does the moving.” (Arnheim, 1954, p. 310). In the most recent and extensive studies on the Wertheimer and Duncker (1929) effects, Cavanagh & Anstis (2023) use flashing dots as probes and produce very vivid and highly reliable motions. Probes that flash within the moving frame are dramatically displaced, with effects much larger than that seen with static probes like Duncker’s. The effect is robust in many experimental conditions. Flashed probes change their apparent locations as if the moving frame were stationary, in line with Arnheim’s conjectures. The grouping of the probes with the frame generates the effects. Probes grouped with the background stay stationary. Cavanagh & Anstis (2023) used wall-like backgrounds for their frames. Let us change the term *background* to *ground* and, in this vein, consider actors and their surroundings.

The perceived coordination of the setting and the actor often minimizes biomechanical and energetic costs (Proulx, 2023). In natural behaviour the body’s surfaces of support are specified by shadows, surface textures and information about the damp or dry, soft or hard states of the ground. Terrestrial motion of animals with limbs does not occur as if in empty space. In a nutshell, in everyday cases, perception involves the ground in the Gestalt for action. In the Gibson (1979) ground-based theory of perception of the visual world we do not perceive

objects isolated in a “perfectly blank frame” (Gibson, 1950, p. 180) and what needs to be explained is the limbs of objects that are active on terrains and floors. Object and ground – this is the fundamental visual scene and other cases are derived or secondary as “a terrain or floor is always present in vision” (Gibson, 1950, p. 180). An implicit scale and order of action in ground-based theory “is a primitive feature of perception” (Gibson, 1950, p. 181). Here, in this vein, we offer case studies, with pictures of limb extensions, grounds and implicit departures from norms. In this brief essay, our goal is to demonstrate some roles of limb extension and the ground in literal and metaphoric representation of actions.

Case studies

We begin with an actor in a literal posture. A vivid well-known picture of limb extensions indicating motion of an actor on the ground is on the cover of *Action Comics* #1 (cover dated June 1938), Superman – in his first depiction– thrusts a car to the right (Fig. 1). Allowing for the hyperbole about the actor’s strength, the picture is realistic.

His arms are up, holding the car tilted to the right. His thighs are about 90° apart and indicate fast motion. Toes bent and heel off the ground, his rear foot makes

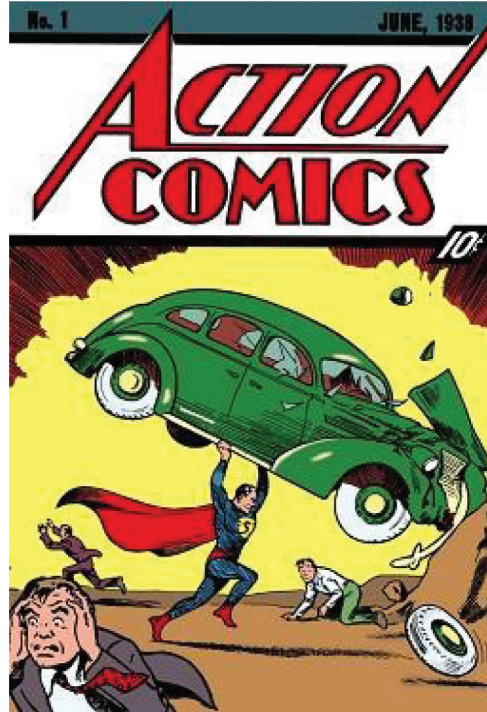


Fig. 1. Superman’s pose in his first appearance. *Action Comics*, #1, 1938. Public domain.

contact with the ground since *it touches his shadow*, a dark line outstretched to the right in front of him (Casati & Cavanagh, 2019).

His rear leg is straight and his front leg – his right– is bent at the knee and not in contact with a shadow, off the ground and poised to swing forward in a fresh step. His right foot has the same posture – bent at the front part of the sole – as the left foot, but is in the air, not like his left foot which is on the ground and in contact with the shadow. The poses are different. Moreover, the ground is firm, since the outline of Superman's rear foot is clearly evident. In sum, the ground supports this early version of Superman in action, and despite no action lines – common in Superman comic strips later – the extended and spread postures of limbs suggest rapid movement in a literal fashion. If the actor is horizontal, face down, both arms bent at the elbow, and the legs bent at the knees, as if in prayer, no limb is extended and the actor is stationary (as in the “Angel” by Francesco Pesellino, 1422-1457, Fig. 2).

We will compare Superman's pose and cast shadow with features of a Géricault painting, the Greyhound bus logo, the Ford Mustang running pony, postures of horses and dancers and Roman mosaics. Superman's literal pose contrasts with horse and dancer metaphoric cases, on-ground and off.

Metaphor and the Géricault *Horse Race* flying gallop

The Horse Race was painted in 1821 by Théodore Géricault alluding to that year's Derby (Fig. 3). On the Epsom Downs course, off-ground horses in flying-gallop



Fig. 2. Francesco Pesellino 1422-1457, “Angel” (right hand, finished by Filippo Lippi).



Fig. 3. Flying gallop. The Derby race at Epsom Downs (1821), painting by Théodore Géricault.

race towards the left of the picture, front legs outstretched, rear legs to the right. Observers take the pose to show high speed (Mastandrea & Kennedy, 2019; Kennedy, Mastandrea, Juricevic & Wnuczko, 2019). Shadows painted to the right help show the ground and indicate the rear hooves of two horses in the centre of the picture are in-air as their contours fail to contact paint showing shadows. Contours of the hooves, vertical or slightly slanted \ and so facing up to the right, indicate they are not in contact with the ground. No turf is kicked up. The ground is firm. A racehorse does not actually adopt a flying-gallop pose, and observers judge that it is not realistic (Mastandrea & Kennedy, 2019). The Géricault suggests fast motion, observers report, but since they deem it unrealistic, its treatment is *metaphoric*.

Greyhound in flying gallop pose literally

The Greyhound bus logo, adopted 1929, has the hound's legs outstretched as if in a flying gallop. For the front and rear limbs to be far apart is *realistic*, Figure 4 reveals, a greyhound touching the ground only with the highly-extended right rear leg and paw. The contour of the paw curls, so the touch does not mean planted on the ground. The ground is yielding as sand is kicked up by the paw, which touches the hound's shadow. Both paws are curled backwards, the left off the ground with space between it and the shadow. The information given by the marked extension of the limbs is of high speed.



Fig. 4. Greyhound in flying gallop pose. Adobe stock image.

Running pony, curled legs and Muybridge's literal depictions

In marked contrast, far from extended, a popular Ford Mustang running-pony image has all the legs tucked under, as in the two Figure 5 top-row-middle Muybridge images of a running horse. The pose is realistic, and the separation from the ground is indicated by the space between the lowest hoof and the horse's shadow. This is one extreme for horses. At the other extreme, quite the opposite of tucked-under, in the middle-row, rightmost image legs are extended fore and aft, and just one hoof makes contact with the shadow. This stance approaches the flying-gallop but a front leg is vertical and touches a shadow on the ground. The other limbs are extended front and rear. The running-pony and the near-flying gallop poses depict speedy horses, but in opposite ways. They depart in opposing directions from merely standing, a default pose, as in the Muybridge bottom right photograph. The ground is firm in all the images, nowhere kicked-up by the horse.

Wright's compromise: Literal and metaphoric in one painting

George Wright's (1860-1942), *The Steeplechase* (Figure 6) includes both the flying-gallop and the running-pony, foregrounding the running-pony since it overlaps the gallop. *The Steeplechase* depicts an early cross-country *point-to-point* race, active at a time when huntsmen would race each other after a hunt, from *steeple to steeple*. Likely familiar with Muybridge's photographs of running horses, Wright painted the canonical flying-gallop, which would have been familiar to

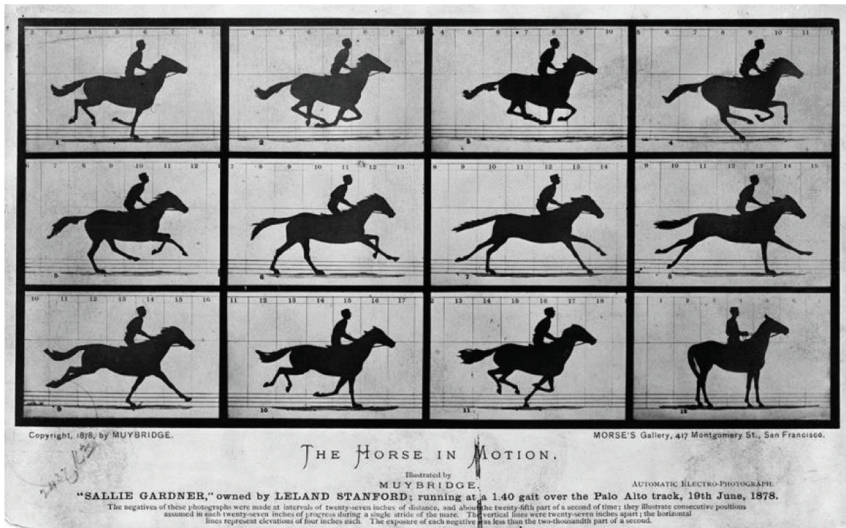


Fig. 5. The Horse in Motion by E. Muybridge. Horse “Sallie Gardner” running at a 1:40 gait on 19th June 1878. Library of Congress Prints and Photographs Division. Public domain.



Fig. 6. George Wright, 1860-1942: *The Steeplechase*. Flying-gallop and running-pony poses in one painting.

his patrons, but added the literally correct legs-curved pose. Asked about realism, in a study with 30 undergraduates asked to rate the Wright horses for speed, the horse with the legs extended was rated 6.4 (SD 2.3) on a 10-point scale, while the legs-curved horse reached 7.3 (SD 2.2) ($t(52) = -2.38; p = .01$). They were rated equally energetic and liked. As Arnheim (1974) hypothesized, ratings of speed and liking were significantly correlated – speed of the extended-limbs horse and its liking rating ($r = .502, p < .001$), speed of the curved-limbs horse and its liking rating ($r = .707, p < .001$).

Wright's horses are off the ground as the shadows do not touch the hooves. Curiously, a foreleg knee of the foreground running-pony horse makes contact with the dark patch of paint depicting shadow. The pose indicates the contact is only of the paint, not of the depicted objects. The knee is in air. Otherwise, the horse would be unstable, likely toppling over or at best crawling along the ground, and more immobile than speedy.

The ground and continued use of the flying gallop

The ground in Figures 1 - 6 is depicted as horizontal, with information in the pictures for an actor largely erect, vertical. If the actor lies down on the ground poses such as legs-curved-together could be static with an immobile actor, resting, sleeping, sick or dead. An actor lying down with legs extended might be stretching or laid out as if for a final medical examination. Limbs far apart would be spread-eagled, perhaps depicting a child making *snow angels*.

Despite Muybridge's pictures showing the flying-gallop to be fictional, artists continued to use it as in Kandinsky's "Der Blaue Reiter" (The Blue Rider, 1903, Figure 7). Its persistence is in keeping with high ratings for motion given to it in Mastandrea & Kennedy (2019).

The prone actor on the ground in a literal pose

An actor lying down with limbs apart might be stretching or laid out for final examination. Figure 8 contains both a flying-gallop horse and a jockey lying-down, fallen, not getting up, limbs spread. Contours of shadows spaced from the contours for hooves indicate the forelegs are off the ground, and a shadow attached to the jockey's left arm and shoulder indicates he is prone on the ground.

Dance and departure from standing

In dance, many poses are on the ground, and in leaps the dancer expressly takes off. In Figure 9, a dancer is frontal or lateral, on the ground or off, and with legs vertical or widely separated. The wider the separation of the legs, observers report,



Fig. 7. Wassily Kandinsky, *The Blue Rider*, 1903. The horse's shadow may be to its right and below.

the more motion is suggested (Mastandrea & Kennedy, 2022). Though in-air pictures show much more motion, as poses on the ground approach the splits they attract higher motion ratings. The in-air motion is literal, and the poses on the ground may suggest motion because they depart from standing as a default pose. Standing is biomechanically efficient, and posing on the ground with leg separation less so. The splits are arduous, but so too is holding an erect pose with legs widely separated.

In the Mastandrea & Kennedy (2022) study, Liking ratings (a small range) were more related to Difficulty ratings (a large range) than Movement ratings (a moderate range). The default of simply standing requires a ground. It is a static pose and departure from it implies motion took place to a new pose requiring more maintenance (more than the default), biomechanically more stressful at an extreme. In contrast, poses in-air, above the ground, imply energy has been expended in the past to reach a frozen moment in the present. The ground's location tells when the energy is expended.

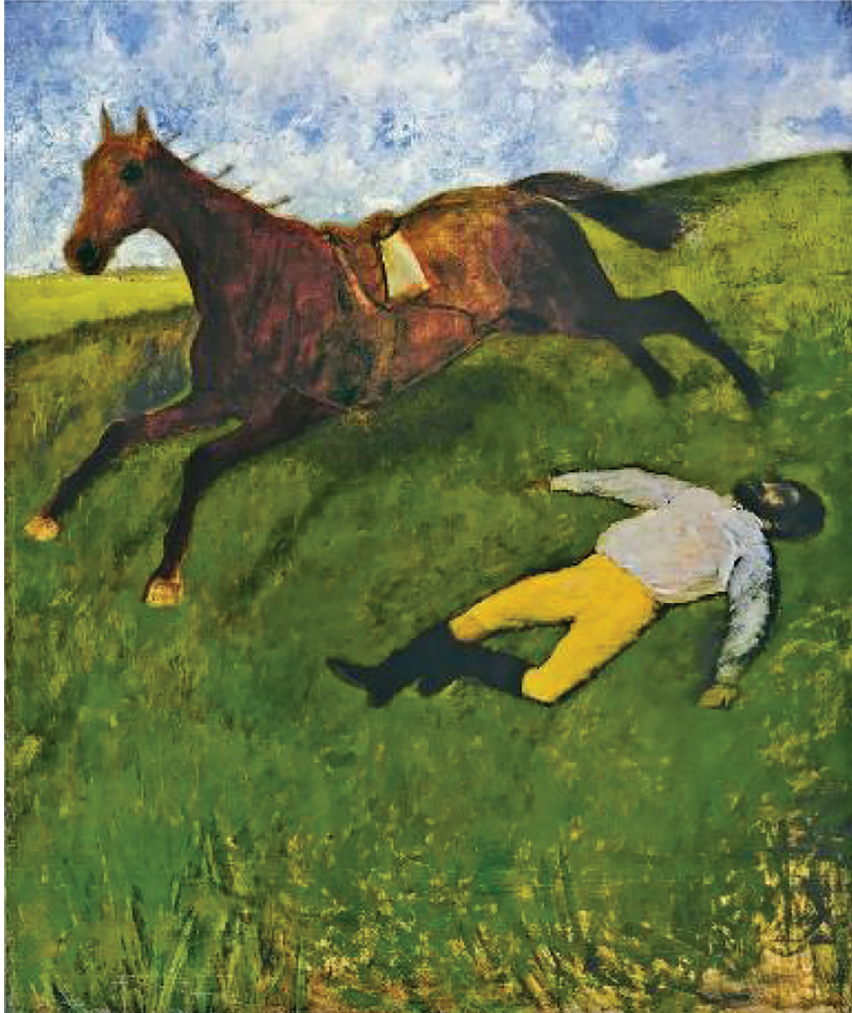


Fig. 8. Edgar Degas, *Fallen Jockey* (1898).

Abbreviated shadows anchor actors on the ground

There are many tropes – hyperbole, meiosis, simile etc. Metaphoric features here may help prepare the way for a thorough examination of tropes in pictures using unrealistic poses to represent movement successfully. To bolster the case with one further example, consider abbreviation. Informative features in pictures can be both highly abbreviated and highly successful. In this connection, abbreviated cast shadows have been used since Roman times to indicate on-ground poses. Figure 10, from Ostia Antica, near Rome, has a compressed C-shape by the feet of the actor, an abbreviated cast shadow, to show he is earthbound, legs close, supporting standing. In contrast, Figure 11 is off the ground as there are no shadows. Floating is

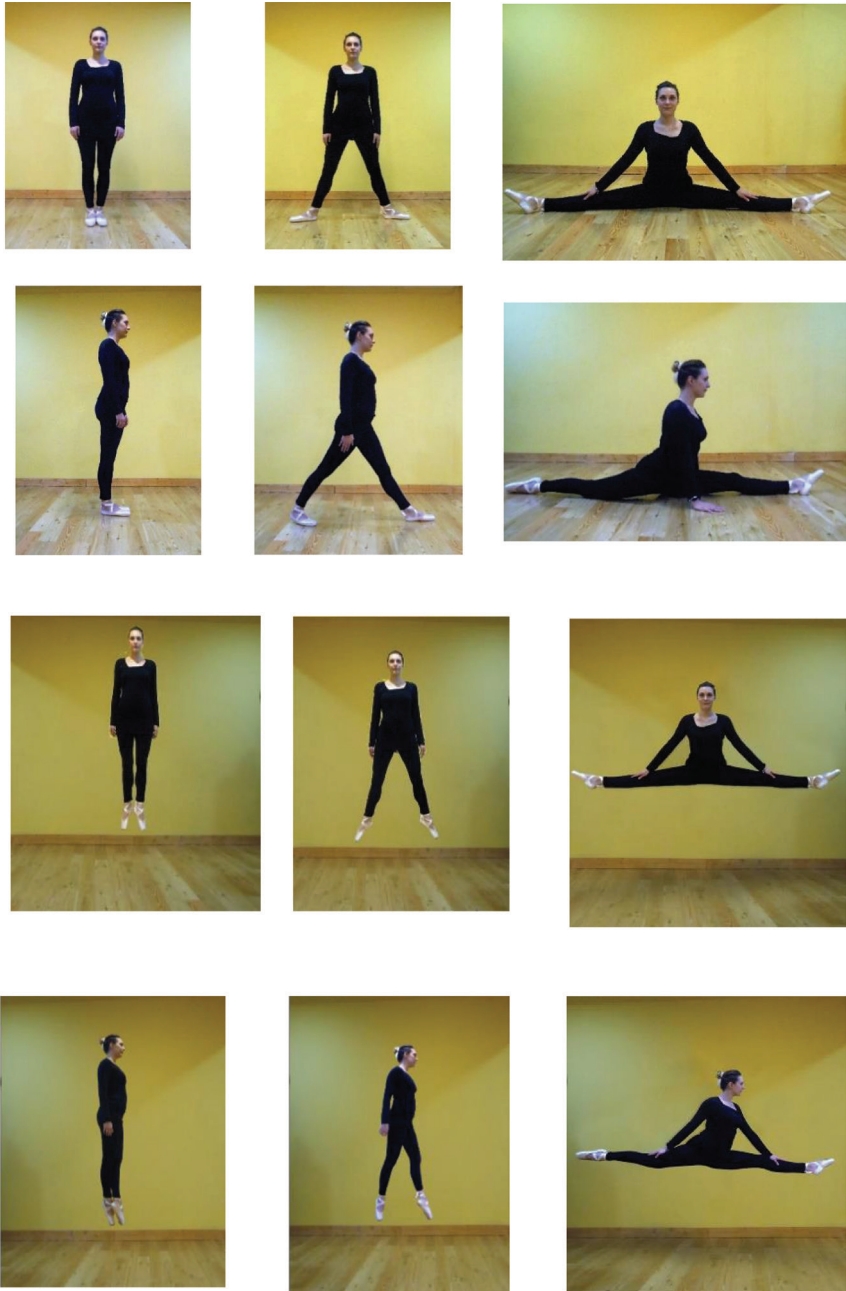


Fig. 9. Frontal and lateral in-air and on-ground poses of a dancer.

suggested by the arms extended in opposite directions, the erect head, body curved to the right, its line continued strongly by the left leg. The ground is absent. The body has no surface of support. The soles of the feet are at right angles to the arms. Compression of the C in Figure 10 is likely foreshortening, as a 4-sided table is depicted elsewhere in the mosaic as a parallelogram, short sides depicting depth, and the rim of a bowl – also elsewhere in the mosaic – is given as an ellipse. Further, in support of the contention that the C is an abbreviation, at the top of the Figure 11 Ostia Antica image V shapes attached to a sea creature with hooves likely are abbreviations for water waves. Pictures use symbolism, metaphor and abbreviation to perceptual effect. For perception, the whole need not be literal. The useful dimensions of figurative depiction of motion deserve exploration, and we will simply point out the option here.

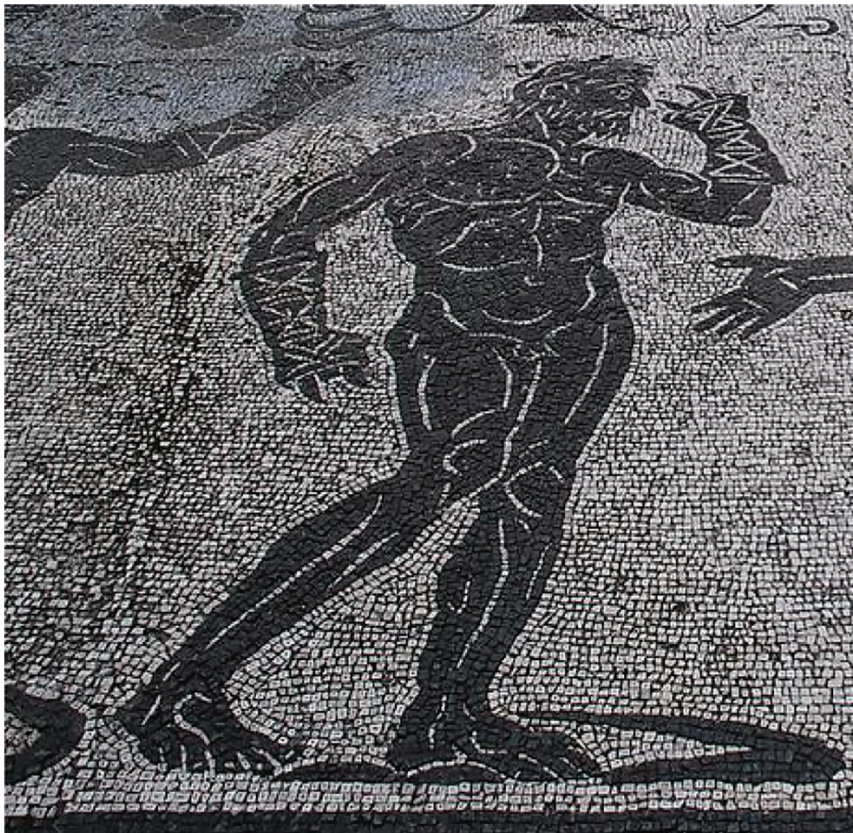


Fig. 10. Roman era mosaic from Ostia Antica with a foreshortened C-shape as a cast shadow at the feet.



Fig. 11. Roman era mosaic from Ostia Antica with no cast shadows on a ground is information an actor floating. The figure includes a sea-creature's hooves with V abbreviations for waves.

Discussion

This brief essay proposes that limb extension shows movement, and a Gestalt theory of this effect should refer to the ground. Depiction of the limb poses can be literal or metaphoric. This essay introduces the extension, ground and metaphor conjectures. Here we offer a few comments on the suggestions and mention studies that might ensue.

Limb posture is the prime index of action. It can indicate departure from standing still. Extended limbs in flying-gallop pictures suggest fast motion, the more extended the more motion. This may be an extreme departure from the default pose of standing, since curled limbs in the running-pony pose also indicate speedy action. Both poses are upright with regard to the ground, as indicated by shadows, and relocating the ground can offer information for low speed or immobility as the actor is lying down. In Gestalt psychology forms are related to wholes, and in this respect, the shadow information for the ground is part of the whole. Likewise, in ecological psychology (Gibson, 1979; Cutting, 1986) specificity requires parts to be considered in their environment. Both Gestalt and Ecological psychology have a forbear in Al Hazen, who pointed out a millennium ago that a pole seen poking above a wall is at an indeterminate distance, but the distance is obvious if the pole stands on a terrain stretching from the observer's feet to the base of the pole. Gibson argued that the ground is the prime basis for three-dimensional perception and, in this vein, we have suggested human and animal limb actions flow in relation to this basic surface of support.

Contrary to Gestalt and ground-based theories of perception, cognitive psychology often contends that the information for perception of shape and action is ambiguous and needs to be supplemented. In contrast, in Gestalt theory, motion perception obeys laws of organization as if subject to “patterns of forces” (Arnheim, 1954, p. 305) and in ecological ground-based theory, adequate visual information comes from limbs and the ground. In cognitive theory, supplements needed to make sense of the optic input come from several sources – past experience for Helmholtz, supposition for Rock and, as the early-Romantic Fichte had it following Kant, the will (Krishnan, 2022). Bayesian models calculate the effects of prior probabilities (Jäkel et al., 2016). The case for supplements is loose. If memory readily modifies perception, it is not clear why other mental faculties such as desire and comprehension cannot. However, all schools of psychology surely have to agree that ambiguity is present in simple cases. Ambiguity arises if the whole is not presented because of overlap from a foreground object, limbs viewed from unrevealing vantage points, or, if our take has value, the absence of information for the ground.

Static pictures – photographs, paintings and mosaics – are treated here. Some are metaphoric. However, we should note that literal and metaphoric static pictures may depict motion in ways that stimulate neurones sensitive to continuous sequential action (Kourtzi and Kanwisher, 2000). The literature on static pictures stimulating motion neurones is now extensive. Of interest is visual area V5 – a posterior part of the middle temporal gyrus (MT) – activated in the presence of a moving stimulus and sensitive to the direction of movement. Damage to this results *akinetopsia*, lack of perceived motion. Static images with implicit motion stimulate neurons in V5 (Mather, 2020). Kourtzi and Kanwisher (2000), using fMRI, found stronger activation of the V5/medial temporal and medial superior temporal cortex by pictures with implied motion compared to pictures of static objects. Besides bottom-up activation from physical features of the implied-motion pictures, some could be top-down via interpretations.

Both static pictures and movies with continuous poses may give rise to impressions of motion. Continuous action may be the origin of the success of the static pictures. The reason is that in perceptual development, some Gestalt principles may actually be the fruit of motion perception. Collinearity and curvilinearity could be mediated by long-range connections in primary visual cortex learned from common object motions. Neural networks can make these connections in unsupervised Hebbian fashion with real-world optic inputs. One model uses spatiotemporal retinal filtering sensitive to changes in the visual input, correlating transient responses (Prodöhl, Würtz & von der Malsburg, 2003). These correlation models are straightforward and relatively simple. They have the form if X then Y and do not need hidden layers, used for exclusive-or options. In all models,

classic Gestalt and modern neural, the brain is biased at birth – less or more – and thereafter self-organized processes use structured input to give rise to perception. If close connections between motion and Gestalt patterns are two-way, this could explain why actual motion and devices in static pictures can stimulate the same motion-sensitive neurones.

Some two-way connections may act as units. Klapp & Jagacinski (2011) argue that motor and perceptual Gestalts are holistic in that they are processed as single units. Brief units of action can be programmed prior to initiation of any part of the movement. Coordination of the hands is often a unitary gestalt. A perceptual pattern such as the reversible Necker cube offers only 1 of its possible percepts at any moment in time. Each of its options is a perceptual Gestalt, and appears quickly as one unit. Less-practiced hand coordinations and less-familiar cube-like patterns would be processed slowly, with attention and effort. In contrast, grouping in apparent motion leads swiftly and without attention to stream segregation in vision. In these terms, information for the adroit energetic action of a familiar object, the object itself, its shadow, the ground location and suitable states of the ground can be unitary and processed efficiently. This could underlie some high liking ratings. By hypothesis, if one feature violates the unit, processing would often be piecemeal and slow, perhaps less liked.

For neural units triggered by limbs, motion and ground it is the limbs that may be the core feature. The information for the ground is often provided by cast shadows, and shadows are highly variable (Casati & Cavanagh, 2019). The illumination required for shadows may be low, diffuse or at a glancing angle. The result may be indefinite shadow contours or highly elongated shadow shapes not immediately relatable to the shape of the body casting them (Kennedy, 1974). The surface on which the shadows fall may be dark or irregular. The most reliable feature specifying that the moving body is on the ground may be contact of a limb with the contours of a dark patch. Compared to the patch, the contours and forms of the limbs may be more sharply defined. Also, information for the ground may be provided by texture in the form of texture gradients. Though the textures surrounding a figure offer excellent information for the shape of the ground and distances along the terrain, they do not specify contact between the body and the terrain with certainty (Gibson, 1950). Shadow cast on the terrain can indicate the object is floating above the ground (Kersten & Mamassian, 2017).

The motion-and-metaphor features treated above are limb postures. Shadows can be subject to tropes, abbreviations showed. To complete the set, consider a metaphoric shadow. A galloping horse has rounded a corner. Let the cast shadow on the ground stretch from under the horse and, in hyperbolic fashion, stretch back from the horse and around the corner. The shadow shows the path that was taken. It is metaphoric.

It remains to be seen what differences ensue neurologically from metaphoric and implied depiction, from poses with unusual biomechanical stress, and from less-familiar departures from norms such as standing still, and from postures given with and without shadows and other optical information for the ground. By hypothesis, though extreme extension in a pose in-air and above ground, indicated by shadows, should strongly stimulate motion neurones, some metaphoric pictures may be much less effective. Even if departure from a default pose includes a stressful pose, if it is biomechanically possible and familiar it may be a strong stimulus for some motion-sensitive neurones. If it is modestly hyperbolic it may be a super-stimulus. If it is overly hyperbolic it may not be as powerful.

Flying-gallop is a pose adopted by greyhounds and other light-bodied quadrupeds such as rabbits and squirrels. The posture is not used by horses galloping or leaping over hurdles. It is not adopted by heavy-bodied animals such as hippos. However, a determining factor in its use is position with respect to the ground as the muscles and tendons of horses find the pose quite possible. They adopt it in diving into water from a height, a fairground attraction that was popular in North America in which the horse would dive into a pool, on occasion from as high as 20 meters. Examples from Toronto around 1907 are illustrated in Wikipedia. The attraction is now frowned-upon by animal-rights groups. The biomechanics and physiological stresses of fast action of animals of different weight-distributions and muscle constituents are factors to consider in the Gestalt of movement and its perception.

In sum, in pictures, we propose that in pictures with extension of limbs the more extended the limbs the faster the motion. Limbs curled can also depict fast motion. Both may function as departures from standing, which is taken to be a standard or norm. In the ecological world, motion takes place in three media: on the ground, in the air and in water. The motion of actors can be depicted literally or figuratively. We illustrated our proposal with ancient and modern art and photographs.

Abstract

We propose that in pictures both the extended limbs of actors and the ground are involved in gestalts for movement. Limbs extend to suggest more motion literally when a dancer is in air and refer to a canonical pose when on the ground. A running pony's curled limbs off the ground depict fast action literally. A horse's flying-gallop off the ground suggests speedy motion metaphorically. Cast shadows indicate the actor's location with respect to the ground. We consider extended and curled limbs, on-ground and off, in literal and metaphoric pictures.

Keywords: Motion, Extension, Gestalt, Animals, Dancers, Ground, Shadows, Extremes

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