ICPA 2019 Posters

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Multimodal Coordination of Sound and Movement in Solo Music and Speech

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Speech and music are the result of a spectrum of coordination patterns, from fine to coarse, produced by multiple motor systems across multiple timescales. At an effector-specific level, features like the area of the opening of the mouth in speech (Chandrasekaran et al. 2009), or the speed of the movement of the fingers in piano (Dalla-Bella & Palmer, 2011) and clarinet performances (Palmer et al., 2009) have been found to directly relate to characteristics of the resulting sounds. At an effector-general level, sound has been found to exhibit different profiles of hierarchical temporal structure (HTS) depending on broad behavioral categories like monologue versus dialog and popular versus classical music (Kello et al., 2017). In this study, we use mixed-effects linear regression to measure the correlation of HTS in sound with HTS in movement as a measure of coordination that reflects the underlying behavioral process. We selected and analyzed 10 videos for each of 10 different types of speech (poetry, teleprompter, theater monologues, spontaneous speech, and a capella singing) and music (flute, guitar, piano, violin, and improvisational piano in jazz) signals. We used frame-differencing to extract overall movement amplitudes from the videos and ran spectral analysis on amplitude envelopes for movement time series and the corresponding amplitude envelopes of audio signals. Log-binned spectral power estimates for audio were regressed onto those for video, along with behavioral category as a fixed effect. Reliable correlations were found for both speech and music, but correlations were reliably stronger for speech. Further analyses of sub-categories indicated stronger correlations for spontaneous performances in both speech and music. We compared these measures of multimodal coordination in HTS with correlations of the amplitude envelopes themselves, smoothed to remove noise in higher frequencies. Results showed reliable envelope correlations in general, but no discrimination among behavioral categories. However, peak lags in cross-correlation functions revealed that movement and sound amplitudes were mostly synchronous for speech, whereas they were more variable for music. In summary, the relationship between sound and movement depends on the underlying behavioral process, with stronger multimodal synergies for speech compared with music, and spontaneous compared with rehearsed performances.

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Learning Differences Between Intra-and Interpersonal Coordination

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Perceptual-motor research has identified a variety of factors that contribute to the process of learning a new coordination pattern. Among these is the difference between learning to coordinate with oneself (intrapersonal) and coordinating with another (interpersonal). Several advantages and disadvantages for coordination have been separately identified for either scenario. For example, coupling strength is greater for intrapersonal coordination, which presumably aids learning due to, e.g., tighter compensation between the limbs. However, there is also a more internalized focus of attention, which has been found to hinder learning. While the evidence for these benefits and hindrances is individually clear, little is known about how they might interact. The current study therefore examined participants as they learned to produce a novel coordination pattern (90° relative phase) alone or in pairs. Participants were implicitly tasked with learning the required pattern as they controlled the vertical and horizontal position of an on-screen cursor to trace a circling target. We observed better performance overall (including initial performance) from pairs, but steeper learning trajectories from individuals. We discuss these findings in terms of coordination dynamics, perceptual information, and attentional focus.

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Non-intentional coordination in Human Machine interactions in high attentional demand

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The goal of this study is to investigate attentional process in the context of non-intentional motor coordination between human and machine.
We know that during stressful situations, attention can be overloaded close to a saturation point, which can cause blindness or deafness of signals (regardless their salience). On the other side, we know that unintentional entrainment is a low-level, spontaneous and unavoidable process not requiring lots of attention (1). The question raised here is therefore: how the unintentional entrainment phenomena impact our attention? And how it can be used to reduce visual attention level in stressful context? We address these questions in a study involving non-intentional entrainment requiring high attentional cost.
Our experiment is a video game-like containing three different tasks that supposed to be achieved at the same time (requiring high attentional level). Participants have to accomplish a monitoring task while swinging their legs at their preferential frequency and respond to alarms that randomly appear. We consider the presence of the unintentional entrainment since the interface synchronizes with the movement of the legs of the participant. The cognitive load is measured using reaction time to alarms. There are three conditions for the alarms and three frequency modalities. Alarms can be visual, audio or audio-visual and can be at the preferential frequency of the participant or plus or minus 20%. Altogether, these conditions allow us to evaluate 1) whether reaction time can be influenced by the interaction between the subject's preferential frequency and the frequency of the alarm and 2) if the fact that the interface synchronizes with the subject can help him/her to react faster to an alarm. We have monitored three variables: motion of the legs, gaze direction and reaction time. The preliminary results showed that reaction time is lower when the interface synchronized with subjects. These results pointed out that a high attentional cost could be reduced when using participants' preferred frequency. But they also highlighted the importance of unintentional tasks in stressful attentional situations.

Reference

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Ecological Perception and Visual Arts: Implications for Understanding

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"Art" is attractive communications signaling affordances for behaviour tethered to ecological conditions. Study of these communications is essential to understanding ecological psychology.
Certain of enumerable factors involved in this understanding are quantifiable and testable. More are currently edge hunches, intimations, intuitions, or speculations that might lead to greater comprehension. In their discussions taking place at Cornell University and in *Leonardo* half century ago, J.J. Gibson, Sir Ernst Gombrich and Rudolf Arnheim primarily attended to drawings and paintings, discussing objects oneself *here* perceives *there*. Concurrently there were early forays by artists producing momentary ecological interventions such as the 1969 Earth Art events. Art world attention was evolving from representation and reportage to direct involvement with ecosystems. Fifty years later there is a convergence of both habits of attention. Artist's creation of ecologically themed works provides an illuminating area for scientist's study and discussion. Yet the language that creative artists and art writers use to discuss environmental works continues to echo Cartesian presumptions about separated "Mind" and "Body" (despite their current attention to what is called "Neuro-Art History"). In contrast, language of ecological psychology or embodied cognition is determinedly integrated. It appears that developments evolving from and beyond the unified position so well articulated by Gibson have much to contribute to the understanding of the arts. Likewise, studies of works and of the processes of their creations from a strictly ecological perspective, whether landscape paintings or direct manipulation of ecosystems, can yield information of value to the conjunctive necessities of science, the arts and philosophy. What can we learn by walking further steps into understanding ecological perception? We could see art objects and viewers as conditions in a continuous ecological process. This would radically move us away from dualist notions of a self *here* perceiving an environment *out-there.* We could recognize that distinctive surfaces are permeable membranes with continuing synaptic connections, observable and measurable. Such awareness would shine light on our ancient desire to be at one with the universe. At this moment now, here, we are.

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Scale-Independent Aggression

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Using fractal analyses to study events allows us to capture the *scale-independence* of those events; that is, no matter at which level we study a phenomenon, we should get roughly the same results because events exhibit similar structure across scales. While fractal analysis has been performed on different types of events at different scales (e.g., Blau, Petrusz, & Carello, 2013), there has been—to our knowledge—no single study exploring a single type of event across all feasible temporal scales of human activity. The current research aims to fill this gap by exploring the fractal structure of aggression, a social phenomenon comprising events that span temporal scales from minutes of face-to-face arguments to centuries of international armed conflicts. Although any number of other social contexts should also exhibit fractal structure, we chose aggression because it is a measurable social phenomenon with powerful real-world consequences that are more likely to be recorded than events in other contexts (e.g., friendships, romantic relationships). We examined the temporal fractal structure of four scales of aggression: *wars* (very macro-level), *riots* (macro-level), *violent crimes* (micro-level), and *body movement during arguments* (very micro-level). For both wars and riots, we attempted to gather a comprehensive list of all recorded events between 499 BCE and 2013 CE using online historical sources. For violent crime, we collected temporal data for 1000 instances of violent crime from police records in one city or town in every state in the United States (which, depending on the city, spanned real-time windows of days to years). For body movements during arguments, we re-analyzed head movement data for dyads engaged in 8-minute argumentative conversations from Paxton and Dale (2017). We discuss our results as they contribute both to the literatures on events and social dynamics, exploring the scale-independence of human social events and the self-organization of human interaction.

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New synergies coordinate joint angles after target perturbation and during adaptation to visuomotor rotation.

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Synergies are defined as temporary task-specific units coordinating degrees of freedom to perform goal-directed actions. Within a synergy degrees of freedom co-vary, hence, one synergy allows performing a task in different ways. This is a prerequisite for adaptive behavior, however, previous studies of adaptive behaviors focused primarily on end-effector movements. We examined whether joint angles were coordinated in synergies during adaptive behavior in two experiments using a target switch and a visuomotor rotation paradigm, respectively. We asked 1) if joint angles were coordinated in synergies, 2) whether joint angles were coordinated in a different synergy, than the synergy used to reach a target in the unperturbed or non-rotation situation, based on the location the synergy occupies in joint space, 3a) which was adjusted first, synergies or end-effector trajectory, in the target switch experiment, 3b) whether adaptations in synergies were as gradual as adaptations in end-effector trajectory in the visuomotor adaptation study. In the target switch experiment, participants (N=12) performed manual reaching movements toward a stationary target on a table where in some trials the target could unexpectedly switch to a new location. In the visuomotor adaptation experiment, participants (N=12) performed manual reaching movements where in baseline trials end-effector's movement direction corresponded to movement direction of a cursor on a screen, while in the adaptation trials cursor movement was rotated 45o in counter-clockwise direction compared to end-effector movement. In both experiments, joint angles primarily covaried, indicating synergistic coordination. A new synergy emerged after the target switch and during the adaptation to the visuomotor rotation, because joint angle configurations occupied different locations in joint space than in unperturbed and non-rotation trials. In the target switch experiment, order of first adjustment was flexible between synergies and end-effector within participants, though most often synergies were adjusted first. During the visuomotor adaptation, adjustments in the synergy occurred much faster than the adaptations in end-effector trajectory. In the discussion we argue that these findings support the two-step framework of Kay (1988), where in one step DOF are coordinated in a synergy, based on self-organization, and in the other step this synergy is confined to produce end-effector movement.

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Increasing task difficulty during practice is not beneficial for motor skill retention
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The optimal challenge point framework states that there is an optimal level of task difficulty that maximizes motor learning. According to this framework, task difficulty is not only influenced by the difficulty of the task itself, but also by the skill level of the individual performing the task. Because the level of a motor skill widely varies between people, it is conceivable that variation in skill affects motor learning outcomes on a group level. Therefore, the aim of the current study was to determine the effects of task difficulty on motor skill acquisition and retention, while controlling for individual skill level. We hypothesized that the difficulty of the task acts as a constraint for motor learning. When the performance requirements are reduced, the demands for task problem-solving diminishes and the available information for learning reduces, thereby reducing the amount of improvement with practice.
Healthy young participants (N=14) were trained to a similar skill level on a mirror star tracing task, after which they were randomly assigned to learn with either an easier (Easy group) or a more difficult (Hard group) task. The difficulty was defined by the width of the wall of the star and motor performance was measured in terms of speed and accuracy.
The results of this pilot study indicate that increasing the performance requirements during practice is not more beneficial for motor learning, since both groups improved to the same amount. This novel results are against our hypothesis, not in line with the challenge point framework, and are also in conflict with prior research emphasizing the benefit of enhanced task difficulty on motor learning. If confirmed, this preliminary results have important implications for learning a sports skill or re-learning a motor skill impaired by medical conditions such as stroke.

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Robotic Models of Obstacle Avoidance in Bats: Assessing the Benefit of Acoustic Gaze Scanning in Complex Environments
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Echolocating bats avoid obstacles in complete darkness by relying on their sonar system. Under experimental conditions, these animals can infer the 3D position of obstacles. However, in cluttered and complex environments their ability to locate obstacles is likely to be largely reduced, and they might need to rely on more robust cues that do not degrade as the complexity of the environment increases. Recently, we have simulated modeling prey capture by echolocating bats. These simulations incorporated a Delayed Linear Adaptive Law (DLAL), which has been documented in bats while hunting prey: the bat's flight direction follows its gaze direction with a delay. Rigidly coupling the head and body reduced prey capture success. Here, we present a robotic model of obstacle avoidance in bats. We implement two obstacle avoidance strategies based on interaural level differences: a Gaze Scanning Strategy (utilizing the DLAL) and a Fixed Head Strategy. This allows us to test whether the acoustic gaze scanning observed in hunting bats might also be beneficial to bats trying to avoid obstacles. Both strategies were successful at avoiding obstacles in cluttered environments. However, the Fixed Head Strategy performed better. This is likely due to the Gaze Scanning Strategy's tendency to look away from the direction of motion, as well as due to the delay it introduces. As acoustic gaze scanning might reduce obstacle avoidance performance, we conclude that strategies based on gaze scanning should be avoided when the bat is unable acquire spatial information and locate individual obstacles.

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Exploring age-related differences in the speed of recalibration after disturbing action capabilities in stepping tasks
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Recalibration, which is the rescaling of the perceptual-motor system to informational variables, has previously been measured using judgements. However practical significance would be greater if studies could incorporate kinematic measures to measure everyday activities. In two experiments, we investigated the speed of recalibration in young and older adults after disturbances to their action capabilities. Participants wore ankle weights that disturbed their action capabilities and were asked to climb a 2-step staircase (Exp. 1) or step over an obstacle (Exp. 2). Ankle weights were scaled to participants' leg extensor strength. Participants' movements were tracked with a motion capture system and several kinematic variables were analysed. For each kinematic variable, we first fitted a

piecewise regression over all trials for each group and condition to find the breakpoint. Next, we fitted two regressions to the individual data using that breakpoint. The two slopes of rearrangement were submitted to an ANOVA with Time, Disturbance type, and Group. Preliminary results were similar for both experiments. A significant effect of time on toe clearance indicated that recalibration took place as the initial and final rearrangement slopes were significantly different. The breakpoints showed that the older group took about 7 trials to recalibrate while the young group took only 4 trials. However, there was no significant effect of age on recalibration, as initial and final rearrangement slopes were similar for both groups. There was also no significant effect of disturbance type. We will discuss the results of both experiments in terms of what they mean for the concept and mechanisms of recalibration.

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Information-based control of steering to static targets and avoiding static obstacles

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The literature suggests that navigating to a static target is accomplished by nulling the target-heading angle (THA, i.e., target eccentricity with respect to the agent's current heading direction), whereas intercepting a moving target is accomplished by nulling the rate of change in the target's bearing angle (BA, i.e., target eccentricity at current agent position with respect to an environment-based reference direction).
Fajen and Warren (2003) demonstrated that walking towards static targets and avoiding static obstacles, positioned at different distances and eccentricities was adequately captured by a model of the behavioral dynamics incorporating not only THA but also target/obstacle distance as informational variables. Walking to intercept rectilinearly moving targets, however, could not be captured by such a THA-based model and required incorporating dBA/dt instead as informational variable (Fajen & Warren, 2007). Most relevant here, they noted that the dBA/dt-nulling model was also capable of capturing the behavior observed in 2003, when walking to static targets. Nevertheless, for several (to be discussed) reasons they suggested that two different strategies were at work in navigation (static target) and interception (moving target).
Using a different VR-based mountain-bike steering task, we replicated Fajen and Warren's (2003) protocol for navigating towards static targets and avoiding static obstacles. We obtained remarkably similar experimental results. A model based on nulling THA and incorporating a distance-dependent stiffness adequately explained the observed behavior. Moreover, a model based on nulling dBA/dt performed as well.
In this contribution we will discuss whether the differences between nulling THA and nulling dBA/dt are mathematically consistent and whether the experimental evidence necessarily leads to the conclusion of two different strategies.

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The Effect of Bi-and Three-Dimensional Cues, Grouping, Luminosity, and Object Shape in the Emergence of Insight: A performance and eye tracking analysis

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Cognitive and ecological models were contrasted to explain the solution of insight problems,. Because of this, the study focused on how the perceptual properties of an object and its environment interact to facilitate the phenomenon of insight.
Undergraduate students (n = 64) solved the 8-coin problem, using eight circular black plastic objects called 'coins.' These coins were placed on a glass platform that could be on or off. The central surface of the platform was divided into 36 cells of equal size. The coins were distributed one next to the other, without separation (grouped), or with a space between them (ungrouped). In addition, the coins were placed on the flat surface (2D cues) or one of the coins was placed upon another coin (3D cues). Because the coins could be presented entirely or with a hole in the center, and the platform could be on or off, 16 experimental conditions were generated. For each participant, the eye fixations on the 36 cells, into which the surface was divided, were recorded (Tobii Eye-Tracker-X2-60Hz).
Based on a performance analysis, dimensionality and grouping effects were detected for each perceptual property as main effects or as a result of their interaction. In terms of luminosity and coin shape, no significant effects were detected either as main effects or interaction.
Fixation times between those who achieved and did not achieve the insight were analyzed. With grouped coins and 3D cues, fixation times of participants who achieved the insight were smaller in cells located at the center of the

platform. With ungrouped coins and 2D cues, participants who achieved the insight had more fixation time on cells located at the upper edge of the platform. With grouped coins and 2D cues, no differences were found. With ungrouped coins and 3D cues, all participants achieved the insight.
The results indicate that only some perceptual properties are relevant in the emergence of insight. Meanwhile, insight was observed in conditions where these properties are attenuated. Based on these results, we discuss that there is an additional process to the interaction between perceptual properties to explain how insight emerges.

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Nest-ed Affordances
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The Western honeybee, *Apis mellifera*, is a remarkable social insect. They exhibit individual and collective dynamics, creating emergent group behaviors as the result of simple rules governing their actions. One collective-driven phenomenon—swarming—involves individual perceptual exploration on behalf of an entire collective. In late spring, an explosion of honeybee propagation produces overpacked hives, causing half of the colony to uproot and leave with the queen. This “swarm” temporarily relocates to a branch near the original colony. Scout bees are sent out in search of suitable locations and return to “advertise” candidate locations through vigorous dances, beginning a drawn-out competition between sites. However, important questions remain unsettled within the honeybee literature: What defines “suitable,” what information specifies a site as “live-in-able,” and how do individual bees perceive that affordance for their entire colony?

Previous research from the biological literature has identified numerous potential factors influencing nest-site selection, including preferences toward locations higher from the ground, with high exposure and visibility, entrances toward the top of the cavity facing southward, and volumes of approximately 40 liters (Seeley & Morse, 1978). Previous work suggests that *motor* exploration—rather than simply *visual* exploration—during numerous brief inspections may be the primary action used for perception of cavity volume (Seeley, 1977). When considering the natural environment of this invertebrate, illumination of nest cavities is rare, and thus visual information is unlikely to be a primary mode of volume perception. Thus, it is still unclear how this seemingly random walking exploration is used in the determination of cavity size, especially given the vast size difference between the scout bee and her colony.

This honeybee phenomenon neatly encompasses multiple questions of interest to ecological psychology: the problems of body-scaled affordance perception, nested affordances, and perception of affordances for others. An ecological approach would help identify *what* information to which scout bees are attuning—and *how* they are doing so—when determining the viability of a location. To that end, ecological psychology will not only help in the explanation of this phenomenon but will benefit from its fundamental underpinning as nested affordances for collective groups.

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Manipulating constraints in motor interventions with young children
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The promotion of contexts conducive to the acquisition and development of motor skills based on non-linear Pedagogy (NP) and the application of the Constraint-Based Approach (CLA) has been evidenced in the literature (e.g. Chow et. al., 2006; Renshaw et al., 2010; Correia et. al., 2018). However, there are still few studies that empirically demonstrate the importance and impact of adopting the principles of NP and CLA in intervention in pre-school physical education. Considering that in the light of this approach behaviour emerges from the interaction of three categories of constraints: individual, task and environment. This communication aims to present a set of preliminary studies that sought to verify the influence of the manipulation of each of these constraints on the behaviour of children preschool age. Considering age an individual constraint, in one of the studies we compared the behaviour of two groups of children of different ages in the same context of free motor exploration. Focused on manipulating task constraints, we sought to verify the effect of instruction and demonstration episodes on exploratory behaviour in terms of manipulative motor skills. Finally, with regard to the manipulation of environmental constraints, we had as main objective to identify the possibilities of action, in terms of the fundamental motor skills (FMS), of a typical recreational space of a kindergarten and then manipulate this environment in order to promote the performance of FMS in deficit. Only pre-school children participated in these studies. The results pointed to differences in motor exploration as a function of age, reinforced the importance of adequate manipulation of instruction and demonstration, and the interaction of these constraints with environmental constraints (e.g., space of action) and individual constraints (e.g., age) and denounced the underutilization of recreational spaces in terms of

opportunities for motor stimulation. These studies illustrate the role of teachers / educators as attentive designers and facilitators of environments that promote the acquisition and development of adaptive motor skills in children.

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Can changing distances shape pre-schoolers' jump affordances?

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The constraints-led approach proposes that teachers can manipulate constraints in their learning designs, to promote adaptive behaviours to emerge from children during class activities. Through the manipulation of constraints, children are confronted with problems to solve, leading them to explore and adapt their actions to achieve task goals. Importantly, specific manipulations of constraints may afford or *invite* certain movements and delimit or inhibit others. For example, if an educator seeks to promote opportunities for children to explore jumping actions, the learning design in the lesson could task the form of a “stepping stones’ game” in which children are challenged to find a way to move from one space to another using imaginary stones (stimulated by physical reference marks on the floor). The distance between these reference points (imagined to be stones) must be adapted to each child’s current capacities and skills in order to invite adapted jumping actions. This communication will address effects of manipulating distances between reference points on pre-schoolers’ opportunities to jump (affordances). Twenty pre-schoolers were challenged to move from one space to another in a room, transitioning between squares (30x30 cm) drawn on the floor. The distance between these squares was systematically manipulated in increasing and decreasing sequences to test the influence of these task conditions on emergent behaviours of children. Prior to each trial, children were asked to share their goals for the task, i.e. whether their intentions are “to jump with two feet’ or ‘hop on one leg’. Children’s behaviours were video recorded and observed actions categorized as: i) jump with two feet, or iii), hop on one leg. This is an on-going research study and data are under analysis. Results will provide insights on effects of task constraints manipulations, helping teachers to understand how they shape the emergent behaviours of children during learning.

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Detecting invariants in probabilistic environments by means of tactile exploration

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Individuals isolate invariants from variants of the environment by means of exploration. In this sense, when the environment is more irregular individuals will show more exploratory movements. We evaluated this assumption in a tactile task. Participants had to find with their index finger a target object (a marble) that was inside of one of two vertically aligned small tubes. Both tubes were located at the left part of a square board; another two tubes were located at the right part of the board. After finding the object in the left tube, participants had to predict in which of the two right tubes was the target object. The target’s location at the right side was horizontally or diagonally aligned with respect to that of the left side. In Experiment 1, the relation between the left and right locations of the target (horizontal or diagonal) was based on probabilities 1.0, 0.9 and 0.8. In the first half of the experimental session, participants were exposed to the horizontal alignment and then, in the second half, the alignment changed to diagonal, or *vice versa*. In Experiment 2, in the first half of the experiment participants were exposed to a condition in which there was not relation between the left and right locations of the target (p= 0.5). Then in the second half they were exposed to probabilities 1.0, 0.9 and 0.8, with horizontal or diagonal alignments. Results showed that as the value of probability decreased (i.e., the environment was more irregular) participants showed more exploratory behaviors. More exploratory movements were also reported when the locations of the target were diagonally than horizontally aligned. These results suggest that participants extracted the invariants of the task by means of tactile exploration.

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Rowing together: synchronisation vs. syncopation

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Crew rowing is often quoted as the natural example of perfect unity. A crew of rowers aims to optimize performance by perfectly moving in synchrony, while they apply all their power at maximum stroke rate. But do they necessarily need to move in in-phase synchrony? Alternatively, crew members may complement each other's movements by rowing in syncopation (i.e., perfectly alternating their strokes: antiphase rowing). By rowing in antiphase, a crew can reduce velocity fluctuations of the boat, which theoretically implies decreased hydrodynamic drag and, most importantly, potentially result in faster race times (Brearly et al., 1998). Laboratory studies already showed that this unconventional crew technique is not difficult to perform and maintain in a stable manner (Cuijpers et al., 2015; 2019; De Brouwer et al., 2013) and suggest that potential hydrodynamic benefits increase for higher racing paces (Cuijpers et al., 2015; De Brouwer et al., 2013). The next step is to verify these results on the water, where other aspects enter the equation (e.g., on the water the rowers need to handle oars while the boat moves through the water, whereas in the lab their pull at their individual flywheels).
The aim of this experiment was to test whether rowers, who never rowed in the antiphase pattern before, would be able to do so on the water. Furthermore, we studied the effect of rowing in antiphase on movements of the boat and racing time. Nine pairs of experienced rowers rowed four 1000 *m* trials in in- and antiphase at 20 and 30 strokes per minute (*spm*). Although the new antiphase pattern was performed less stably than the in-phase pattern, antiphase was more stable at 30 than at 20 *spm*. The confirmed drastic reduction in velocity fluctuations of the boat by rowing in antiphase was indeed even more pronounced at 30 *spm*, which concords with the findings from the lab. Given the potency to improve antiphase rowing through practice and optimization of the design of the boat, these results provide a promising first indication of the benefits of antiphase rowing on water.

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Coordination Dynamics of Coupled Dissipative Structures

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Inter- and intrapersonal coordination can be understood as the result of dynamically unfolding self-organizing processes, wherein behavioral and task constraints are mutually satisfied (Jirsa, 2004). Dissipative structures are a foundational example of such a self-organized dynamical process. These spontaneously ordered systems are driven by flows of energy and matter. Organisms are a type of dissipative structure, whose self-organized behaviors are owed in part to thermodynamic contingencies (Kondepudi, 2012). Understanding the behaviors of organisms qua self-organizing systems will be aided by a thorough investigation of the behavioral properties of dissipative structures.
To this end, we investigate the coordinative behavior of coupled dissipative structures. Our system consists of beads immersed in oil and subject to a high voltage. The electrical field causes the beads to become dipoles, and ultimately self-organize into branching tree-like structures. The trees demonstrate a tendency towards states of increased current, which in turn increases the stability of the trees. Given this self-maintaining behavior, we consider these trees to be rudimentarily end-directed. The trees are coupled through a shared distribution of charges on the oil surface, and thus are mutually constrained. Previous research (Davis et al., 2016) has provided evidence that these trees are coupled at the system-level to increase the rate of entropy production.
We expand on these earlier observations of the coordinative behaviors of a two-tree system through new experiments and measures. Additionally, observations made in the electrical system are compared against the predictions from a dynamical systems model of the electrodynamics at work. Together, we show that the trees are coupled through the electrical field that both drives their behavior and is simultaneously changed by their behavior. Both the individual trees and the system as a whole work to maximize the rate of entropy production. The result is a coordinative dynamics that is similar to that exhibited by living systems under some conditions. A physically grounded account of end-directed coordination may provide the underpinnings for a generalized theory of intra- and interpersonal coordination.

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Team up! How children move and speak when they work together

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When two people collaborate, their body movements and speech coordinate and synchronize. In other words, the dyad becomes a coupled social system. Although the general consensus was *more-is-better* when it comes to coupling strength and synchronization, recent studies show that it is functional to modulate the degree of coupling, and that this modulation reflects task specific affordances. In other words, there is a tension between strong and weak coupling between individuals in a dyadic task, whereby both seem to be jointly related to better performance. Interestingly, within individuals, such a tension between strong and weak coupling is also evident when it comes to gestures and speech. A person's gestures and speech are tightly coupled. However, when individuals learn, their gestures and speech decouple, which is related to better subsequent performance. Specifically, the transition to a more advanced cognitive insight goes along with so-called gesture-speech mismatches. In the current study, we investigated how children's gestures, speech, and head movements are coupled when they collaborate during a dyadic balance scale task. We collected data at the Connecticut Science Center. We tracked children's hand movements and head movements, recorded their speech, and video-recorded their interaction. We were specifically interested in the dynamics of coupling and uncoupling of gestures, speech, and head movements between the two children when they interact and learn from each other. to this end, we analyzed how their gestures, speech, and head movements synchronize on multiple scales and whether we could detect leader-follower patterns. Furthermore, we investigated how this multiscale synchronization is related to the dyad's task performance. This presentation will provide an overview of methods, analyses, and preliminary results. We will showcase an innovative project that focusses on how children collaborate and attune their behavior, which provides new insight in how children learn from each other.

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Optical and Gravito-Inertial invariants are used to perceive and control altitude above ground: the case of rotorcraft piloting

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The ability to control movement in rich and changing environments is one of the most important perceptual–motor skills humans possess. When walking, driving, or flying we must control our direction in a manner that will allow us to reach our goal while avoiding collisions with obstacles. In the present study, we consider a specific example of this ability: rotorcraft piloting, in particular how pilots regulate altitude. Of all of the perceptual–motor tasks performed by rotorcraft pilots, altitude maintaining in low-altitude flight (i.e., LAF) is one of the most demanding perceptive and cognitive tasks pilots have to perform. They have to maintain an altitude as low as possible while travelling at a maximum speed. A minimum requirement for successful LAF is that the pilot be able to keep the rotorcraft's altitude near a specified value. Flying too high can lead to radar detection whereas flying too low can lead to ground contact (Gray et al., 2008).
Previous research on altitude maintenance in LAF has focused either on optical cues provided by 2D features in the visual scene (e.g., splay angle: Flach et al., 1992) or on optical cues provided by the presence of 3D objects (e.g., object size: Kleiss and Hubbard, 1993 ; objects density: Winterbottom et al., 2001 ; occlusion: Gray et al, 2008). However, little is known about the relative importance of 2D or 3D cues relative to, in combination with, other information such as gravito-inertial invariants involved in altitude maintenance: how pilots go about making use of this information?
Two experiments of LAF and in various optical and gravito-inertial conditions were realized on the IMose simulator (EuroMov, University of Montpellier) with the cooperation of 13 naïve participants. The task consisted in estimating (experiment 1) or maintaining (experiment 2) an altitude of reference, in a series of LAF above a hilly terrain. The results indicate that the amplitude of the perturbation is better perceived when the motion cabin is combined to the optical cues especially when it is negative and occurs in good visibility conditions. Results are discussed in light of the global array (supra-additive) theory.

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Cognitive dynamics of discovery: insight from the Soma Cube
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Humans have a profound ability to solve problems. Everyday we organize our activity into sequences that allow us to accomplish simple immediate tasks, like getting ready for work, to more distant ill-defined tasks, like obtain a pay raise. From a traditional cognitive perspective, actions merely execute the structure provided by the cognitive system. However, this traditional approach to cognition was conceived without consideration of how we come to be able to organize activity to a problem or even how the simplest action is coordinated. The current research attempts to bridge this gap by asking: How we discover solutions, new understandings and organizations of behavior through our own activity.
We use a model task, the Soma Cube, to explore the dynamics of discovery. The Soma Cube consists of 7 uniquely shaped pieces that can be assembled into a 3x3 cube. What is important is that there are many solutions (480 distinct solutions) to the puzzle but none of the solutions are obvious and every solution requires multiple steps to complete. Solving the cube requires apprehending a set of abstract spatial relationships. The only means of acquiring this understanding is through assembling and disassembling the pieces of the puzzle. Eye and hand movements were tracked as participants made multiple attempts over a 45-minute period. In one condition, participants were instructed to try and find as many ways to assemble the pieces into a cube as possible. In the other condition, participants were instructed to freely assemble the pieces.
In the cube task, most participants readily found multiple different solutions and there was no significant difference in the total number of manipulations of solvers and non-solvers. In the free task, participants rarely discovered the cube and instead explored different types of affordances between the pieces. Through assembling and disassembling the pieces, participants in the cube task were able to discover solutions and learn to recognize paths to solutions. This finding supports the contemporary approach to cognition that posits that cognition may just be the operation of a complex system of non-cognitive processes.

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Intentional dynamics in automated vehicle driving: time to kiss the mistress of teology in public
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The goal of this poster is to illustrate how the introduction of automation into classical perception-action paradigms forces researchers to focus on the issue of actor intentionality. In perception-action research, driving an automobile is a prolific research paradigm and has advanced our knowledge on human locomotion (Fajen, 2005; Gibson & Crooks, 1938; Harrison, Turvey, & Frank, 2016; Mathieu, Bootsma, Berthelon, & Montagne, 2017). However, it has ignored the driver's intentionality by opting for scenarios in which a particular intention is assumed (Jacobs & Michaels, 2007), e.g. braking toward an object. Indeed, as Jacobs and Michaels (2007, p. 7) point out: "assuming a particular intention is required to define and identify specifying variables". However, the deficiencies of this axiom might become evident as automation is introduced into the classic automobile-driving research. As opposed to the manual driver of an automobile, who can plausibly be assumed to have the intention of driving safely, the intention of a 'driver' of an conditionally automated vehicle may arguably be to engage in a non-driving-related-task. Consequentially – as intentions define task situations – the specifying variables relevant to the driver's actions may shift from ambient optic flow to signals on their smartphone. But here comes the challenge: In the next level of vehicle automation (c.f. SAE Level 3, conditional vehicle automation), the driver will engage in non-driving related tasks while remaining in stand by for taking back manual control at a reasonably short notice (SAE, 2014). Therefore we cannot axiomatically assume an intention of the driver to either text or remain attuned to ambient optical flow. From a perception-action account it is inevitable to understand the intentional dynamics of the driver in the animal-environment system (Shaw & Kinsella-Shaw, 1988; Kelso, 1995) – or as biologist Haldane points out "teology is like a mistress (…), you can't live without her but you don't want to be seen with her in public" (cited in Kelso, 1995, p. 138). The time has come to kiss the mistress in public.

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Occluded but not hidden: Learning to interact with complex dynamics with causal depth
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The (re)learning of motor skills relevant to real environments should emphasize the ability to anticipate complex dynamics. Competing theories emphasize internal forward models or anticipatory dynamics. While internal models are meant for learning problems, it less known how anticipatory dynamics handles novel task spaces. To construct a paradigm that can serve as common grounds for theoretical comparisons and also as a relevant model of interaction with complex unstable objects, we tested if participants could stabilize or learn to stabilize a chaotic system with hidden dimensions. Formally, this is a chaos control problem. Three groups practised an auditory-motor synchronization task by matching their sonified hand movements to one of three sonified tutors. In the first group (interactive unpredictable, IU), participants learned to entrain the dynamics of a chaotic system through their movements. They only controlled and received feedback from one of the three dimensions of the system. This could be framed as a problem of modelling hidden causal dynamics or interacting with occluded but not hidden non-linear task space. A second condition consisted of a stimulus that was a predictable sine wave (non-interactive predictable, NIP). The third condition resembled the first but coupling was one-directional master-slave (non-interactive unpredictable, NIU). Importantly, this instantiated the conditions for strong anticipation. Only in IU did all measures of performance increase with practice: synchronization (cross-correlation), dynamic similarity (convergence of maximum Lyapunov exponents), and causal interaction (transfer entropy both ways). The pre-post comparison of performance with different stimuli exhibited most improvement in IU. No learning and generalization was observed in NIU and, in fact, performance was surprising low. Some learning and generalization was seen in NIP. Learning to entrain a chaotic system with two hidden dimensions is feasible provided that the participant is afforded causal interaction with the system. This implies that the strong anticipation account needs to include interaction and learning through parameter dynamics, otherwise it fails to provide an alternative to internal models. Additionally, the paradigm confirms the role of variability in optimizing skill acquisition in practical circumstances.

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Influence of the amplitude of the finger force on loudness discrimination acuity of self-generated sound
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The ability in auditory perception can be improved through the training with self-generated sound. Although this has been investigated in tone perception, particularly as off-line processing, the mechanism for loudness perception is still unknown. Loudness perception of the sound generated by motor execution may change depending on the magnitude of the motor execution through auditory-motor interaction. This can be expected from our daily experience that a stronger stroke produces a louder sound in tapping on the desk, piano playing and so on. We here focus on on-line processing of loudness perception for the self-generated sound. The study aims to examine whether the perceptual bias and accuracy in loudness perception are modulated depending on the amplitude of the produced force in finger movement.
Participants discriminated a difference in loudness between two stimulus sounds presented sequentially. The first sound was produced in conjunction with the force generation task by vertical movement of the finger. We set three force target (1N, 2N, and 4N) and this can be achieved with visual feedback. The second sound followed 1000 ms after without any movement production. The sound pressure level of the first sound was always the same, and the sound pressure level of the second sound was varied. We also tested the condition that the loudness discrimination task without finger movement (Non-Motor condition) as a control.
Point of Subjective Equality (PSE) and Just Noticeable Difference (JND) were compared by two-way ANOVA with motor factor (Motor / Non-Motor) and force as within-subject factors. JND in Motor condition was significantly smaller than the one in Non-Motor condition, indicating that the acuity of loudness perception can be improved by generating the sound in conjunction with the motor execution. Multiple comparisons showed that JND was significantly increased when finger force strength was large. We did not find any significant differences in PSE. The results suggest that the control of small force in the movement may be important for more precise acuity of loudness discrimination on self-generated sound. Auditory-motor interaction may contribute to loudness discrimination in on-line processing.

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Social Development: Evaluating Relationships across Developmental Domains in Typical and Atypical Development

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Social interactions are dynamic and involve coordination of physical actions and social communication. These interactions depend on task and situational factors that change from moment to moment, requiring perceptual attunement to relevant information to successfully guide action. Systems approaches of development are at the forefront of developmental science and recognize the multiple components that drive development and relate mutually as well as reciprocally across multiple time scales. As a consequence, research is needed that explores relationships among developmental domains in order to better understand patterns of typical and atypical development. In Study 1, we conducted stepwise regressions between interpersonal synchrony, rhythmic action capabilities (as measured through in-phase and anti-phase drumming), and mental health assessment of social communication in children with and without autism between 6 and 10 years of age, Interpersonal synchrony was measured while performing two tasks—an interpersonal hand-clapping task that required interacting directly with a partner and an interpersonal imitation task which requiring imitating a simple motor tapping sequence in synchrony with a partner. We found that in children with autism, age was a significant predictor of interpersonal synchrony. However, in children without autism, synchrony in interpersonal hand-clapping was predicted by social communication and age while in the interpersonal motor imitation task, synchrony was predicted by social communication only. These findings suggest that interpersonal synchrony likely continues to develop throughout childhood and is modulated by social skill. It also provides support for autism models that suggest children with autism have a slower developmental progression of social interaction and communication skills. Finally, it raises an interesting question of whether social synchrony interventions could improve synchronization abilities and in turn impact social communication abilities more generally. In Study 2, we explored the relationships between social communication and perception, action, cognition, and emotion in typically developing children. Preliminary results show that social communication was related to perception, action, cognition, and emotion measures. Conversational skill was positively correlated with age but negatively correlated with one cognitive and one action measure. Taken together, these results suggest that a comprehensive approach to monitoring behaviors across multiple domains is important for all children.

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Representing reality: Investigating the perception-action couplings of expert football goalkeepers under representative performance constraints

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Representative Design has become a frequently used term across sport science (Pinder et al. 2011). Brunswiks original assertion that there “is little technical basis for telling whether a given experiment is an ecological normal, located in the midst of a crowd of natural instances, or whether it is more like a bearded lady at the fringes of reality” (Brunswik, 1955, p.204) led towards a key concept, representation design. Brunswik (1955, p.198) proposed that researchers “must resist the temptation {. . .} to interfere” with the environment and “instead strive to retain its natural causal texture in the stimuli presented to participants” (Dhami et al, 2004 p.962).
In football goalkeeping, early work on expertise used a penalty kick task in in-situ and digital environments (See Savelsbergh et al. 2002). Whilst the findings are interesting, it is worth proceeding with caution and attention should be turned towards creating representative experiments that are reflective of the environment the individual inhabits. This study attempted to show differences in perceptual behaviours between a traditional task, and a representative task. In a professional football case study, 4 goalkeepers took part in both conditions over a season. Using the Quiet Eye(QE) (Vickers, 1996) as the perceptual mechanism for analysis, eye behaviours were recorded via an SMI-ETG mobile device, and coded with a Vision-In-Action system.
QE duration was significantly longer (t_2=2.66,P≤0.05) in Penalty trial (PT) than in the Representative trial (RT) (50.75%±2.84% v 45.57%±0.93%). QE onset occurred significantly (t_2=4.75,P<0.05) earlier in PT than in RT (21.13%±4.21% v 36.38%±4.30%). Significant differences were observed (t_2=3.36,P≤0.05) in QE offset, with PT occurring earlier than in RT (73.48%±1.58% v 82.40%±3.79%). In PT, a significantly greater (t_2=3.27,P≤ 0.05) number of fixations occurred at the ball (6.75f±2.22) than the visual pivot (2.25f±1.26). However, in RT, there was no significant differences between mean number of fixations at the ball (7.75f±2.22) and visual pivot (6.25f±3.5).
Our findings here illustrate the task specificity of expertise. To try and provide an account of what expert performance looks like, coaches, practitioners and talent developers must be certain they are utilising environments that are reflective of where expert behaviours exist.

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Neural Resonance as a Source of Critical Fluctuations
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Prigogine wondered if a lawful account of the activities of a system with many degrees of freedom could be devised, even though such systems are prone to random fluctuations (Prigogine & Nicolis, 1971). His problem mirrors the issues raised by Gibson and Bernstein, and his strategy for addressing it has been adopted by some in ecological psychology. Prigogine argued for an ordering principle he called "*order through fluctuations*," where macroscopic laws govern the response of a system to fluctuations (*ibid,* p. 112). A system with a steady state driven by a disequilibrium will tend to dissipate fluctuations. If the disequilibrium is of critical magnitude, however, the dissipative forces maintaining the steady state are weakened, and the steady state itself is destabilized. A *critical fluctuation* is one that, rather than being damped, is amplified, forcing a reorganization of the system (possibly into another steady state). Over the last several decades, theorists in ecological psychology have offered that the organism is continuously maintained near a state of *multiple* criticality, poised to engage in any number of alternative actions when reorganization is forced by a critical fluctuation. In this talk, I will outline a proposal for how nervous systems might be involved in this process. The nervous system is made up of a variety of endogenously active elements which, because of the activity they generate, modulate the activities of one another. These activities are coordinated as coupled oscillations, nested over a variety of spatiotemporal scales. Among the numerous kinds of modulation taking place in nervous systems is *neural resonance*, where neurons respond to modulatory influences of the right frequency, the *resonant* or *preferred* frequency. The Gibsonian notion of information pickup involves spatiotemporally structured environmental interactions. As such, the temporal structure of information pickup makes it a candidate for an organism-environment level modulatory influence over the activities of the nervous system, the sort which elicits neural resonance. Under this proposition, neural resonance would amplify micro-level dynamics, generating a macro-level critical fluctuation and selecting between alternative poised states.
Prigogine, I., & Nicolis, G. (1971). Biological order, structure and instabilities. *Quarterly Reviews of Biophysics*, *4*(2-3), 107-148.

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Foreign Language Learners' Interaction with Google Translate - Affordances Lost and Found
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Google Translate and similar free online machine translation services are well-known to be frequently used by learners of foreign languages, albeit machine translation was not originally intended for language learning purposes. Despite the fact that we know that language learners frequently use these sites, and despite an increasing number of studies on how the use of machine translation affects different aspects of text quality and/or language complexity or accuracy, we still know fairly little in detail about how pupils use online translation sites. Data on language learners' digital translation strategies are frequently self-reported and often lack precision.
The presentation will give examples of findings from an ongoing study on the interaction with Google Translate among upper secondary school learners of Spanish as a foreign language. 31 upper secondary school pupils in Sweden (ages 17-18) were followed during one school-year as they wrote six essays, using laptops. 16 focus pupils had their laptop screens recorded, enabling a detailed analyses of writing behaviours, translation strategies and interaction with the *Google Translate* interface. In total, 50 hours of screen recordings have been analysed. Among the results can be seen an extensive use of *Google Translate*'s possibility to switch fast between languages, enabling multiple control translations to and from the target language, and a widespread use of reformulations written step by step directly in the translation box, making use of the site's possibility to see how translations change word by word.
The pupils' interactions with the online translation site are discussed from an affordance perspective, focussing on the possibilities afforded by the translation site, and on the pupils' abilities to choose among and make relevant use of these affordances. Implications for foreign language teaching in digitalised classroom settings will also be discussed.

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Embodied rhythm perception by resonant neural networks.
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How do we perceive rhythm? According to the standard approach, perceiving rhythm consists in extracting the relevant features of the stimulus' temporal structure such as beat and meter. Extracting such features from information implies forming internal abstract representations that may be encoded in some arbitrary neural form. Such encoding could then be fed onto a motor system to induce movement in synchrony with the external rhythm. If, on the other hand, the perceiver's response to the external rhythm consists in the generation, amplification, and sustainment of complex rhythmic patterns at the level of its neuronal firing oscillations, the question arises: what is the relationship between the internal pattern and the external pattern? When perception is "successful", the two patterns will be *synchronized*. Is this synchrony and correspondence enough to sustain a representational account of rhythmic perception?
In this talk we will argue that because of the way the perceiver's rhythmic patterns are generated—through self-organization and resonance—their synchronization with environmental patterns does not warrant a representational interpretation. Rather, the perceiver's responses are a case of *embodied directedness*. Embodied directedness is a form of intentionality different from representational aboutness in that the isomorphism between perceiver and environment is not as a case of encoding or modeling but a case of tuning behavioral potentialities.
Embodied directedness implies that the patterns amplified at the level of the perceiver abide by their own embodied dynamic principles and constraints and are only modulated by information about the external dynamics. We will show a model of sensorimotor auditory resonance and tuning that supports a view of rhythm perception (or perception rhythm) as a case of embodied directedness. When networks of oscillatory neural units constrained to influence each other through lateral connectivity are exposed to external rhythmic patterns, they come to synchronize with them through resonance. However, their dynamics remain autonomous as exemplified by the generation of structures that go beyond that of the stimulus.
Large, E. W., Herrera, J. A., & Velasco, M. J. (2015). Neural networks for beat perception in musical rhythm. *Frontiers in Systems Neuroscience*, 9, 159.

2

Does Restricting Observers' Arm Movements Degrade Their Judgments of Others' Reaching Affordances?
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Observers perceive others' affordances (e.g., Mark, 2007; Stoffregen et al., 1999; Ramenzoni et al. 2008a, 2008b). Most but not all of those studies supported that observers do so by attending to actor-environment relations. An exception was Ramenzoni et al. (2008b), who demonstrated that observers wearing ankle weights that encumbered their capabilities underestimated others' maximum jump-to-reach capabilities, which suggests that observers use their own abilities, i.e., observer-environment relations, to judge others' affordances.
The present study further investigated whether observers attend to observer-environment relations when perceiving others' maximum reach capabilities. Participants judged a confederate's maximum reach capability while their own arms were held either freely by their sides (unrestricted condition) or placed behind their back (restricted condition). Prior studies found that such arm restriction led to more erroneous judgments about one's own reaching capabilities, which suggests that people exhibit exploratory arm movements prior to judging their own reaching capabilities (Widlus & Jones, 2017). That result is consistent with a large body of literature that indicates restricting exploration degrades one's ability to accurately judge one's own affordances (e.g., Mark et al., 1999; Yu, Bardy, & Stoffregen, 2011).
If observers attend to observer-environment relations when judging the confederate's maximum reach capability, then 1) judgment error based on the confederate's capability would be greater in the restricted condition than in the unrestricted condition, 2) judgment error based on the observer's capabilities would be lesser than when based on the confederate's capability, and 3) judgment error based on the confederate's capability would positively correlate with the degree of dissimilarity between observers' and the confederate's capabilities.
The present results did not support any of those predictions, which suggests observers did not use information about their own abilities to judge the confederate's ability. The differences between the present results and those reported in Widlus and Jones (2017) suggest observers explore differently when judging their own or others' affordances. The co-specificity hypothesis states that intentions, exploratory movements, and information are uniquely related to one another (Turvey, 1988; 1990). Thus, exploration differences when observers judge their own or others' affordances suggest observers pick up different information in those two situations.

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Intrapersonal and interpersonal coordination linked through a dynamical systems perspective
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The principles of dynamics in coupled oscillators are reported in intrapersonal rhythmic movements, such as the coordination between different limbs (1) and interpersonal coordination, which different people synchronize their movements (2). However, these dynamical similarities have been addressed separately and the relation between intra- and interpersonal coordination is still unclear. Here, we examined whether one's ability to coordinate their own body (intrapersonal coordination) is correlated with their ability to coordinate with someone else (interpersonal coordination).
Eighteen participants performed a stepping task with their preferred frequency in three 30s trials. Next, they performed the task while watching pre-recorded videos of a confederate who was performing the same task with close or far frequency to each participant's preferred frequency (spontaneous setting). Finally, they did the task while they were explicitly asked to coordinate their limbs with the confederate's movements (intentional setting). Vicon motion capture was employed to record movements.
Results revealed a significant positive correlation ($r=0.59$ and $r=0.63$ for close and far frequency, respectively) between the variability of relative phase in intra- and interpersonal coordination in intentional setting. Indeed, those who had more variability in coordinating their own body showed more variability in coordinating their body with someone else. These results support studies showing that the same underlying rules govern our movements in intra- and interpersonal scales. Moreover, this could suggest that the ability of one to control their own body could be a potential marker of the interpersonal coordination performance, which can be proposed as a behavioral biomarker of some psychiatric disorders.

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Online organization of grip force control during continuous scaling of load force oscillations
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A recent study found that the grip force applied to maintain grasp of a hand-held object was controlled in differing fashions depending on the degree of variations in load force exerted by the object as it was oscillated. In particular, tightly synchronous grip force adjustments were observed in conditions where overall load force levels were greater and oscillations were more pronounced. Likewise, grip force adjustments were only intermittently coupled to load force in conditions where load force oscillations were diminished. The current study investigated the nature of the transition between these two behavioral modes by scaling the overall level and prominence of load force oscillations continuously in time. We observed smooth transitions between clear regimes of intermittent and continuous coordination, irrespective of the scaling direction, indicating that grip force control can fluidly reorganize as parameters affecting grasp (e.g., fluctuations in load force) change over time.

3

How does Jumping Spider get an affordance of passable ? - Experimental verification using small mobile robot -
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Jumping Spiders can move on tree branches without falling while avoiding obstacles. They are only about 5 mm in length and have small brains, thus it is considered that they do not have enough calculation ability to create a three-dimensional model of the environment and to plan a safety route. The way how Jumping Spiders get the passable route is still open question, and one possible explanation is to employ Affordance. It can be considered that Jumping Spiders move on only movable area based on Affordance instead of planning a route. Here, the question is how Jumping Spiders obtain the Affordance.

In this paper, we focus on the mechanism of the eyes of the Jumping Spiders, and we propose a hypothesis that the passable area in its view is directly obtained from the difference between two defocused images.

Each eye of the Jumping Spiders has two retinas at different distance from the lens. It means that two different defocused images can be obtained at the same time. The blur on the images depends on the distance between the objects and the eye. Thus, by just subtracting one image from the other, an area that is on the certain distance from the eye can be obtained, and this area directly means the passable area.

To verify this hypothesis, we develop a small mobile robot. This robot has two cameras with different focal length and a micro-computer. The micro-computer obtains the passable area by just comparing the two defocused images without creating three-dimensional model, and it controls the robot toward the passable area.

Experiments were conducted and we confirmed that the robot could move on a narrow board without falling while avoiding obstacles.

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Perceptual-motor learning in climbing: Relations between fluency and gaze entropy

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The aim of this study was to examine the relations between climbing fluency and gaze entropy during a learning protocol and transfer tasks. **Method:** Seven climbers followed a learning protocol (i.e., ten sessions composed of three ascents). Effects of practice were assessed through three test sessions (i.e., a pre-, a post and a retention test) each consisted in four routes: the control route climbed during the learning sessions and three transfer routes. The transfer routes differed on (1) the distance between handholds, (2) the handholds shape or (3) the handholds orientation. The geometric index of entropy and the relative gaze entropy were measured to assess respectively the climbers' fluency and the degree of spatial randomness of their gaze behavior. A 4 (Routes) x 3 (Sessions) repeated measures ANOVA and a Pearson product correlation were performed on these two variables. **Results:** Participants showed greater improvement of their geometric index of entropy between pre-test and post-test on the practice route compared to the routes where the handholds shape or orientation were modified. No improvement between pre-test and post-test was observed for the route with increased handholds distance. In the same vein, the gaze path was less random (i.e., the gaze transition from an area of interest to another was more predictable) during post-test compared to the pre-test. Moreover, the gaze path was less random on the control route compared to the transfer routes. A Pearson-product moment correlation revealed a significantly positive correlation between the two variables. Thus, the more organized the gaze path was, the smoother the hip trajectory. **Discussion:** Participants improved their fluency by developing their route-finding skill on the practiced route, and they more effectively transferred this skill to environment with new structural property (i.e., increased distances between handholds) than to environment with new functional properties (i.e., new handholds shape or orientation). Congruently, their gaze path became more organized after the learning sessions, suggesting that while participants learnt to better chain their actions on the routes, they also needed less exploration to discover the properties of the climbing route as they learnt to pick up relevant information.

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Multifractality of Postural Sway Affects Affordance Perception of Reachability in Virtual Reality

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Tasks such as walking, reaching, and standing require differing levels of postural stability. Postural equilibrium is necessary to perceive the location of objects (Lee, Pacheco, & Newell, 2018). This study compared affordance judgements of reachability across tasks that place different constraints on maintaining balance. Participants viewed a 3D virtual reality (VR) environment with a stimulus object (red ball) placed at different egocentric distances. Using a within-subjects design, participants were asked to make judgements on reachability while in a standard stance condition as well as two separate active balance conditions (yoga tree pose, and toe-to-heel pose). Feedback on accuracy was not provided, and participants were not allowed to attempt to reach. Response time, affordance judgments (reachable, not reachable), and head movements were recorded on each trial. Specifically, head movement time series were recorded by harnessing position data from the Oculus Rift VR goggles at 30Hz. Consistent with recent research on reaching ability (Weast & Proffitt, 2018), the reachability boundary occurred

around 120% of arm length, indicating overestimation of perceived reaching ability. Response times increased with distance, and were shortest for the most difficult yoga tree pose, suggesting that in order to maintain a difficult pose, participants responded more quickly. Head movement amplitude and total amount of movements increased with increases in balance demands. Surprisingly, the coefficient of variation was comparable in the two poses that had increased balance requirements, and was more extreme in a less constrained, ostensibly easier pose for the shortest and longest distances, indicating a pose by distance interaction. More complex descriptors of postural sway (i.e. multifractality) were more predictive of perception in more complex postural tasks, demonstrating that standard measures of central tendency do not suffice for describing the multiscale interactions of postural dynamics in functional tasks. The insights gathered from this study will provide a fuller understanding of the perception of affordances in everyday tasks such as reaching and grasping.

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Sequence Design 'Optical Dot System' for Bicycles

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The Sequence Design 'Optical Dot System' (ODS) has been developed to improve driving safety by controlling the sequential sight/ optic flow with the layouts of oval-shaped road markings (2006-). ODS has been experimented at 'Intelligent Transport System Center' laboratory of The University of Tokyo (2009, 2012, 2018), and field trial at the Gate Bridge in Kawasaki (2012). The achievement of the implementation on the site are, to 'Metropolitan Expressway'(MEX) in Saitama (2008, 2017) and to 'Usui Bypass: National road No.18' in Gumma(2019). The sustained effectiveness of ODS has been proven through the implementation in MEX since 2008.
However, in shared roads for pedestrian and the bicycle, the frequent occurrence of bicycle accidents involving pedestrians are the serious issues in Japan since the ownership rate of bicycle is one in 1.5 persons (2007), quite high, comparable level to the Netherlands and Germany. In order to address this problem, ODS was resized to be adopted for bicycles. In this research, we performed the subject experiment at an actual site on the bridge. With ten cyclists, running a downward grade in vertical alignment on a long bridge. The test road was composed of three different road marking sections: 'ODS/large', 'ODS/small', 'traversal line'. Additionally 'plain' as the criteria with no pattern. The results showed that the running speed on ODS sections were significantly decreased, while the 'traversal line' had no speed-control effect, as same as the case on 'Plain' section. When the test-subjects were instructed to run with one's appropriate speed, their speed were various by each of them. Contrary all of them were not aware of being controlled by ODS to the similar speed when they have ran the road with the sections with patterns. As a verification result, significant effectiveness of ODS was observed, controlling the bicycle's speeds naturally without any alert.
Keywords: Optic flow, Perceptual Design Approach, Driving Speed Control, Optical Dot System, Sequence Design.

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Effects of lower-limb laterality and stance asymmetry confirm an inter-leg metastable coordination dynamics during upright standing.

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Metastability refers to a property of dynamical systems with multiple coexisting weakly stable states to flexibly switch between those states. Metastability is conjectured to reflect an adaptive state of biological system organization and has been evidenced in various studies of both brain and behavior. This includes the coordination of neuromusculoskeletal degrees of freedom involved in maintaining upright stance. We hypothesized that the coordinated actions of the left and right legs during upright stance would exhibit the properties of a metastable coordination dynamics. We used cross-wavelet analyses to assess coordination between the centers of pressure under the left and right feet. The Haken-Kelso-Bunz (HKB) model provided a minimally complex model of the coordination dynamics of two coupled oscillatory subsystems. We used the HKB model to develop hypotheses regarding the form and stability of coordination patterns. Consistent with the predictions, we observed 1) coordination taking the form of metastable, transient epochs of stable phase relations, 2) preferences for in-phase and anti-phase coordination patterns, and 3) changes in pattern stability and phase leads associated with both biomechanical asymmetry (i.e. standing asymmetrically) and functional asymmetry (i.e. a functional preference for one leg). Furthermore, dynamic form and stability were mediated by the availability of visual information. Our findings confirm the existence of a metastable coordination dynamics associated with the task of maintaining upright stance. We discuss the implications of these finding for understanding the functional organization of the posture system, and we present an initial theory of postural control understood as a metastable dynamical system.

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REDISCOVERING HENRI BERGSON AND TIME DURATION

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Henri Bergson's debate with Albert Einstein on the theory of time in1922 was of great historical importance but no longer remembered by most. Bergson's definition of time always has duration and continuous flow. This perspective of time placed Bergson in direct opposition to Einstein's theory that an individual's point of view can be discrete, static and immobile without momentum or inertia. Although Einstein prevailed, it required a Special Theory of Relativity to explain how a viewpoint can be without motion or inertia. Bergson knew this perspective was false and in today's modern world of quantum superposition and quantum computing physical systems always have duration. Bergson framed this theory of time duration within the language of the analytic and intuition. He believed that the double characteristics of quantitative and qualitative or unity and multiplicity could be used to explain our perception-actions. This multiplicity of time scales embedded or nested within the whole is described in the Stanford Encyclopedia of Philosophy as qualitative multiplicities, where there is heterogeneity and no juxtaposition. Gibson's ecological model of perception and the writings of Robbins on Holographic Theory have complimented and reinforced Bergson's theory of duration where time not space creates the contexts of perception- action. A new 'neuro-ecological' theory by Northoff called the Spatial Temporal Theory of Task-Unrelated Thought (STTT) explains how consciousness requires spatiotemporal scaffolding and how 'rhythmic structures of the brain's internal state to the external events or objects' (ie musical piece) are a musical metaphor for world-body-brain dynamics. This new awareness of 'triple spatial expansion' and alignment of qualitative multiplicity of these time scales can be transformational in how individuals and communities perceive and act. Framing perception-actions within the duration of time is a paradigm shift for the way that medicine is practiced and communities are defined. In the words of Bergson, we feel humility through "a qualitative progress" which consists in a "transition from repugnance to fear, from fear to sympathy, and from sympathy itself to humility." Keywords: Theory of Time, Special Theory of Relativity, Bergson's Holographic Theory, Gibson's Ecological Model of Perception, Stephen Robbins, Georg Northoff, Spatial Temporal Theory of Task-Unrelated Thought, Spontaneous Brain, Affordances.

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A systematic review on anticipation training programs in sport

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Anticipation in sport is one of the most relevant factors with regard to performance. Research shows that experts outperform novices in the pick-up of information, in their response time, and gaze behavior. Training programs developed during the last 30 years show that anticipation can be improved in short periods of time of laboratory training. Despite the general interest in anticipation training, and several narrative reviews on the topic, there have been no systematic attempts to summarize the literature findings. The present work provides a systematic review of anticipation training programs in sport between 1990-2018. A database search was performed using PsycINFO, PsycARTICLES, SPORTDiscus, and Web of Science. Three groups of descriptors were used, joined by "AND" operators: a sport related term (Sport), anticipation related terms (Anticipation OR Perception OR Prediction OR Estimation OR Judgment), and training related terms (Learning OR Training OR Skill acquisition OR Perceptual training OR Visual-perceptual training OR Instruction OR Perceptual learning OR Perceptual-skill training). The final review included 40 studies. Data extracted from the studies was organized in three categories: design (quality assessment and sample), training (type of training), and dependent measurements (performance, retention, and transfer). The quality assessment revealed problems with the sampling in the sense that most of the research was done with students. From the total of 1655 participants that were analyzed, 1030 were novices, 413 were classified as medium skill, and 212 were experts. This indicates that most of the anticipation training studies addressed the early stages of learning. Of the studies, 67% and 28% used control and placebo groups, respectively. Video stimulation was used in 91% of the studies, although most of the authors claimed that there should be a movement toward more representative designs. Regarding performance, 68% of the studies reported improvements in the laboratory. Retention and transfer tests were performed in 32% and 25% of the studies, respectively. In these cases, 86% of the retention tests and 36% of the transfer tests revealed significant effects. These percentages indicate that improvements in the laboratory are often maintained over the time, but do not necessarily transfer to on field performance.

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PREDICTING RESILIENCE BREAKDOWNS IN DYADIC COORDINATION

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When performing in teams, individuals form a dynamical system and need to coordinate well with each other to ensure that they can constantly adapt to the changes in the task demands and the environment as they can severely perturb the functional state of the system. In the psychological literature, the return to the previous level of functioning following a perturbation, is called *resilience*. When a system loses resilience, it approaches tipping point, where a seemingly minor perturbation can cause an abrupt, negative shift in the system's (performative) state. In order to prevent such transitions, we need to identify what methods can detect early warning signals of resilience loss within systems. According to Hill, Den Hartigh, Meijer, De Jonge, and Van Yperen (2018), such warning signals can be derived from time-series data of a so-called collective variable that captures the system's ongoing dynamical interactions and thus reflecting its current state.

In the current study, the participants were instructed to perform a cooperative Fitts task using Nintendo Wii devices, while competing against normed scores. The dyads moved their cursors in an antiphase coordination pattern (opposite oscillation) on a large screen (2m x 1m, 1920 pixels x 1080 pixels) while aiming for static targets. During the task they were exposed to several preprogrammed perturbations (i.e., losing to predicted norm scores). While performing, the two-dimensional positioning data on the screen was measured with 100Hz. To map out the changes of the system's (i.e., the team) state over time, we applied a sliding window cross-recurrence quantification analysis to the positional data to determine the stability (i.e., determinism) and the complexity (i.e., entropy) of the systems behavior. Finally, we applied change point detection analysis to these running statistics of dyads that suffered a breakdown in performance to determine whether these measures indeed precede critical transitions. In this talk, we will present the outcome of these analyses, their implications, and their limitations in predicting breakdowns in resilience.

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Skill acquisition for playing Japanese cup and ball

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The purpose of this study was to investigate relationships between performance and movement in six healthy right-handed males (age: Mean (M)22.3 (Standard Deviation (SD)1.5) years) as they learned the skills needed to play Japanese cup and ball. Japanese cup and ball is played with a device consisting of a spike-shaped handle attached to a ball by a string and connected to three shallow cups (small, medium, and large). Participants were asked to catch the ball with the medium and large cups in a sequential and rhythmic manner. The movements of reflective markers pasted on the cup and ball and participants' bodies were sampled by an optical motion-tracking system at 500Hz. Participants performed one block (a 1-min performance test, a 5-min training, and a 1-min performance test) each day of the 7-day experiment.Each participant followed his own training regimen. These results were as follows: 1) The maximum number(Mx) of sequential catches on the last day (M40.0 (SD33.9)) was significantly higher than on the first day (M12.0 (SD18.5)) ($F(6,30)=3.82$, Mean Squared Error (MSe)=131.75, $p<.05$), and participants' performances improved as a function of the number of blocks(B) performed ($Mx=3.25B+11.62$). 2) The total number(T) of catches on the last day (M63.8 (SD31.4)) was significantly higher than on the first day (M25.0 (SD30.5)) ($F(6,30)=6.60$, MSe=132.18, $p<.05$), and participants performances improved as a function of the number of blocks(B) performed ($T=4.89B+24.90$). 3) The participant with the highest Mx and T scores stretched his knee when he tossed the ball and bent his knee when he caught the ball. 4) The angle of this participant's knee ranged from 130 to 160 degrees, and this participant controlled the cup and ball with his upper limbs while moving his upper body up and down. 5) The angle of the knee of the participant with the lowest scores ranged from 160 to 170 degrees, and this participant rarely moved his upper body up and down. These results suggest that players should control the cup and ball with their upper limbs and their whole bodies, using the self-organizing information systems underlying the perception-action coupling.

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Perceiving the maximum stand touching height when attaching sticks on upperlimb: Testing the position, weigth, and perceptual modality factors

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Individuals can act to perceive more information from the environment, and get the information about the possibility of their action as well. The main concern of this study is to test whether the weight of the sticks that are attached to different parts of the arm affects the standing reach height. In order to increase the rate of correct judgement, participants are offered by different opportunities for exploration (dynamic touch, visual information after dynamic touch, and dynamic touch with visual information). In experiment 1, we recruited 24 adults and assigned them to two groups randomly. The participants of the first group had to attach heavy sticks prior to light sticks, and they were attached light sticks prior to heavy sticks in the second group. In each group, participants had to attach different sticks to their upper arms, front arms, and the back of their palms. There were 4 trials in each condition, and 24 trials totally. There were 36 participants recruited for the second experiment. They were assigned to three practice groups randomly. The first one was a dynamic touch learning group, the second one was visual perception after dynamic touch learning group, and the last one was a dynamic touch with visual perception learning group. After practicing, they were assigned to judge the stand-reaching height with different sticks attached to upper arms, front arms, and back palms. We conclude that when the sticks were attached to the wrist, participants had the maximum perception of stand-reaching height, and when heavy sticks were attached, participants have a heigher perception of stand-reaching height then light sticks. The position of attached sticks didn't affect the perception of maximum stand-reaching height. In experiment 2, perceptual learning from different perceptual modalities didn't affect the maximum stand-reaching height when sticks were attached. When the sticks were attached to the wrist, individuals had the maxmium perception of stand-reaching height, and they had a higher perception of stand-reaching height when heavier sticks were attached. Learning with visual perception can cause more correct perception when the sticks were attached and asked to hold.

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Distance Perception in Water and Land Environments for People with Different Swimming Ability

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Introduction: Action-specific effects on perception suggest that people perceive their world depend on their ability to act. This effect has been found not only in terrestrial but also underwater environments. Underwater targets were judged closer by better swimmers compared to worse swimmers. In the swimming course, safety in waters is important as well as swimming skill. We concerned if students with better ability to swim would underestimate target distance on water surface. Thus, this study investigated the effect of swimming ability on distance perception of targets on water surface, and the difference of distance perception between water and land. **Methods:**Sixty college students were recruited as participants. They were different in swimming distance: (1) 14 participants without swimming ability (swimming 0 meter); (2) 16 participants can swim less than 10 meters; (3) 15 participants can swim more than 10 but less than 25 meters; (4) 15 participants can swim more than 25 meters. In the water session, participants stood in swimming pool and sat on the shore, judge the distance of five targets (5m, 12m, 19m, 26m, 35m) on the water surface. Judgements were made with oral report and matching distance. In land session, distance perception was made in athletic field. **Result:**For all distances, no significant differences were found among four swimming ability groups in distance perception of target on water surface or on land. Thus, action-specific effect is not found in our water environment study. Perhaps participants' swimming ability were equally poor so that they show no difference on distance perception in water environments. However, distance perception of two near targets (5m and 12m) on land is significantly shorter than those on water surface.

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Multimedia Mobile Devices and Obstacle Types Induced Action and Perception of Walking through Aperture

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Introduction: Walking through narrow space in the environment is a common situation of human movements. Maintained clear detecting ability is helpful for accurately perceiving the possibility of walking through aperture. However, while multimedia mobile devices bring convenience to daily life, it may negatively affect user's behavior

and safety due to inappropriate use. Based on ecological psychology approach, this study was designed to examine the impacts of the operations of mobile devices, obstacle types, distraction activities, and cognitive load on the perception and performance of walking through apertures. **Methods:** Eighty-four adults were randomly assigned to 6 treatment groups and 1 control group. The treatment groups included: (1) a hands-free cell phone conversation and the autobiographical recall task, (2) a hands-free cell phone conversation and the mental arithmetic task, (3) a hand phone conversation and the autobiographical recall task, (4) a hand phone conversation and the mental arithmetic task, (5) the autobiographical recall task by texting, and (6) the mental arithmetic task by texting. Except control group, all participants were required to use the smart phone in the specified operation and walked through apertures formed by humans or poles. Critical point for walking through aperture was calculated by minimum aperture width and participant's shoulder width. Kinematic datum, including walking velocities, the degrees of shoulder rotation, and safety margin were measured by 3-D motion capture system. Finally, working load was assessed by NASA-Task Load Index. **Result:** The findings suggested that: (1) Obstacle types affected the affordances of walking through aperture, and the various indicators of crossing behavior in addition to the angle of shoulder rotation. The operations of mobile devices affected the walking velocities and the relative time of shoulder rotation appearance; and (2) the critical point of walking through aperture was affected by the mobile phone operation–distractions or obstacle types. The cognitive loading of communication content affected the angle of shoulder rotation and workload index.

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Aesthetic effect of white sand in Japanese Zen gardens

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In his first book, James Gibson proposed the "ground theory" of visual space perception, which emphasized the role of the information derived from background surfaces"especially, ground surfaces. Japanese Zen gardens are an interesting space from the viewpoint of Gibson's theory as well as environmental aesthetics. In typical Zen gardens, objects such as rocks and plants are arranged on the ground surface, which is covered with white sand. It is possible that such ground surfaces have an effect on the distinctive aesthetics of Zen gardens. In this study, I conducted an experiment to examine the relationship between the amount of white sand and observers' aesthetic feelings in various Zen gardens.

For the experiment, I sampled 38 Zen gardens located in traditional Buddhist temples in Kyoto. Because Zen gardens are generally placed adjacent to a structure, I defined the standard observation point as the center of the structure's porch. I took a photograph of each garden from the observation point using a digital camera equipped with a circular fisheye lens. In the experiment, the photographs were presented on a 27-inch computer monitor. A technique called VR panorama made it possible to display the fisheye images without projective distortion. Twenty-three participants observed the gardens and rated them with respect to three aesthetic feelings: beauty, interest, and preference.

In the analysis, I first measured the proportion of the area (i.e., solid angle) occupied by white sand in each garden's photograph. Then I examined the relationships between the proportion of white sand and each aesthetic feeling by fitting a quadratic function. The obtained models showed that beauty and preference had inverted U-shaped relationships with the proportion of white sand. The model of interest also showed a similar relationship, although this model's validity was not statistically significant. These results suggest that a moderate amount of white sand contributes to the creation of aesthetics in Zen gardens. I speculate that such white sand has the same aesthetic effect as blank spaces (i.e., unpainted parts) seen in Japanese-style paintings.

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Selection of Affordances and Detection of Invariants in Schedules of Reinforcement

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Ecological psychology and behavior analysis share the view that behavior can be explained scientifically through the examination of the relationship between the animal and the environment. While behavior analysis has focused on examining the function of the operant response. That is, the consequences of the actions of the animal. Ecological psychology has emphasized the relevance of the animal's behavior capabilities relative to the environmental properties. Thus, research on operant learning has studied reinforcer parameters such as frequency, delay, and magnitude of reinforcement, and has paid little attention to the effects of the environmental surfaces on behavior, such as those provided by the affordances of the operant conditioning experimental situation. In two experiments, rat's lever pressing was followed by food deliveries according to different schedules of reinforcement in two conditioning settings (single-operandum and three-operanda situations). This research showed that rats behavior adjusted orderly to variations in lever height and force requirement during the process of lever pressing acquisition, and in conditions of instrumentally conditioned lever pressing. Since operant and pavlovian conditioning cannot give

account of these results, findings are discussed in terms of the opportunities for action offered by the arrangement of the operanda, as well as of the detection of invariants within the schedules of reinforcement.

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Defining and measuring egocentric target direction from motion trajectories towards a target

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In developing his new approach to visual perception, Gibson's career was paved with radical ideas. Gibson's last book tried to integrate all his intuitive insights but left many issues unresolved including the role of body posture (i.e., relative orientation of body parts). The central idea of Gibson's 1966 book, the perceptual system highlighted the significance of the contribution of the entire body to visual information pick-up. In the 1979 book, however, there is no clear integration of the perceptual system with the process of information detection from the ambient array. Gibson's emphasis on the objectivity of information in the ambient array led him to downplay the role of eye-movement, head orientation, etc. Over the past two decades, prism goggles were often used to challenge the sufficiency of optic flow in information detection (Rushton et al, 1998; Warren et a., 2001). In this debate, the centre of optic expansion was contrasted with egocentric target direction as an alternative source of information in moving towards a target. Warren et al (2001) seem to have resolved the conflict between the two competing views without discussing the role of changes in body posture in prismatic experiments. Also, there was no mention of the problem of defining egocentric target direction in distorted body posture while wearing prismatic goggles. The present paper is discussing the empirical difficulties in measuring changes in body posture while wearing prismatic goggles in visual adaptation tasks such as walking towards a target (Morton & Bastian, 2004). Nevertheless, a proposal is presented on how to derive an abstract measure of egocentric target direction from motion trajectories.

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The effects of leader-follower traits on the symmetrical structure of joint actions performed by school children

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Spatial-temporal patterns of multiagent coordination (e.g., walking in a jammed place) are often constrained by the geometrical characteristics of the task environment and the dispositional characteristics of the agents involved. This experiment aimed to investigate the association between leader-follower traits and the geometrical constraints of a task environment when groups of three children perform of a multiagent coordination task. The task environment of triadic jumping (Kijima et al, 2017) comprised three or four hoops (φ=0.7m) aligned in the regular triangle or square shape, respectively. Groups of three 2nd, 4th, or 6thgraders (each N≈20) were asked to stand in one hoop each and jump to the left or right hoop. The timing of the jump was cued by a metronome tone presented every three seconds. Children were instructed to jump simultaneously in the same direction as others to avoid collision. All (non-)verbal communication about the jumping direction was prohibited. We also asked the class teacher to rate the leader-follower tendency of each child using a seven-point Likert scale ranging from +3 to -3 indicating the tendency of a child to be a *leader* or *follower,* with 0 indicating that the child displayed both tendencies on *average*. These ratings were made in reference to daily school activities. We designed two combinations of three children based on their scores; "Different" comprised a *leader*, a *follower*, and an *average* child, and "equivalent" consisted of three *average* children. An analysis of each child's timing to initiate jumping revealed that lead jumpers (*i.e.,* a jumper who jumped earlier than the others) in equivalent triads was completely determined according to their position in the jumper-hoop geometrical configuration. For example, in the square geometry, the child next to the open hoop became the lead jumper 80-90% of the time. However, the probability of the classroom leader in the different triads being the lead jumper was relatively higher, irrespective of hoop position and configuration. Finally, the results indicated that the spatial-temporal structure of the triadic joint action system was constrained by the functional symmetry of the system elements as predicted by group theory.

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The effect of retinal eccentricity on visually induced motion sickness
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Driven primarily by the game industry, virtual reality (VR) technology has continued to advance rapidly. The key technology used in VR is a head-mounted display (HMD) that conveys a compelling sense of immersion in the virtual environment. Exposure to a virtual environment, however, can produce visually-induced motion sickness (VIMS) with symptoms such as dizziness, nausea, or disorientation. Because visual inputs are unaccompanied by the corresponding vestibular and somatosensory inputs during VR exposure, the CNS receives incongruent information from different sensory channels. Sensory conflict theory contends that it is the contradictory information across the various sensory channels that causes VIMS. For Gibson, perception and action are coupled, thus forming a continuous loop. For some people, the coupling between perception and action is compromised in the virtual environment, making the task of maintaining posture more challenging than in the real world. Proponents of postural instability theory contend that such degraded capacity to control posture is what triggers VIMS in VR. What is depicted in VR is the first-person perspective of self-motion, that is, visual illusions of self-motion, also known as vection. The retina is functionally partitioned into center and periphery with the peripheral retina more sensitive to vection. In the current study, participants wore an HMD masked at the central 10° (peripheral vision), peripherally except for the central 10° (central vision) or unmasked (control) to watch “The great wall,” a highly immersive 3D ride along China’s Great Wall while in a rocket-powered rickshaw. The Simulator Sickness Questionnaire was administered to assess VIMS symptoms before and after the VR exposure. In addition, a wireless motion tracking system collected postural sway data via sensors attached to each participant’s head, torso, and hip. All three conditions produced motion sickness symptoms after VR exposure, but for the peripheral vision group, the symptoms were more severe. Interestingly, full vision perturbed the posture most, particularly in the AP direction. Although results demonstrated that the retinal periphery is more susceptible to VIMS, the discrepant result between subjective ratings of motion sickness symptoms and the extent of postural perturbation will require future study.

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Stereoscopic vision in patients with Alzheimer's disease
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As the South Korean population ages rapidly, one health problem that has emerged is dementia. Of all types of dementia, the most common is Alzheimer’s disease (AD) accounting for approximately 70% of cases of dementia with its prevalence expected to grow as Korea becomes an “aged society.” AD is a progressive, fatal neurodegenerative disorder with memory impairment as its hallmark deficit. Recent research has demonstrated that visual impairment is also prevalent in this disease. The visual deficits identified to date include contrast sensitivity, color discrimination, figure-ground separation, object and face perception, structure from motion, and optic flow. A few studies also report abnormalities in stereoscopic vision, although some report no such impairment. Stereoscopic vision, or stereopsis, refers to the perception of depth obtained on the basis of information provided by binocular disparity, the differences between the right and left retinal images. All these studies measured stereoacuity to assess stereoscopic vision. Different experimental methodology, task, and/or apparatus may have contributed to the conflicting evidence. The present study investigated the effects of AD on stereoscopic vision. Sixty participants (20 AD patients, 20 mild cognitive impairment patients, and 20 healthy elderly controls) participated in the study. Two cubes, one on the left and the other on the right of the center of the monitor, appeared at varying distances from the observer with their relative distances controlled in two disparity conditions (i.e., absolute vs relative disparity) combined with two disparity directions (i.e., crossed vs uncrossed disparity). In the absolute disparity condition, one object appeared to lie directly on the screen and the other object appeared to be either floating in front of the screen (crossed disparity) or floating behind the screen (uncrossed disparity). In the relative disparity condition, both objects appeared in front of the screen (crossed disparity) or behind the screen (uncrossed disparity). The distance between the two objects varied at 4 different levels. Participants identified the object that appeared closer to them. Results demonstrated comparable performance with all three groups performing accurately.

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Moving Art: The Embodied Dynamics of Artist, Art and Beholder
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Art is known for its ability to move people, literally as well as figuratively. This attracts scholars from psychology, philosophy and various other fields, investigating the groundings of aesthetic creation and perception. Following

Merleau-Ponty, we see art creation as an embodied activity, materializing in the artwork and subsequently re-instantiating in the beholder. The affordances of the environment as well as the action capabilities of the artist give rise to an embodied activity that manifests itself in the physical work of art. In turn, the perception of an artwork brings about distinct bodily movements (e.g. postural control) in the beholder. It remains an intriguing question how the perception-action dynamics of the artist during the creative process is transmitted to the beholder through the physical work of art.
The aim of the current study was twofold: (1) To explore postural control while looking at different artworks belonging to different artists within and across different art movements, and (2) to capture the relation between postural control and subjective appraisal within and across artworks as well as art movements. Experiment 1 focused on the differences between individual paintings within an art movement (Modern Art) in depth. Experiment 2 broadened up the scope of the study including the similarities and differences within as well as across various art forms (architecture, painting, music) and movements (Renaissance and Baroque).
Results show that, despite large inter-individual variability, different artworks elicited significantly different postural-sway patterns. Moreover, postural-sway patterns were associated to the appraisal of the works of art. We argue that the affordances realized by the artist during the creative process, some of which are specific to the historical period in which the artist is living ('Zeitgeist'), are captured and reflected by the artwork. This process can partly be re-instantiated during aesthetic experience, resulting in distinct bodily movements. Therefore, the present study provides experimental evidence of a truly embodied aesthetic experience during the creation as well as the perception of art, connection artist and beholder across space and time.

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Recurrence analysis of motion energy reveals nonverbal synchronization between client and therapist within and across therapy sessions.
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It is theorized that interpersonal synchronization is the social glue that smoothens out communication. Individuals that are stuck in their development and fail to communicate in proper manner may lack this synchronization. There are therapies being used in practice that try to (re) learn this interpersonal synchronization. However evidence on the efficacy of these practices are lacking due methodological challenges in gathering data to study synchronization. A new method, Movement Energy Analysis (MEA), has the potential to overcome these problems. MEA uses the difference in grey-scale pixels to detect frame-by-frame change in pre-defined region that indicate the body motion of the selected person. However, it is unclear if it is a viable method to study nonverbal movement synchronization in a naturalistic therapeutic settings between youth with severe communication problems and their therapists. This study aims to answer this by analysing the video recordings of 7 therapeutic dyads with Movement Energy Analysis (MEA), then analysing the MEA data with Cross Recurrence Quantification Analysis in order to describe the dynamics of the client-therapist dyads. The goals of the global treatment plan of client-therapist dyads will be related to cross-recurrence measures, especially the patterns of leading and following behaviour observed in diagonal recurrence profiles.

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Influence of experience on eye gaze patterns and identification of normative gait from biological motion
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Gait dysfunctions caused by diseases or injury often leads to an abnormal walking pattern. Physical therapists (PT) usually rely on observation to diagnose and plan interventions specific to the pattern demonstrated by a patient. It is expected that through a process of education of attention, individuals learn to attend to the most useful information. Such information is believed to be gathered from focusing on primary areas of the walking pattern. Determining the that is reliable for diagnosing is of main relevance for training of PT students. Thus, we compared what body areas PT students and novices are looking at for gathering information when evaluating gait patterns. Joint motion of three amputee walkers (Walker A: K3 level, Walker B and C: K4) and health walkers were utilized to build three biological motion models through principal component analysis. Each model was based on one amputee walker. We then build 6 videos from each model displaying a synthesized point-light walker varying in weighing from 0, 20, 40, 60, 80 to 100% between healthy walking and the given amputee walking features. For each trial, participants were presented with one set of videos randomly ordered for 23s. The goal was to rank the videos from 1 to 6 based on the weighing. Participants performed a total of 30 trials (3 set*10 repetitions) wearing an eye tracking system. PT students showed higher accuracy rate (86, 83 and 53% for Walker A to C, respectively) than novices (73, 40 and 52%). In terms of eye gaze, novices spent most time fixating the legs (78.37%) while PT students spent relatively

more time on pelvic (21%) and shoulder (20.93%). This shows that fixation on pelvic and shoulder areas is related to better accuracy in gait pattern identification. We speculate that the case that overall rotation of the trunk might be the informational variable that PT students learn to attend.

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The dynamics of movement synchronization during feeding

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The process by which infants move from a feeding pattern based only on sucking (liquid feeding) to another, based on a more intentional synchronization with their caregivers, who spoon-feed them, is quite a dramatic transition (Van Dijk et al., 2012). This work presents some preliminary results from a study on the development of movement synchronization between mothers and their children, in the first few weeks after the introduction to solid food.
In previous studies, we observed that in the first 6 weeks after the introduction to solid food, mother-infant dyads showed signs of increased co-regulation and synchronization of their respective feeding behaviors (e.g. offering food, accepting/refusing). Learning this new skill requires that infants, among other things, coordinate their position and movements with the complementary position and movements of the caregiver. The present study explores this complex transition by tracking the coupling of mother's and infant's movements during feeding sessions in the course of this critical period.
Preliminary data from 5 mother-infant dyads were analyzed. In a first phase, movement trajectories of mother's hand and infant's face were obtained by applying an automatic movement detection algorithm (TLD, Kalal et al., 2012; for applications to mother-infant interactions see López Pérez et al., 2017). The time series so obtained were then cleaned from outliers, noise or tracking errors and subsequently categorized into a 5-category directions Cartesian scheme on a frame-by-frame basis. In a second phase, these categorical time series, appropriately mapped between each mother and her infant, were analyzed with cross-recurrence quantification analysis, a nonlinear time series method. For each dyad and for each session a diagonal-wise recurrence profile was extracted.
The recurrence profiles indicate that coordination patterns change over time and that while at the beginning of the feeding transition the mother follows the infant's movements with a small delay, in the following weeks a more consistent and stable pattern of synchronization emerges, although individual differences are also evident. The results are consistent with a theoretical view, according to which mothers enact actions around the baby's natural moves and hence co-create meaningful patterns of interaction (Rączaszek-Leonardi et al., 2013).

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Effects of task and environmental constraints on postural control in dart throwing

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Two experiments were directed at postural coordination in dart throwing. Darts can be thrown using only the elbow and wrist while keeping the rest of the body stationary. In order to introduce variability in the coordination pattern, distances to the target (Experiment 1), and the characteristics of support surface (Experiment 2) were varied. Dart throwing data were obtained using a wireless motion tracking system via sensors attached to the index finger, wrist, elbow, shoulder, hip, knee, and ankle of the right side (the throwing hand) with additional sensors attached to the head and the left shoulder, for a total of 9 sensors. Cross-correlations between joints (wrist-elbow, wrist-shoulder, wrist-hip, wrist-knee, wrist-ankle, elbow-shoulder, elbow-hip, elbow-knee, elbow-ankle, shoulder-hip, shoulder-knee, shoulder-ankle, hip-knee, hip-ankle, and knee-ankle) were used to construct coordination patterns. The standard deviations of the head and the right shoulder motion were used to assess body sway. In each condition of target distance (Experiment 1) and support surface (Experiment 2), participants threw darts 20 times, preceded by 20 practice throws. Different patterns of coordination arose as a function of target distance and support surface. Coupling strengths between joints were rearranged to cope with different demands imposed by different task constraints. Of particular interest was the finding that body sway was minimal in the narrow beam condition, less than in the wide plank or foam-rubber mattress condition. Results suggest that the motor control system accomplishes a goal-directed movement by reassembling the multijoint kinematic chain dynamically under different task constraints.

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Sensory substitution and on-line route selection

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The traditional view that guides the design of sensory substitution devices (SSDs) implies that SSDs should provide users with information to build spatial representations of a scene. Those spatial representations would be necessary to form a plan of the preferred route to follow. However, it is also possible to conceive the information to-be-provided by SSDs as allowing for a dynamic, continuous, and on-line process of perception and action that does not rely on mental representations. To illustrate this possibility, we conducted an experiment with a short-range device, the Enactive Torch (ET), that provides vibrotactile information about environmental surfaces. Sixty participants performed a navigation task in which they aimed to avoid five foam obstacles before reaching a target. We divided participants into three groups on the basis of the sensory modality used: (1) restricted visual information, (2) acoustic and vibrotactile information, and (3) restricted visual and vibrotactile information. Participants in the different groups followed similar routes, although participants with restricted vision had fewer collisions and needed less time to reach the target location. The selected routes overlapped with the routes predicted by Fajen and Warren's (2003) dynamic model of visually-guided locomotion. These findings indicate that route selection may be based on local, short-range information, and hence that SSDs do not necessarily have to provide information about the full scene so as to allow users to plan routes in advance.

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Immediate meaning of places: how SoftGIS surveys map digital multi-dimensional affordances of places?

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How do people perceive meaning of places? In one hand, this has been described as a result of slow social constructive processes. In the other hand, grounded on the theory of affordances, immediate perceived functional, social and symbolic place meanings also arise from fast direct perception-action processes, which are iteratively actualized and reconfigured over time through co-constitutive relations between environment, culture, body and mind (Raymond et al., 2017). Heft (2018) sustains that actions in the environment are nested to the affordances of objects and of place, which emerge through social participation. In the present study, the youth in place immediate experience and place meaning is theoretically hinged on actualized affordances of places (Kyttä, 2004), and methodologically grounded on a place-based methodology designated as SoftGISchildren (Kyttä et al., 2012). SoftGIS methods express a participatory mapping process that depends on participants' capacity to recall their experiences in the physical environment, leading to an attribution of meaning for specific places (Brown & Kyttä, 2014). Using a place–based web survey, 145 sixth to ninth graders of the Great Lisbon area were asked to digitally attribute meaning to places. Participants detected 1632 meaningful places of their daily environment in a web-map and marked them using functional, social, leisure and emotional place transactions, namely, actions, activities, social behaviors, feelings, and symbolic meanings. We propose that such individualized digital juxtaposition between place and place transactions shows that subjects are being able to digitally detect a mutuality fit between themselves and the displayed environment. In this sense, we argue that youth are in fact attributing immediate place meanings by mapping digital multidimensional affordances of places. Moreover, it implies that perceived place meanings are being actualized in the presence of environmental cues and perceptual components that exist in specific socio-physical settings through a digital interface. The actualization of affordances of places, over time, enable youths to become specialists of space -*spatialists*-, turning spaces into places. Moreover, the use of SoftGIS methodologies adapted to children and young people creates opportunities for participation of these actors in planning processes related with use, value, meanings and shaping of places.

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Linear and Nonlinear Determinants of Action-Scaled Affordances

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Research on aperture passability has established that perceiving and acting upon this affordance relies largely on intrinsically body scaling the width of the gap to the width of the actor (Warren & Whang, 1987). Further research on

action scaling has shown that the “width of the body in motion” is also an important dynamic property (Franchak, Celano, & Adolph, 2012). This property is operationalized as the amount of lateral sway produced during walking, and it is often quantified using a time-independent measure of variance, such as the Standard Deviation (SD). The SD measures the magnitude of overall variance around a central point, but it makes the assumption that any deviation from the mean value is random error or noise. Given the dynamic and sequential dependent qualities of human movement, nonlinear measures that quantify the determinism or predictability of a movement over time may prove informative to understanding affordance perception.
In the current experiment, participants walked naturally along a 5 meter path and passed through doorways of various widths while the position of their shoulders were tracked using the HTC Vive tracking system. Dependent behavioral measures included the distance from the door when shoulder rotation onset occurred and the angle of shoulder rotation when passing through the door. Lateral shoulder sway for each trial was quantified linearly by the SD (a measure of sway magnitude) and nonlinearly by the Sample Entropy (a measure of the regularity of the sway pattern over time).
Results showed that the SD and Sample Entropy of lateral shoulder sway were significant predictors of the onset of shoulder rotation but not the angle of shoulder rotation at crossing. Trials with higher SD values resulted in shoulder rotation onsets closer to the aperture, while trials with higher SampEn values resulted in shoulder rotation onsets farther from the aperture. Results are discussed in terms of their implications for the use of nonlinear analyses to better understand action-scaled affordances.

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The Relationship Between Lateral Sway Variability and Determinism During Walking
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Movement variability is inherent to human motor control. While early researchers claimed that variability is due to random noise or error, proponents of Dynamical Systems Theory (DST) suggest that variability is driven by physical, informational, and task constraints within a complex and dynamic actor-environment system. While linear analysis variables, such as the Standard Deviation (SD), quantify the amount of variance in a system, nonlinear analysis techniques, such as the Sample Entropy (SampEn) allow researchers to quantify the amount of randomness or determinism in a time series. With these tools, Riley & Turvey (2002) showed that variability in human movement is not entirely random. They found an inverse relationship between variability and observed randomness in postural sway data, such that more variability was related to increased determinism. Our current research extended the scope of this finding to the rhythmic lateral sway produced by natural walking.

In two unrelated experiments, participants walked forward 2-4 meters at a natural pace. This task was part of either 1) an aperture passability study in which participants walked through doorways of various widths with their eyes open, or 2) a distance estimation study in real and virtual environments, in which participants completed blind walks to previously seen targets. The HTC Vive was used to track the position of the shoulders in space, and both the SD and SampEn were calculated from the sustained walking phases of each trial. Despite considerable differences in experimental tasks and environments, both experiments produced strong negative correlations between the SD and SampEn of the lateral sway (*r*s = -0.72, -0.58). On trials when participants produced larger amounts of lateral sway, the sway pattern itself was more regular and predictable.

The goal of this poster is to prompt discussion about the meaning of this trend with respect to dynamical systems theory and recent findings from the field of motor control, including the role of variability in motor learning (Herzfeld & Shadmehr, 2014), changes in gait complexity related to aging and neurodegeneration (Scafetta, Marchi, & West, 2009), and optimal states of structured variability for adapting to perturbations (Stergiou & Decker, 2011).

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The online flow of self-organization
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When people perform repeated actions, there is always cycle-to-cycle variability. Over recent decades, it has become clear that movement variability rarely equates with white noise. Rather, trial-to-trial variability in human action reveals fractal long-range dynamics. Here, the notion of fractal scaling is extended from trial-to-trial variation at the endpoint (e.g., response time, movement time, etc.), to the evolution of scaling at various stages of the movements. This has allowed to test various hypothesis about the emergence of 1/f noise is coordinated action.

Three types of time series data were analysed; respiration, reciprocal movement times in an aiming task, and arm movements in a whole-body lexical decision task. The results indicate monotonical increases in fractal scaling from the initial to the latter stages of movement. Moreover, the strength of the increase in scaling was manipulated systematically in the Fitts task and the lexical decision task. The results suggest that the online flow of self-organization a) can be manipulated, and b) is associated with successful task execution. The results are interpreted as support for the notion of interaction-dominant dynamics as driving human coordination.

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How Much for Joint Action: Assessing the Cost of Coordination

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When people work together to perform a repetitive joint action task, synchronous coordination between them frequently emerges (Richardson, Marsh, Isenhower, Goodman, & Schmidt, 2007). Thus, synchrony seems to be advantageous for coordination, but there is also reason to believe that metabolic energy expenditure of the pair is decreased as participants adapt to each other and deviate from moving at their eigenfrequencies (Turvey, Schmidt, Rosenblum, & Kugler, 1988; Wagnild & Wall-Scheffler, 2013). To determine if coordination is energetically advantageous , the current study tests how different degrees of coordination impact the energy expenditure of the individuals. To assess energy expenditure at different levels (change in heart rate, respiratory exchange ratio), we created a physically decoupled sawing apparatus that allows for the manipulation of the level of information exchange and, through that, of coordination. Participants are frequency matched within 3% of their natural frequencies and complete three conditions: Single Action (SA), Pseudo Joint Action (PJA), and Factual Joint Action (FJA). During SA, participants are told that they are sawing a log alone (SA), indicated to them via a visual display of their saw with one handle on the log and their progress on sawing their own log (progress bar). During PJA, participants are told that they are working together to saw the log, see a two-person saw moving down the log, and receive feedback about the joint progress of log sawing. Importantly, during PJA there is no information exchange between participants as they are visually and acoustically occluded from each other. During FJA, the instructions and the feedback provided to participants is the same as in PJA, however now participants have full informational exchange. Our data analysis focusses on the participants' movement dynamics in all conditions to assess successful manipulation of coordination patterns. Subsequently, we analyzed to what extent coordination affects changes in energy expenditure. Results showing an adaptation of energy expenditure per condition and interactions within the pair will be discussed in context of related findings.

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Cortical activity in response to optic flow perception in infants.

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Cortical activity in response to optic flow perception in infants

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Electroencephalogram (EEG) was used to investigate brain electrical activity of full-term and preterm infants at 4 and 12 months of age as a functional response mechanism to structured optic flow and random visual motion. EEG data were recorded with an array of 128-channel sensors. Visual evoked potentials (VEPs) and temporal spectral evolution (TSE, time-dependent amplitude changes) were analysed. VEP results showed a significant improvement in full-term infants' latencies with age for forwards and reversed optic flow, but not random visual motion. Full-term infants at 12 months significantly differentiated between the motion conditions, with the shortest latency observed for forwards optic flow and the longest latency for random visual motion, while preterm infants did not improve their latencies with age, nor were they able to differentiate between the motion conditions at 12 months. Differences in induced activities were also observed, where comparisons between TSEs of the motion conditions and a static non-flow pattern showed desynchronized theta-band activity in both full-term and preterm infants, with synchronized alpha-beta band activity observed only in the full-term infants at 12 months. Full-term infants at 12 months with a substantial amount of self-produced locomotor experience and neural maturation coupled with faster oscillating cell assemblies, rely on the perception of structured optic flow to move around efficiently in the environment. The poorer responses in the preterm infants could be related to impairment of the dorsal visual stream specialized in the processing of visual motion.

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Development of perception of looming visual motion: A longitudinal study of full-term and preterm infants.
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Development of perception of looming visual motion: A longitudinal study of full-term and preterm infants
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Abstract
High-density electroencephalogram (HD EEG) was used to longitudinally investigate developmental trends in evoked and induced electrical activity as a function of visual motion perception in full-term and preterm infants during the first year of life. The infants were presented with the visual motion paradigm of “looming”, where a virtual visual object approached on a direct collision course under three different accelerations. The infants were tested at 4-5 months and again at 11-12 months, where their looming-related brain responses were measured on a trial-by-trial basis. Analyses of looming-related visual evoked potentials (VEPs) revealed, for the full-term infants only, a significant decrease in time-to-collision of their looming-related VEP responses with age. In addition, the 12-month-old full-term infants showed looming-related brain activity at a fixed time-to-collision, irrespective of loom speed. The preterm infants, on the other hand, did not show a significant decrease in time-to-collision of their looming-related VEP responses, and they did not show their responses at a fixed time-to-collision at 12 months of age.
Time-frequency analyses (TSEs) revealed that the full-term infants showed shorter brain responses in higher frequency-bands with increasing age, while the preterm infants showed their brain activity in the same frequency-band and for the same duration during both test sessions. Although some preterm infants showed an increase in late alpha and early beta band synchronization, this increase was less prominent, and some preterm infants did not show an increase at all.
The preterm infants’ poorer performance can be related to a deficit in the processing of visual motion, a dorsal stream function.
For comparison, this study will also investigate the looming-related brain responses of a particularly precocious baby who was tested at 7, 9, and 11 months, and who started walking before he turned 10 months.

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Visual Extraction of Kinematic Information Specifying Intention in Full-body Motion
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Intention recognition supports safe human-robot interaction and planning supportive movement trajectories for assistive devices such as prosthetics and exoskeletons. Generally, intentions translate into a person’s full body kinematic patterns, and human observers are well attuned to early differences in those patterns. Studies in kinematic specification of dynamics (KSD) suggest that humans can perceive other humans’ intentions by observing very simplified motion displays, and thus KSD is often studied through point light displays, which distill images and videos of human movement down to moving points that represent the joint centers. However, despite the fact that we know people can read intention through motion, it is not yet known how this information is expressed. To determine the essential kinematic information that allows us to differentiate intention, we analyzed four intentional sit-to-stand (STS) transitions: STS to stand, STS to reach forward, STS to reach and sit down again, STS to reach up. Initially analyzing the differences in information carried in the full-body motion, we created two predictive regression models using principle components analyses (PCA) that suggest that, while similar, the four intentional motions are reflected by distinct differences in essential kinematic information along the first two principle components. Subsequently, we created point light displays from the motion data and used eye-tracking to determine which information is used to make accurate judgments about the intention in the respective motion displayed. Results show that participants could successfully distinguish between the four movements. An analysis of gaze durations and gaze frequencies on the point-lights using repeated measures ANOVAs with planned contrasts based on the first two principle components of the motion showed that average gaze durations and frequencies for point-lights in PC1 and PC2 were significantly greater than averages for the non-essential point-lights. Additionally, average gaze frequency was significantly greater for point-lights in PC2 than for those in PC1. These findings suggest that observers attend to essential kinematic information to correctly distinguish intentional motion. The contribution of these findings to the understanding of human intention identification are discussed in the context of present and future research.

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Multiagent Activity as Union Between Task-Dynamics and Physical and Informational Constraints

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Human groups are extraordinary in their capability to self-organize to achieve tasks efficiently. Examples include the formation of a bucket brigade to transport objects, the coordinated timing of musicians in a band, and the placement of teammates to allow for scoring opportunities. What are the processes that enable the resultant patterns we observe in multiagent activity? How can we design artificial-agent systems that are sensitive to these dynamics when embedded in a task context, and how can we use this information to steer groups towards preferred behaviors?
I will present research my colleagues and I have conducted over the years in investigating the emergence of human multiagent activity via a dyadic collaborative problem-solving task. The task, human “shepherding,” requires human pairs to find a coordinated strategy to retrieve and contain fleeing interactive agents to a pre- or group-specified target region. Given different constraints acting on participants (e.g., whether participants complete the task using hand-held controllers on a tabletop display or walk around in an immersive virtual reality environment), the solutions top-performers adopt are found to be manifestations of the task-level dynamics that define “shepherding” or “containment” more generally. Specifically, the optimal solution to immobilize repulsive objects is to negate all lateral forces acting upon the object – for which a circle is the most stable solution. Despite task difficulty and physical and environmental constraints acting on individuals, top-performers do in fact learn to coordinate their actions with their partner to form a stable circle-structure around the object herd. Examples from other animal-environment systems (e.g., wolves, whales) indicate that despite differences in constraints, the same qualitative behaviors emerge, demonstrating dynamic similitude.
Taken these insights, I will also present recent work creating human-inspired low-dimensional dynamical models of human “shepherding” behaviour comprised of dynamical motor primitives and demonstrate that, when working with an artificial avatar, human novices can learn to adopt this near-optimal solution, with most participants unaware their partner was computer-driven. Further, I will conclude with a discussion of pilot work seeking to apply virtual artificial agents to steer behaviors and promote better coordination in future human interactions.

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Neuromuscular Coupling in Spontaneous Synchronisation

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Tapping or nodding along to music is one of the many demonstrations of humans spontaneously synchronising to environmental rhythms. There is growing evidence that movement synchronisation to an external rhythm is affected by the characteristics of the involved rhythm. Specifically, discrete auditory rhythms facilitate movement synchronisation compared to continuous auditory rhythms.
In this study the effects of auditory stimulus continuity on movement entrainment was investigated for more complex rhythms with two metrical levels. In addition to the effects on movement, cortico-muscular coherence (CMC) was explored as a neuro-physiological correlate of motor entrainment. CMC, i.e., the coherence between electroencephalographic (EEG) and electromyographic (EMG) signals, is considered a functional measure of motor control and is sensitive to sensory stimuli. Stimuli that facilitate movement synchronisation, i.e., discrete auditory rhythms, were therefore expected to increase the magnitude of coherence.
The presented sequences consisted of 3Hz stimuli with 1Hz accentuation. The 1Hz and 3Hz stimuli were either Discrete (50ms tones) or Continuous (sinusoidal amplitude modulation), resulting in 4 variations of sequences: D[1Hz]-D[3Hz], C[1Hz]-C[3Hz], C[1Hz]-D[3Hz], D[1Hz]-C[3Hz], and a control condition without stimulation. The sequences were presented while the participants produced either finger tapping at their preferred tempo to examine spontaneous movement entrainment, or maintained constant pressure with their right index finger to investigate CMC modulations using EEG and EMG recordings.
Results showed no significant difference in spontaneous movement synchronisation between the auditory sequences. These results suggest that the effect of stimulus continuity does not extend to more complex rhythms containing metrical structures and/or the two frequencies embedded within the sequences (1 & 3 Hz) were too far from participants’ preferred tempo, usually around 2 Hz, to affect their movement.
Accordingly, we also did not find any effect of the stimulus continuity on CMC, however functional relations between CMC and movement synchronisation cannot be inferred because the stimuli did not have the expected effect on movement.

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Perception by scanning: Development of finger movement in braille reading
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Perception by scanning: Development of finger movement in braille reading

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The movement of fingers scanning the braille cells has been considered an important factor in braille reading (Hughes, Van Gemmert, & Stelmach, 2011). Typically, fluent braille readers scan parts of the text with two hands moving independently of each other: The left hand reads to the middle of the line where the right hand joints it, which finishes reading that line while the left hand moves to the next line (Wright, Wormsley, & Kamei-Hannan, 2009). When reading aloud, the hands of the braille readers are considerably ahead of the voice, where the voice, the left hand, and the right hand are in touch with different parts of the text simultaneously. How do braille readers achieve the perception of the pattern of braille cells on the basis of a succession of different tactile samples from the two scanners (c.f., Turvey, 2018)? How does this remarkable skill of active touching develop? In this presentation, we will report on the ongoing longitudinal study on the development of movement kinematics of braille reading fingers while reading aloud in primary school children with different skill levels. Based on the preliminary results, we explore the relation between the intermittencies of the scanning movement of fingers, the division of labour between the two hands, and the development of braille reading fluency.

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Modeling and Simulating Action Dynamics in Underconstrained Tasks
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Affordances can often be actualized in many different ways while still ensuring task success. For example, one could lean over to put an item on a shelf or gently throw the item from a short distance. The aim of the present research was to investigate the action dynamics that emerge from such underconstrained tasks using an object transportation task. Participants were instructed to transport balls between a starting location and a large wooden box located 9 m away. The temporal interval between the sequential presentation of balls was manipulated as a control parameter and was expected to influence the distance participants moved prior to throwing or dropping the ball into the target box. A two-parameter state space derived from the Cusp Catastrophe Model was employed to illustrate how behavioral variability emerged as a consequence of the underconstrained task context. Two follow-up experiments were conducted where the model predicted the observed action dynamics as a function of increasing task constraints. Task solutions, and changes to their availability, cannot be defined solely within the organism but must be considered to exist at the interfaces within the organism-environment system. However, depending on the system at hand, a constraint may destabilize a given solution to the task. For example, if you begin having tremors in your extremities, your body no longer moves in a manner that you are accustomed to and you are forced to adapt in some way if you wish to remain successful. Future research using Virtual Reality is currently under way to quantify change in action dynamics in the face of potentially destabilizing constraints. Quantifying and understanding the effect of different kinds of destabilization processes can then form a basis for exploring system-wide interventions to reclaim previously lost solutions.

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Gaze strategy adapting to ecological constraints: The case of a expert calligrapher

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Copy drawing called Rinsho is the most basic learning method in Chinese calligraphy. In this case study, we focus the gaze strategy which support the process of modifying character positions. We examined the polar coordinates of the head rotation which alternately observe the written drawing and the model. The direction of the head showed stability to the number of trials both at drawing periods and at interval periods. On the other hand, head direction was adaptively changed between drawing periods and intervals in response to character positions.Calligrapher's observation showed a high degree of proficiency combining flexibility and stability, which consist of both sensitivity to external constraints and robust consistency through trials.

In addition, the frequency of head rotation was 0.9 seconds per time which indicates that the copy drawing requires observation amounting to 50 times per a character which is higher compared to eye movement in portrait drawing under intense time constraint (Miall & Tchalenko 2001, Land 2006).

The characteristic visual search given in this case study seemed to have resulted from ecological constraints specific to Chinese calligraphy, that is (a) the act of rewriting lines is strictly prohibited, and (b) the movement of brush tip must be at a constant speed to prevent outflow of india ink on the paper. Calligrapher's action was driven by water which drips by gravity and surface tension.

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Kendo players can anticipate possibilities of next movements of an opponent based on observing its previous movements

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Visual information is important for skilled interaction with players and environment in sports. Many researchers have indicated that experienced players can perform rapid and accurate anticipation of spatio-temporal events based on visual information. These researchers asked players to observe actual movements of opponents, and players anticipated results of observed movements. Thus, players observed movements halfway to be anticipated. However, can experienced players perceive important information to anticipate next movements of opponents based on observing its previous movements and not observing next movements halfway? Players in a university kendo club participated in this experiment. A player in the same club presented experimental stimuli as an opponent. The opponent and one of the participants took a normal ready stance at far distance (225 cm) on a face to face position and then the opponent approached the participant just one step (35 cm) and stopped there. The opponent slightly changed height of her left heel, pivoting foot to jump for strikings, during the approach movements, 1) low condition; heel was contacted on floor, 2) high condition; heel was elevated to the same height as the normal ready stance, 3) middle condition; heel was elevated to the middle height just between those of low and high conditions. The opponent could strike with shorter movement time from the high condition because the opponent needed to execute longer preliminary movements in order to adjust her pivoting foot and posture before strikings from the low and middle conditions. We didn't give any instruction about the stimuli to the participants and they also couldn't observe these heel conditions directly during the experiment. We asked the participants to observe the approach movements of the opponent and to answer whether they felt the opponent could strike from the stopped postures without any preliminary movements. The participants could distinguish differences among three stimuli and they felt the opponent could strike faster when they observed the high conditions. Thus, experienced players can perceive important information to anticipate next movements of opponents based just on observing its previous movements. These slight and advanced visual information might influence on skilled interaction in sports.

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Critical Fluctuations as an Early-Warning Signal for Sudden Gains and Losses in Patients receiving Psychotherapy for Mood Disorders

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Examining longitudinal patterns of therapeutic change offers a window into developmental processes. Also, the question of how day-to-day experiences relate to emergent and lasting structures of behavior (i.e., psychopathology) is at the heart of psychological science. Based on a complex systems framework, we tested whether sudden gains and losses in symptom severity, which we conceptualized as order transitions, were preceded by increased levels of complexity in daily self-ratings of the therapeutic process (indicative for critical fluctuations), that could serve as predictive early-warning signals for such transitions. Data was collected from 328 patients receiving psychotherapy for mood disorders who completed daily self-ratings about their therapeutic process using the therapy process questionnaire (TPQ). Sudden gains and losses were classified from the 'problem intensity' scale of the TPQ. The other items of the TPQ were used to compute the early-warning signals. Early-warning signalspredicted an increased probability for sudden gains and losses in a 4-day predictive window. These results show that psychotherapeutic change can indeed be seen as an (cascade of) order transition(s) preceded by destabilization of existing (rigid) behavioural patterns. Detecting early warning signals that predict these order transitions (i.e., critical fluctuations) may be highly relevant for clinical practice because they signify developmental windows of opportunity in which a system is more susceptible to change.

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Talking about targets, verbalization during action facilitative or debilitative?

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Strategies such as self-talk and verbalization have recently received considerable attention in the field of sport psychology. These strategies are reported to enhance movement learning and endpoint accuracy in certain environments (Theodorakis et al., 2012; Janelle et al., 2003; Tod et al., 2009). It is posited that verbalization during movement execution increases the ability to allocate attentional focus to the task at hand (Landin (1994) as cited by Theodorakis et al., 2012). Specifically,"trigger words" such as target-related features are expected to improve a performer's ability to pick-up facilitative information for functional actions. Meanwhile, visual fixation on a target prior to movement initiation is found characteristic of high levels of accuracy in goal directed movements (Mann et al., 2007; Vickers, 1996; Frehlich et al., 1999; Janelle et al., 2000; Adolphe et al., 1997). Consequently, we would expect verbalization during goal-directed movements to facilitate the pick up of information in performance environments resulting in improved endpoint accuracy. However, there are inconsistencies in the literature, particularly regarding skilled performers, where verbalization may actually elicit "reinvestment" behaviour resulting in de-automatization and deterioration of performance. In the present study we investigate if verbalization during movement influences how actors explore the target surroundings to gather information for goal achievement. Participants (n=36) in our study made visually guided touch gestures on a tablet using a stylus to targets located in one of seven possible positions along a semi-circle. During verbalization trials participants called out the position of the active target (1 to 7) while performing the movement, i.e. participants called out 'one' for the first target in the sequence. We analyzed the endpoint error distribution for the peripheral and middle targets. Contrary to our expectations verbalization of the target position did not improve overall constant or variable error. Unexpectedly, Target 1 (the utmost left target) had higher constant and variable error in the verbalized trials compared to the control. These findings suggest that verbalizing target properties can in fact decrease performance, thus verbalization action does not always attune actors to action relevant information.

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A time series approach to random number generation: from static to dynamic assessment of executive functioning

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According to Lezak (Lezak et al., 2012), executive functioning (EF) preside how or wether a person goes about doing something (pp. 37). This description of EF implies that executive processes by definition occurs in time as a sequence of interacting and cascading cognition and EF is, therefore, best described as an dynamic process. However, our assessment of EF performance is rooted in static concepts, like *what* and *how much*, and, consequently, all time-based information of how a person goes about doing something is lost. In the current study we use the random number generation (RNG) task to assess EF. In this task individuals are instructed to generate a random sequence of digits and the quality of EF performance is intepreted in terms of departures from mathematical randomness. However, this standard interpretation of EF performance still results in static outcome measures. To adress this problem, we adopt recurrence quantificantion analysis (RQA) as a nonlinear method that quantify the characteristics of any temporal pattern in the number sequence. Given this data, we firstly investigate the

intepretability of EF performance of both the regular and RQA approach and relate this to the to scientific literature. Secondly, we broaden our understanding of EF as reflected in RNG performance by comparing this RNG data with a broad range of neuropsychological tasks.
To this end, 137 in- and outpatients administered for assessment to the Centre of Excellence for Neuropsychiatry in Venray were included in the current study. The assessment procedure included several EF tasks as well as global IQ measures. Furthermore, the RNG test was administered to all patients as part of this assessment procedure. Regular RNG measures were computed using software by Towse and Neil (Towse & Neil, 1998), while RQA measures were extracted from the data using the casnet toolbox for R. In this clinical sample we show that, despite some inconclusive results, RQA offers many more perspectives to broaden our understanding of EF as reflected in RNG performance.

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Does first-order optical information explain behavior when intercepting targets following circular trajectories?

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Human locomotor interception is often considered to be accomplished by nulling changes in the target's bearing angle θ, that is, by nulling dθ/dt (cf. Fajen & Warren, 2007). However, Bootsma et al. (2016) recently demonstrated that, in a (direction-constrained) lateral locomotor interception task, reliance on first-order (dθ/dt) information could not satisfactorily explain the spatiotemporal characteristics of displacement patterns observed. Most relevant for the present contribution was their finding that when participants were confronted with curving target trajectories explanations of the interception behavior required inclusion of higher-order (e.g., $d^2\theta/dt^2$) information.
In this study we sought to confirm this finding in a different (velocity-constrained) locomotor interception task, where participants had to steer a vehicle in order to intercept a moving target. Moving at a constant speed of 20 m/s through the simulated environment, seated participants controlled their direction of displacement by operating a steering wheel. After stabilizing participants' initial heading direction during a preparatory phase, targets could appear at five different lateral positions (-20, -10, 0, +10, +20 m) at a constant distance-in-depth of 60 m with respect to the participants' initial heading and position. Moving at a constant speed of 10 m/s, targets could move (clockwise or anti-clockwise from the bottom) along circular trajectories of 20 or 40 m radius, giving rise to a total of 20 different target motion conditions.
We first present qualitative and quantitative characteristics of the movement patterns exhibited under the various conditions, such as steering initiation times and the presence of movement reversals. In line with the analysis method proposed by Bootsma et al. (2016), we then relate these characteristics to concurrent operative magnitudes of informational candidates θ, dθ/dt, and $d^2\theta/dt^2$. Pending ongoing analyses, we expect to demonstrate that 1^{st}-order (velocity) information is not sufficient to explain steering behavior in this task.
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Perceiving the whole person: Intersectionality in ecological psychology

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Ecological psychology has advanced theory in perception-action-cognition by grounding it within lawful organism-environment relations, allowing us to understand *why*—and not merely *how*—behavior unfolds. As ecological psychology has grown, it has naturally shifted to examine more interpersonal and social phenomena, embracing Gibson's early intuitions that the environment is not simply objects and surfaces but also other organisms. While these steps have allowed for a fuller explanation of human (and non-human) behavior, we argue that ecological psychology must grow to more fully capture impactful social dynamics by considering how *intersectionality* impacts social effectivities and social affordances.
Briefly, the feminist concept of intersectionality is rooted in the idea that different aspects of our identities (e.g., race/ethnicity, gender identity, socioeconomic status) cannot be dissociated from one another and necessarily interact with one another (Crenshaw, 2005). For feminism and identity theory, intersectionality captures the ways that a person's *whole* identity constrains their ability to interact with others and engage with their environment.

In ecological terms, our intersectional identities would shape both our social effectivities and our social affordances. While these abilities and opportunities are largely social in nature, the impact of social identities is no less real than physically situated identities: The idea that an apartment affords renting, that a room full of people affords entering, or that a job opening affords a paycheck is specific to complex social effectivities based on multiple identities. Viewed from a purely physical lens, the affordances of each of these examples would be identical for everyone, regardless of social identity; however, we know that this is not the case, as some people are denied access to housing, places in physical space, and economic security based on a multitude of identity-related factors. Ecological psychology already captures some aspects of intersectionality well—for example, by acknowledging that our experiences of and opportunities for action within the world are shaped by our different physical bodies and abilities (e.g., Franchak & Adolph, 2013). Here, we discuss the opportunities that embracing intersectionality provides ecological psychology, the challenges that an intersectional ecological psychology faces, and potential avenues for future research.

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Unstable coupling of women's body sway with imposed motion precedes visually induced motion sickness
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Motion sickness is preceded by differences in the quantitative kinematics of body sway between individuals who (later) become sick and those who do not. In existing research, this effect has been demonstrated many times, but only in measures of body sway, relative to the Earth. However, research has shown that body sway can become coupled with imposed oscillatory motion of the illuminated environment. The nature of this coupling may differ between individuals who become sick and those who do not; that is, motion sickness could be preceded by instability in the coupling of body sway with imposed oscillatory motion. We asked whether body sway would become coupled to complex oscillations of the illuminated environment, and whether individual differences in such coupling might be precursors of motion sickness. In a moving room, standing female participants were exposed to complex, sum-of-sines oscillation of the illuminated environment for up to 40 minutes. We separately monitored kinematics of the stimulus, and of the body. Using Average Mutual Information, we examined the strength of coupling between the room and the body as a function of time during exposure. Following exposure, 9 of 30 participants (30%) stated that they were motion sick. The incidence and severity of motion sickness were consistent with previous studies. For the positional variability of postural activity, the temporal evolution during exposure differed between participants who (later) stated they were motion sick and those who did not, replicating previous studies. In a novel effect, the temporal evolution of coupling also differed between participants who later reported motion sickness and those who did not. Our results show that women can couple the complex dynamics of body sway with complex imposed motion, and that differences in the nature of this coupling are related to the risk of motion sickness. In future research, we will examine coupling in relation to visually induced motion sickness in men.

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Sensitivity to changes in dynamic affordances for walking on a ship at sea
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Walking necessarily includes lateral oscillations of the body as weight shifts between the feet. These oscillations are not static states of the body, such as the position of the center of mass relative to the feet, or the angle of the body relative to the direction of balance (Stoffregen & Riccio, 1988). These lateral oscillations can influence relations between animal and properties of the environment, that is, affordances. Walking along a narrow path (for example, a gap between buildings, or a slot canyon) will be constrained (among other things) by the walker's ability to control lateral oscillations, so as to avoid bumping into walls. The greater the person's ability to control lateral oscillations, the farther they can walk. Control of lateral body oscillations in walking will be influenced by relations between properties of the body and properties of the environment. changes in the body's mass (and mass distribution) tend to influence actions that are available. Added mass can change the perception of affordances for stance (Regia-Corte & Wagman, 2008). At the same time, walking ability can be influenced by oscillatory angular motion of the ground surface, as happens routinely on ships at sea (Walter et al., 2019). We asked whether sensitivity to dynamic affordances can comprise simultaneous constraints arising from added mass and ship motion. While standing on a ship at sea, participants made repeated judgments of how far they could walk along a marked path that was 20 cm wide without stepping outside the path. Judgments were made without added weight, and while wearing weights at the ankles. Mean judged walkable distance differed between weight conditions, as predicted, with judged ability being smallest in the ankle weight condition. Over a series of 8 judgment trials in each condition, judgments gradually improved (without feedback or practice) only in the ankle weight condition. Performance trials (after completion of judgments) confirmed that judgments accurately reflected actual walking ability. Overall, without

walking practice or judgment feedback participants showed sensitivity to changes in walking ability arising from simultaneous changes in added mass, and in motion of the support surface.

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Sensitivity to changes in dynamic affordances for walking

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Walking necessarily includes lateral oscillations of the body as weight shifts between the feet. These oscillations are not static states of the body, such as the position of the center of mass relative to the feet, or the angle of the body relative to the direction of balance (Stoffregen & Riccio, 1988). These lateral oscillations can influence relations between animal and properties of the environment, that is, affordances. Walking along a narrow path (for example, a gap between buildings, or a slot canyon) will be constrained (among other things) by the walker's ability to control lateral oscillations, so as to avoid bumping into walls. The greater the person's ability to control lateral oscillations, the farther they can walk. Control of lateral body oscillations in walking will be influenced by relations between properties of the body and properties of the environment. changes in the body's mass (and mass distribution) tend to influence actions that are available. Added mass can change the perception of affordances for stance (Regia-Corte & Wagman, 2008). We asked whether added mass can change the perception of affordances for walking along a narrow path. We adapted the method of Mark et al. (1990). While standing, participants made repeated judgments of how far they could walk along a marked path that was 30 cm wide without stepping outside the path. Judgments were made without added weight, and while wearing weights at the torso, or at the ankles. Mean judged walkable distance differed between weight conditions, as predicted, with judged ability being smallest in the ankle weight condition. Over a series of 8 judgment trials in each condition, judgments gradually improved (without feedback or practice) in the torso weight and ankle weight conditions. Performance trials (after completion of judgments) confirmed that judgments accurately reflected actual walking ability. Overall, without walking practice or judgment feedback participants showed sensitivity to weight-related changes in walking ability, extending the findings of Mark et al. (1990) from the domain of sitting to walking.

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Body sway is sufficient for perception of changes in affordances for walking

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Walking includes lateral oscillations of the body as weight shifts between the feet. These lateral oscillations can influence relations between animal and properties of the environment, that is, affordances. Walking along a narrow path (for example, a gap between buildings, or a slot canyon) will be constrained by the walker's ability to control lateral oscillations, so as to avoid bumping into walls. The greater the person's ability to control lateral oscillations, the farther they can walk. Control of lateral body oscillations in walking will be influenced by relations between properties of the body and properties of the environment. Changes in the body's mass (and mass distribution) tend to influence actions that are available. Added mass can change the perception of affordances for stance (Regia-Corte & Wagman, 2008). We asked whether added mass can change the perception of affordances for walking along a narrow path. In Peterson et al. (2019; also submitted to ICPA), participants made similar judgments after first experiencing effects of added weight while stepping in place (blindfolded). Peterson et al., found that judgments were reduced while wearing weights, consistent with subsequent reductions in actual walking performance. However, Mark et al. (1990) found that body sway was sufficient for learning about changes in affordances for sitting. Accordingly, we asked whether body sway might be sufficient for learning about changes in affordances for walking. While standing, participants judged how far they could walk along a marked path that was 30 cm wide. Judgments were made without added weight, and while wearing weights at the torso, or the ankles. While wearing weights, participants were not permitted to walk, step, or otherwise move their feet. In each condition, a series of eight judgments was followed by actual walking. Mean judged walkable distance was significantly lower in the Ankle Weight and Torso Weight conditions than in the No Weight condition. This result shows that without walking practice or judgment feedback participants showed sensitivity to weight-related changes in walking ability. The results extend the findings of Mark et al. (1990) from the domain of sitting to walking (cf. Ramenzoni et al., 2008).

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Detrending prior to continuous (Hilbert) phase determination

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Research on coordination between cyclical processes often involves calculation of phase angles, for instance to determine the phase relation between two (or more) oscillating time series. As accurate phase analysis requires near-to-harmonic oscillations, several methodological studies already illustrated the importance of appropriate normalization of the time series prior to phase determination, in order to cope with computational artefacts due to 1) (variations in) oscillation frequency and 2) offset of the oscillation center (for an overview, see Lamb & Stockl, 2014). In my proposed poster presentation, I will focus on another substantial source of artefacts, namely gradual or sudden *half cycle variations of amplitude and oscillation center*. (Note that also the Hilbert procedure is subject to such artefacts.) Based on analysis of generated signals with known properties as well as empirical data, the poster will demonstrate how this may lead to errors in the calculation of continuous (Hilbert) phase, and how this may potentially lead to erroneous (even contradictory!) interpretations. Potential solutions are provided, which entail detrending the oscillation center by means of high-pass filtering (see, e.g., Blikslager & De Poel, 2017) or normalization per half-cycle (see, e.g. De Poel & Noorbergen, 2017). The latter method is preferential as it also corrects for the previously mentioned artefacts (Lamb & Stockl, 2014) and is vitally dependent on pertinent definition of what is considered a (half-)cycle and the determination of the onsets thereof. When half-cycle behavior deviates too much from ideal harmonic shape this still introduces artefacts though, which may or may not be problematic to the research question of interest. Nonetheless, detrending prior to phase determination offers a general solution to cope with potential artefacts in continuous (Hilbert) phase, and in particular for analysis of empirical signals that show substantial (systematic) oscillatory variations over cycles or half cycles.

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Perception-brain-action coupling during an interception task

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One of the primary functions of perception is the prospective guiding of actions. To study the relation between perception and action, links should be made between behaviour and brain activity (Holth et al., 2013; Makeig et al., 2009). In this study, we combined high-density EEG analyses with movement trajectory measurements during an interception task. Adults had to intercept a horizontally moving target car, by vertically moving another car with their finger on a large touch screen tablet. The target car moved at different speeds and was occluded just before the designated catch area. Following previous research (Engan et al., 2011; Lee et al., 2001ab), we found that the adult participants used a tau-coupling strategy to catch the target car. Thus, the catching movement is controlled by keeping constant the action gaps between hand to catch area and hand to target. We found movement-related potentials (MRPs) in the medial frontal and posterior regions. The different speeds of the target car had a significant effect on the EEG activity measured. In addition, we will explore the relation between tau-coupling of the movements and the related EEG activity. Hence, this study provides insights into perception-action coupling during an interception task and emphasizes the importance of combining behavioural data with brain activity analyses.

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The Dynamics of Plant Nutation: The Case of Bean Plants

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Since plant nutation was described by Charles Darwin[1], its kinematic aspects have been thoroughly studied and several mechanisms have been postulated as realizers of the movement.[2, 3] Moreover, nutation has been also taken to be an integral part of climbing plants exploratory activity to find a support to climb in their environment[5] and, more generally, an instance of plants' adaptive and controlled goal-directed motion[1, 4]. However, the goal-directed organization of plant motions along with the way in which different mechanisms account for nastic and tropic components of nutation both in the general case and in terms of goal-directedness still require experimental adjudication. One aim of this paper is to address these issues by providing a methodology to achieve a better understanding of the nature of nutation through a careful characterization of its underlying dynamical organization as a function of proximity to relevant external stimuli. A second aim of our paper is to contribute to the discussion regarding the adaptive and controlled nature of nutation. We apply the proposed methodology to study the nutation dynamics of bean plants while they approach a support to climb (a pole) and hypothesize that if nutation is an adaptively controlled motion, the dynamical organization of nutation must change as the plant approaches the pole. In particular, the dynamics of nutation are expected to become: (i) *more non-linear* when close to the pole; (ii) *more deterministic* due to the influence of the pole in the plant; and (iii) *more complex* as the result of being an adaptive, controlled process to achieve a behavioral goal.

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The role of chromaticity in postural control mechanisms.

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Studies relating the control of stance to imposed oscillation of the illuminated environment suggest that, in most cases, postural control is most strongly related to optic flow in the retinal periphery. We asked whether this relation might differ as a function of the chromaticity (color) of light. Detection and identification of colored stimuli is reported to be best near the fovea and declines in the visual periphery. In particular, sensitivity to red-green color variations declines more steeply toward the periphery than that of blue-green variations. It has also been reported that some colors appear to move more rapidly than others. We synthesized and extended these reports to the domain of perception-action, using chromatic lighting variations in a moving room.
We replicated common experimental designs used in the moving room paradigm, in terms of motion stimuli, trial duration, instructions to participants, and so on. Young adults were exposed to oscillation of the illuminated environment in a moving room. Room oscillation consisted of a simple sinusoid at 0.2 Hz, with amplitude of 2.5 cm. Individual trials were 60 s in duration, and participants were instructed to stand quietly, maintaining their gaze on a monochromatic pattern on the front wall of the moving room. Three different chromatic conditions were utilized: full-spectrum, red, blue, with luminance being matched across conditions. A magneticmotion capture system was used to collect postural data of the head and torso. Responses will be evaluated in terms of the positional variability of the head and torso, and separately in terms of the strength of coupling between participants and the moving room apparatus, as quantified using Average Mutual Information. We predict that coupling will be strongest in full-spectrum lighting and weakest in red lighting.

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Postural time-to-contact as a precursor of visually induced motion sickness.

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The postural instability theory of motion sickness predicts that subjective symptoms of motion sickness will be preceded by unstable control of posture. In previous studies, this prediction has

been confirmed with measures of the spatial magnitude and the temporal dynamics of postural activity. Such metrics are extrinsic, in the sense that values of these metrics do not have inherent functional meaning. For example, a particular value of self-similarity may or may not correspond to the risk of falling. In the present study, we examined whether precursors of visually induced motion sickness might exist in postural time-to-contact. This measure of postural activity is related to the risk of falling, in that for postural tau, a value of 0 s means that the individual is no longer able to recover from a postural perturbation, and must either step, stagger, or fall. Standing participants were exposed to oscillating visual motion stimuli in a standard laboratory protocol. Both before and during exposure to visual motion stimuli, we monitored the kinematics of the body's center of pressure. We predicted that postural activity would differ between participants who reported motion sickness and those who did not, and that these differences would exist before participants experienced subjective symptoms of motion sickness. During exposure to visual motion stimuli, the multifractality of sway differed between the Well and Sick groups, replicating previous studies. In addition, postural time-to-contact differed between the Well and Sick groups. This was true during exposure to visual motion stimuli, but also before exposure to any motion stimuli. The results provide a qualitatively new type of support for the postural instability theory of motion sickness. The postural instability theory of motion sickness is rooted explicitly in the concept of the detection and realization of affordances for stable control of posture, and on the consequences of failure to detect or realize these affordances. Postural time-to-contact, as an intrinsic measure that can, in principle, be perceived directly, may be the "unit" not only for the etiology of motion sickness, but also for the recovery from sickness that naturally occurs with continued exposure.

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Resource constraints on human foraging behavior

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We measured foraging patterns of human participants using Quick Response (QR) codes as simulated resources. We placed QR codes primarily on walls or railings of the interior of a school's administrative building. The task was to locate as many QR codes as possible within a set timeframe. Participants a QR scanning application on a mobile device to acquire resources by scanning the QR codes. Two experimental conditions utilized the same set of QR codes, one where all QR codes were valued equally, and another condition where a subset of fifteen visually distinctive QR codes were worth substantially more. Based on prior research on human hunter-gatherers (Brown et al.,), we hypothesized that human foraging would exhibit Lévy-like dynamics, where short movements in random directions are connected by much rarer, but much larger movements. Lévy-like behavior has been identified in a range of foraging behaviors, and may increase search effectiveness under certain circumstances (). Both the effectiveness and dynamics of search behaviors may be altered by differences in resource distributions, values, and other embodied constraints. We examined the temporal and spatial displacement series produced by participants, both individually and in aggregate. This experiment provides a template for further explorations of foraging behavior in a naturalistic, but controlled environment, allowing examination of the effects of different levels of constraints on search behavior, such as ecological, embodied, and task constraints.

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The structure of behavioural variability and complexity matching as marker of social interaction during naturalistic activities

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Previous research has provided cursory support for the hypotheses that (1) the structure of human behavioural fluctuations is co-related with differences in task activity and (2) that the structure of co-acting individuals' behavioural variability converges during social interaction—so called complexity matching. The majority of previous work investigating these two hypotheses, however, has primarily focused on a small subset of simple or contrived behaviours within the context of controlled laboratory tasks. The aim of the current study was to investigate how the structure of human behavioural fluctuations varies as a function of different naturalistic activities and the degree to which complexity matching between co-actors could serve as a task-independent marker of social interaction. Seventy-eight undergraduate students (26 individuals and 26 pairs) participated in a 1.5-hour experiment involving five self-paced (unsupervised), semi-structured activities around the University of Cincinnati campus. Wearable

technologies (Empatica E4 bio-sensing wristbands and iPhones) were used to record the participants' behavioural activity via accelerometers. Detrended fluctuation analysis was then employed to index the fractal structure of the participants' behavioural signals as a function of the different activities performed. The degree of complexity matching observed was also evaluated as a function of task activity, with a pseudo-pairs analysis employed to confirm the validity of the complexity matching results. The results revealed significant differences in the fractal structure of behaviour as a function of task activity. Additionally, pairs were found to exhibit significantly higher levels of complexity matching for all activities compared to pseudo-pairs (i.e., compared to chance), and the degree of complexity matching remained stable and robust (relatively unchanging) across the different activity types. Collectively, the results confirm that 1) the fractal dynamics of naturalistic human behaviour co-varies with the environment and task goal, that 2) the behavioural variability of co-acting pairs becomes globally coordinated during everyday co-activity, and 3) that this convergence in behavioural variability can serve as a robust, task general method for detecting social interaction.

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The coordination dynamics of learning to dance

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The current experiment investigates the coordination dynamics of dancers of various skill levels learning a dance sequence from an expert dancer. Participants were tasked with following along with the movements of the expert dancer as they performed the sequence multiple times. The speed/tempo of the dance was varied throughout the experiment in order to investigate the changes in behavioural coordination as a function of tempo. Both the expert and novice dancers' movements were tracked using a Rokoko IMU-based motion tracking system and Vive 6DF positional trackers. Results revealed changes in the stability of participant's coordination dynamics as a function of speed, time and level of expertise. In a second study, the same dance learning task was then preformed within a virtual reality environment in order to investigate the degree to which human actors can also learn dance sequences from a virtual instructor. As expected, similar effects of speed, time and level of expertise on participants' coordination dynamics were observed, with the results indicating that individuals can learn dance sequences from a virtual instructor.

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Considering the Roles of 'Empathy' in Ecological Approach from Peirce's Perspective

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There are still many debates about the concept of "empathy." This presentation clarifies the roles of "empathy" in the ecological approach, from the perspective of C. S. Peirce.
Some studies suggest the distinction between emotional and cognitive empathy (Smith 2006). They refer to the vicarious sharing of emotion as emotional empathy, and perspective taking as cognitive empathy. Since the discovery of mirror neurons, other studies consider that the mirror mechanism plays a major role in empathy (Iacoboni 2009). Furthermore, an examination of the history of "empathy" (Wispé 1986) revealed that the term is derived from "Einfühlung (feeling into)," a term used by German psychologists, which is often confused with "sympathy (fellow feeling)," as discussed by Darwin and Adam Smith.
Based on Peirce's view, I classify "empathy" as follows: (1) "sympathy" forms a whole system comprising parts such as sense of unity and belongingness; (2) "empathy" forcefully affects us from the outside, e.g., through the mirror mechanism or emotional contagion; (3) "Einfühlung" projects something from the inside to the outside, e.g., perspective taking or creation of metaphors. This classification can be applied to each of the following ecological approaches to "empathy": (1) sensorimotor empathy (Chemero 2016) or the interaction dynamics of aesthetic experience (Brinck 2018), (2) some models that link affordance with the mirror mechanism (Iacoboni 2009), and (3) ecological metaphors (Hölzl 2015). Accordingly, considering how "empathy" works in the ecological approach, I attempt to explain its social aspects.

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Bee-ing in the World: A Phenomenological-Ecological Investigation of Sensorimotor Unity in a Novel Insect Tracking Task

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The conceptual influence that the philosophical tradition of phenomenology had on James Gibson is well documented (Heft 2001). But while extensive evidence has been garnered to corroborate key concepts and ideas outlined by Gibson (1979), there has been comparatively little work to investigate the empirical support for the phenomenological antecedents of ecological psychology—a notable exception is Dotov, Nie and Chemero's (2010) examination of Heidegger's (1927) views.

Our focus is on what French phenomenologist Maurice Merleau-Ponty (1945) called the "*sensorimotor unity of the body*," a notion that few ecological psychologists know but which we think most would readily recognize as consequential. For Merleau-Ponty, being-in-the-world (i.e., our existence and experience as embodied agents) involves three aspects of sensorimotor unity. First, it involves an integration of the senses with one another: in Merleau-Ponty's example, seeing and hearing are "pregnant" with each other. Second, it involves an integration of perception and action: for him, the body is "not a collection of adjacent organs, but a synergic system" that works together "in the general action of being in the world." And third, it involves an integration of subject (the perceiver) and object (what is perceived), or in his words, it entails "the unity of the senses and of the object."

We conducted an experiment to investigate these three aspects of sensorimotor unity. Participants engaged in a multimodal orientation task in virtual reality. They were asked to track a moving target (a "bee"), which was presented in different information conditions, from audio-visual (i.e., the bee was visible and its buzzing sound was spatialized), through spatialized audio only (i.e., the bee is invisible), to no information (i.e., invisible and mono audio). Our dependent measure was angular error, or the difference between head orientation and bee position throughout the task. Besides finding a significant difference in performance using traditional analyses, our fractal analysis of the time-series using DFA also revealed a significant difference in dynamics. These results lend support to the three-pronged "sensorimotor unity of the body" Merleau-Ponty wrote about, illustrating how multimodal exploratory behavior generates information and also demonstrating the informational (de)coupling of the agent/bee system.

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An exploratory examination of play skills in three-on-three basketball games and their ecological perspective

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This study attempts to show the relation between humans and their environment in sports through the experimental examination of three play skills—dribbling, passing, and shooting—in three-on-three basketball games under the influence of the following four environmental constraints: using low bouncing balls, using ellipse shaped balls, playing in a narrow court, and playing in a wide court. As a result, constraints of the nature of balls such as low bouncing and unusual shape affected the performance of the player only while dribbling and not while passing or shooting. Through a detailed examination, it was also revealed that the performance while dribbling can functionally be differentiated into three types. And one of these types is not affected by the constraints of the nature of balls—low bouncing and unfamiliar shape—although the other two are. These results were discussed from the ecological perspective especially with the concept of "General awareness (Reed, 2001)".

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Out of sight, out of mind? Gamma oscillations during occlusion events in babies

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Data on visual tracking and reaching suggests that infants are able to have a neural representation of both visible and hidden moving objects during the first half year of life. However, little is known about how the neurons in the brain of infants behave during temporary occlusion of moving objects.
The present study investigated induced oscillatory activities in relation to temporarily occluded moving objects in the human infant brain. Using high-density EEG and frequency analysis, we analysed the induced brain responses in infants before, during, and after temporary occlusion of a car driving around a rectangular path with three different

speeds. The mean age of the infants was 10.6 months (SD = 1). All infants had between 2 and 25 weeks of self-produced locomotor experience.
The individual TSEs of the infants showed a pattern of synchronized gamma-band (> 30 Hz) activity before the occlusion of the car in the visual and central brain sources of interest, while a pattern of induced desynchronised oscillatory activity (ERD) within the gamma frequency band was found during the occlusion of the car in the visual sources of interest. TSEs of the motion after the occlusion of the car showed similar oscillatory activity as the motion before occlusion.
The synchronized event-related brain activity observed may indicate that fewer, but more specialized neuronal networks were activated in synchrony when the car was visible than when it was hidden. The desynchronized event-related brain activity observed during the temporary occlusion suggest that larger neuronal networks were communicating with each other, to keep the object in mind during the occlusion of the car. Strengthening of synaptic connections and increasing maturity of visual pathways during the first year of life may help account for the use of the high-frequency oscillations.

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The Effects of Psychological Momentum on Affordances
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The Effects of Psychological Momentum on Affordances
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In sports, psychological momentum (PM) develops when athletes perceive they are moving toward or away from a desired outcome, such as the victory (Den Hartigh, Gernigon, Van Yperen, Marin & Van Geert, 2014). According to recent research, this perception elicits positive and negative changes in athletes' psychological states (e.g., confidence, optimism), as well as their momentary abilities (e.g., Den Hartigh et al., 2014; Den Hartigh, Van Geert, Van Yperen, Cox, & Gernigon, 2016; IsoAhola & Dotson, 2014, 2016). Interestingly, abilities are a key ingredient of the concept of affordances, which are the action possibilities for organisms in their environment (Gibson, 1979). In this experimental study, we aimed to provide a first test of a possible link between PM and affordances. We examined whether athletes' judgments of affordances vary with PM. We designed a golf course on which participants, after a training, were asked to place the ball at their maximum "puttable" distance from the hole. Next, participants played a golf putting match against an opponent, in which the first to take a lead of 5 points would win the match. They wore visual occlusion goggles to prevent them from seeing the actual result, and we manipulated the scoring pattern to induce positive (from -4 to +4 points) or negative PM (from +4 to -4 points). We then asked the participants again to indicate their maximum puttable distance from the hole. Results provided first evidence for a PM-affordances link: Relative to the baseline distance (100%), the judgment of the puttable distance corresponded to 113% during positive PM (95% CI = 97% to 130%) and to 83% (95% CI = 69% to 95%) during negative PM. Together, these results suggest that athletes' affordances change when they experience positive or negative PM. This sheds a new light on the dynamics of perception-action processes and PM in sports.

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Calibration Transfer of Perturbed Optic Flow to Real and Virtual Environments
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Previous research has evaluated the extent to which individuals calibrate to different sensory perturbations. For example, when the coupling between one's walking rate and the resulting optic flow rate is disrupted, to be made either visually faster or slower, individuals have been shown to calibrate their respective walking rates (e.g., Rieser, Pick, Ashmead, & Garing, 1995). The extent to which the calibration of optic flow during walking transfers to a distance estimation task has varied greatly, and a lack a methodological consistency, specifically with respect to the types of locomotion, the virtual reality hardware employed, and the pretest/posttest environment utilized (i.e., real or virtual), have made it difficult to pinpoint an explanation for this variability. Accordingly, the purpose of the present experiment was to evaluate whether the transfer of calibration from a virtual environment to the real world is analogous to the transfer of calibration from within a virtual environment. In either a real-world or virtual environment, participants completed blind walking distance estimates before and after experiencing perturbed virtual optic flow via a head-mounted display (HMD). We used blind walking instead of imagined walking due to the importance of haptic feedback for distance estimation in the absence of visual feedback (Schwartz, 1999). To appropriately compare differences in calibration transfer to both real-world and virtual environments, the methodology and the experimental

protocol were kept identical between the two. Results showed that calibration transferred comparably to both real-world and virtual environments. However, the demonstrated calibration effects differed depending the type of perturbed optic flow experienced, with individuals in the slower optic flow condition eliciting a greater magnitude of calibration transfer to both environments. Findings suggest that perturbations in virtual environments can be calibrated and transferred to real-world environments and that newer virtual reality hardware allows for increased accuracy in distance estimation.

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The Impact of Ageing on Information-Movement Coupling in a Virtual Road Crossing Task

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Road-crossing is complex, dynamic task which requires actors to synchronize their movements to unfolding perceptual information that specifies the potential for colliding with oncoming traffic, a process known as information-movement coupling. Lee et al. (2001) demonstrated how time-based information (tau) could be used to guide movements through the principle of tau-coupling which considers the closing of two physical gaps synchronously (X and Y) by keeping the taus of the gaps in constant ratio k. When crossing the street, a strategy pedestrians could adopt is to couple their movements to the front bumper while maintaining a large aperture to ensure that the pedestrian reaches the other sidewalk first. For older pedestrians, this presents a significant challenge. Older adults often experience a decline in both perceptual abilities and physical capabilities which contributes to a decreased ability to calibrate perception to action (Doherty, Vandervoort, & Brown, 1993; Lobjois & Cavallo, 2009). Similarly, children's ability to coordinate self-movement to dynamic external information is less finely tuned than adults, despite children selecting similar temporal gaps to adults suggesting the same use of time-to-arrival information to specify affordances in road-scenarios (Grechkin et al., 2013; Morrongiello et al., 2015). This suggests the ability to adopt an effective information-movement strategy undergoes significant change throughout the lifespan. The aims of the present study were to investigate this further and see if i) pedestrians use an information-movement coupling strategy to control how they cross a gap between cars to ensure safe crossing, and ii) if age impacts on the ability to regulate road crossing speed as a function of time-based information (tau). The current study was conducted in an immersive, interactive virtual reality environment using participants from three different age groups (Children: 10-12 years old; Younger adults: 19-39 years old; Older Adults: 65+ year olds). Participants were instructed to cross the road if and when they thought it was safe to do so. The preliminary results will be presented with the present paper analysing the percentage of trials in which tau-coupling was successful across age groups and how long they maintained this coupling across different temporal gap sizes.

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Affordances and depiction

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Depiction is one of the oldest human acts. Behavioral scientists have struggled mightily to understand depictions as objects of perception. James Gibson participated in this struggle, early and often. The importance that he placed on the issue is shown by the fact that his final book (Gibson, 1979) contained an entire section devoted to depictions. The struggle continues. In part, the issues persist because behavioral scientists so often use depictions as stimuli in research. In this talk, I argue that the terms of the discussion should be shifted. Rather than focusing on depictions as objects of perception, it may be helpful to try to understand the affordances of depictions. What good are they? Why have we, for so many thousands of years, devoted so much time and effort to the making of so many depictions? What "opportunities for action" depend upon depictions, or are facilitated by depictions? I argue that depiction *is*afforded, and that depictions *have*affordances. I argue that the affordances of depictions are not different in kind from the affordances of many other things. I offer a list of the uses that we make of depictions. That is, I describe some opportunities for action that (I claim) people have attempted to exploit using depictions. I note that humans are not the only species that use depiction to accomplish perception-action goals and that, accordingly, any analysis of depictions cannot be limited to *human* depictions. Critically, I argue that the affordances of depictions (e.g., a photograph of a rock) often differ qualitatively from the affordances of things depicted (e.g., a physical rock). This argument leads to important implications for our use of depictions as "substitutes for reality" in perception-action research.

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Exploratory behaviors affect motor learning in board sports
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It has been suggested that learners need to explore and discover new motor behaviors by sensing various information from the environment and their own body. Thus, even when all learners are instructed in an identical environment, the rate at which motor learning progresses often differs across individuals. This observation suggests that the motor learning process is associated with the way the learner discovers and explores novel environmental information or relationships among limb movements. This study investigated associations between the characteristics of the exploratory behavior of each learner, and individual differences in the rates at which motor learning occurred, by longitudinally observing the developmental process by which participants learned to ride a caster board. A caster board is shaped like a skateboard but has two decks jointed by a torsion bar and one wheel mounted to each deck with a caster. As the two decks twist back and forth, moving both front to back and side to side, the board is propelled forward without the need to place a foot on the ground. Instead, a rhythmical twisting motion of the rider's shoulders, hips, and legs moves the board forward. Subjects in this study were asked to learn to perform two rounds on a caster board in a 5m × 5m area without falling. The kinematics of their riding behavior were recorded using four optical motion-capture system cameras.Variations in the range and rhythmicity of the trunk rotation and of the posture were analyzed according to the characteristics of the exploratory behavior of each subject in each trial. The results showed that fluctuation in these variables was associated with the process of skill acquisition. That is, their learning progressed as the learners themselves explored and used a trial-and-error approach to learning various movements. It suggests that the exploratory behaviors of each learner affect individual differences in motor learning progresses in a board sport.

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Affordances as semantic information: a proposal for a quantitative formalization
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Affordances are a central notion of ecological psychology as they determine possibilities of an animal in an environment and enable goal-oriented action. They define value (semantics) of the environment from the vantage point of an animal. However, affordances were only defined in a rather informal manner by James Gibson. Contemporary authors, especially Turvey and Chemero, proposed more formalized approaches to defining affordances, but such which are not-quantitative and in which all definitions are formulated case-by-case with respect to specific possibilities and features of an animal and/or environment. Hence, they are not generic and are of little help in tasks such as detection of factors constituting affordances in complex animal-environment systems or measurement of complexity of an environment with respect to an animal.
In the presentation I show how affordances can be defined in a formal, generic and quantitative way while honoring their relational ontology using a method based on information theory and recent developments in complex systems theory and related fields. Starting from the idea of (semantic) information as a *difference-that-makes-a-difference* – which can be traced back to cybernetics of Gregory Bateson – I argue that affordances themselves can be viewed as such differences, and thus they can be viewed as semantic information, that is information functionally significant for an animal. Then, I show how the problem of measuring semantic information can be tackled in the context of ecological psychology and for this purpose I adapt a recently developed method which was originally formulated in thermodynamical terms. In the end I show how this approach can be used to detect relations between features of an animal and an environment that are associated with affordances and to measure complexity of an environment with respect to an animal. The example analysis is based on a simple, idealized model of an animal-environment system.

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Performing Bimanual Rhythmic Coordination Under Stereotype Threat
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Stereotype Threat (ST; Steele & Aronson, 1995) is a phenomenon which occurs when one "is in a situation or is doing something for which a negative stereotype about one's group applies." (Steele, 1997, p 614) Experiencing ST typically causes one to perform worse on the task at hand, with a variety of possible mechanisms responsible. ST research has historically focused on academic contexts, investigating ways in which it may contribute to achievement gaps, as well as possible interventions. However, there is evidence that ST can also affect athletic performance. The athletic tasks employed in ST research typically do not provide dependent variables with well-

founded relationships to factors which feature in modern theories of motor control and coordination. Such dependent variables may instead be found in paradigms stemming from the synergetics perspective of Haken (1983/1987), particularly its formalization in the Haken-Kelso-Bunz (HKB) model of rhythmic coordination (Kelso, 1984; Haken, Kelso, & Bunz, 1985).
The current experiments induce ST in the context of a bimanual rhythmic coordination (pendulum swinging) task, based on the HKB model. Demonstrating ST in a rhythmic coordination task may provide new insight into the mechanism(s) by which ST operates, and relatedly, the range of factors which have the potential to influence basic coordinative processes. In Experiment 1, ST was induced for one group of participants in a between-groups design. Movement frequency and detuning were manipulated within-subjects. Cross-recurrence quantification analysis (CRQA) and analyses of aggregate measures (mean relative phase, SD of relative phase) were performed on time series data from the coordination task. Analyses were also performed on multiple self-report measures (stereotype activation, mood, task difficulty, rhythmic coordination experience and competency). In Experiment 2, a distraction task was added. Results suggested that ST can be induced in rhythmic coordination: ST yielded significantly lower ratings of perceived rhythmic coordination competency, higher stereotype activation, and more negative mood compared to others. ST also led to marginally higher standard deviation of relative phase.

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Difference in bifurcation mode of attacking and defensive action observed in kendo players with different skill levels

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We aimed to investigate the perceptual-motor control mechanism of kendo players that enables rapid (completed in < 0.5 s) switching movement. Expert (N=8) and intermediate (N=8) male kendo players were instructed to step forward to the opponent (co-operator) from the basic preparatory posture. If the opponent moved his right forearm ("*kote*") to the front of his chest, participants were instructed to strike the opponent's *kote*. Both the experts and intermediates were fully trained to strike the opponent's *kote* with a 1.2-m-long bamboo sword "*Shinai*", held with both hands, in < 0.5 s to move the opponent's *kote*. Conversely, if the opponent attempted to strike the participants' heads ("*men*"), participants had to withdraw their striking action and switch to the defensive action to prevent the opponent's *Shinai* hitting the participant's head using their own *Shinai*. We measured the participants' three-dimensional position of whole-body segments, including the head, trunk, foot, and *Shinai* using 27 reflective markers' positions, which were recorded using an optical motion capture system (360 Hz, Prime17w, OptiTrack, Inc.). These data were used to calculate the roll-pitch-yaw angle of each segment. In both groups, the participant's head was stabilized to the direction of the opponent's *kote* during striking action that was maintained by compensatory rotation of the head-trunk segments. On the other hand, when the participants switched to the defensive action, all intermediates tilted the *Shinai* to the right side, whereas the experts moved the *Shinai* to the left side trajectory similar to that for their striking action. Thus, kendo players basically tilt *Shinai* to the right side to take defensive action, and intermediates' actions would be bifurcated in this manner. Experts also could attack or defend by switching left and right trajectory, but they also switch to the defensive action while initiating the attacking (i.e., left tilt) posture of *Shinai*. This qualitatively different movement of the experts would emerge from the attractor space that would include not only two attractors for left (attack) and right (defense) trajectories, but also different attractors that would be bifurcated from initial trajectory to the attractor of attacking action.

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A high-density EEG study of differentiation between two speeds and directions of simulated optic flow in adults and infants

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A high-density EEG study was carried out to investigate cortical activity in response to forward and backward visual motion at two different driving speeds, simulated through optic flow. Participants were prelocomotor infants at the age of 4–5 months and infants with at least 3 weeks of crawling experience at the age of 8–11 months, and adults. Adults displayed shorter N2 latencies in response to forward as opposed to backward visual motion and differentiated significantly between low and high speeds, with shorter latencies for low speeds. Only infants at 8–11 months displayed similar latency differences between motion directions, and exclusively in response to low speed. The developmental differences in latency between infant groups are interpreted in terms of a combination of increased experience with self-produced locomotion and neurobiological development. Analyses of temporal spectral evolution (TSE, time-dependent amplitude changes) were also performed to investigate nonphase-locked changes at lower frequencies in underlying neuronal networks. TSE showed event-related desynchronization activity in response to visual motion for infants compared to adults. The poorer responses in infants are probably related to

immaturity of the dorsal visual stream specialized in the processing of visual motion and could explain the observed problems in infants with differentiating high speeds of up to 50 km/h.

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Coordinating postural sway: Do children with and without a neurodevelopment disorder differ?
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Children with a neurodevelopmental disorder, such as autism, ADHD and dyslexia, often experience learning problems. However, many of them also experience problems with postural control. One potential explanation is that this is the result of a deficit in the cerebellum, which may result in a timing deficit. In the present study, we examined one such timing mechanism, namely the interpersonal coordination of postural sway. Data was collected for dyads consisting of either children with (n=183) or without (n=106) a neurodevelopmental disorder. In a cooperative task, these dyads had to recreate as many tangram puzzles as possible within 10 minutes. In addition, children performed the task individually before and after the cooperative part. While performing the tangram puzzle task, the children both stood on a Nintendo Wii Balance Board that recorded their individual postural sway. The collected postural sway data was first analyzed using Cross Recurrence Quantification Analysis and subsequently subject to a Multilevel Regression Analysis. Our results showed that a) dyads performed better than individuals and b) that normally developing children outperformed children with a neurodevelopmental disorder in the cooperative task. However, both groups showed comparable coordination of postural sway. Thus, although the outcome is different (i.e., dyads without a neurodevelopmental disorder outperformed the dyads with a neurodevelopmental disorder), the underlying process appears to be similar for both groups.

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Effects of Arm Restriction on Reaching Judgments and Associated Perceptual Learning
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Exploratory movements provide information about agents' action-capabilities in a given environment (i.e., affordances). For example, regarding reaching, it is well known that exploratory head movements specify egocentric distance (Bingham & Stassen, 1994; Bingham & Pagano, 1998; Mantel, Stoffregen, Campbell, & Bardy, 2015). Further, there is initial evidence that exploratory arm movements specify arm length. Specifically, manipulation of the arm's inertia tensor, which is revealed through exploratory arm movements, influences reaching judgments (Anderson & Turvey, 1998).
The current experiment sought further evidence regarding whether exploratory arm movements are necessary to make accurate reaching judgments. To do so, an arm restriction paradigm was employed. It is well-known that restricting relevant exploratory movements degrades the accuracy of affordance judgments (e.g., Mark et al., 1990; Yu, Bardy, & Stoffregen, 2011). Therefore, if exploratory arm movements are necessary to make accurate reaching judgments, then restricting arm movements should degrade the accuracy of reaching judgments.
Participants (n = 32) judged their maximum reaching ability either while holding their arms behind their backs with their dominant hand grasping their non-dominant wrist (Restricted Condition), or while their arms swung naturally at their sides (Unrestricted Condition). Judgments were made actively, by walking forward or backward, in order to allow participants to generate the exploratory movements they would normally create (with the exception of arm movements in the Restricted condition) when moving toward an object with the intention to perform a reach (Mantel, Bardy, & Stoffregen, 2010). Each participant completed nine experimental trials.
Judgment accuracy was significantly greater when arm movements were unrestricted as compared to when restricted, supporting that exploratory arm movements are a component of reach-ability judgments. Further, participants' judgments improved over trials only when their arm movements were unrestricted, and the benefits of this learning did not carry over when the unrestricted condition was immediately followed by the restricted condition. This learning occurred without performance feedback, and is in line with prior findings that have indicated that exploration is necessary not only to make accurate affordance judgments, but to improve one's judgments over time (e.g., Mark et al., 1990).

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Multiscale Modeling of Transitions in Social Coordination Dynamics

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Social actions and interactions are pervasive in human life. However, in some social interactions, particularly in collaborative contexts (e.g., teamwork and psychotherapy), the effectiveness of those interactions can directly facilitate desirable/undesirable outcomes (e.g., successful team problem solving, therapy effectiveness). Varying forms of interpersonal coordination in different modalities (e.g., behaviors, speech/language, and physiology) emerge in many interactions and these can function toward facilitating effective interaction processes and outcomes (Louwerse et al., 2012; Palumbo et al., 2017). During social interactions, as in any dynamical system, patterns of coordination form and dissipate at different scales.
Historically, researchers have used aggregate measures to capture coordination over time. While those measures (e.g., mean relative phase, cross-correlation, coherence) have provided a wealth of information about coordination in social settings (e.g., Marsh et al., 2009), some evidence suggests that coordination may change over the time course of typical experimental settings and vary at different scales (e.g., Schmidt et al., 1998; Wiltshire et al., 2018). Thus, we posit that we should move beyond quantifying aggregate measures of coordination for a given interaction by focusing on how the relative strength of coordination changes over the time and scales that comprise social interaction.
Our multiscale approach involves two general processes, which we apply to a dyadic collaboration data set (Chanel et al., 2013). First, we utilize a wavelet transform to decompose social action time series into their component frequencies (i.e., scales), preserving temporal information and then, quantifying phase synchronization at each of these scales between series of two social actors (Tass et al., 1998). Second, we provide example applications of several methods for capturing transitions in coordination dynamics including dynamical complexity (Schiepek & Strunk, 2010) and thresholded cross-wavelet coherence plots (Fujiwara et al., 2016). Our goal is both pedagogical and practical, illustrating points of convergence and divergence for these methods. We advance directions for understanding the function of coordinated social action across contexts so that, in turn, this information can be used to augment the efficacy of those interactions.

References Available Upon Request

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Phase Transitions in Coordination of the Wrist to Other Body Parts at Different Tempi in Professional Drum-set Players

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Drum-set players need to coordinate the different body parts to play the instrument at a requested tempo. What kind of postural control enables them to achieve this? The present study investigated how the phase of the right wrist changes with respect to that of the elbow, the shoulder, and the head in professional drum-set players as a function of tempo (N=3). Participants performed an 8-beat rhythm task at different tempi using an electric drum set consisting of hi-hat cymbals, a snare drum, and a bass drum. Tap-pressure data of each instrument and 3D motion data of the participant were recorded and analyzed. As indices of performance accuracy, synchronization error of tapping with a metronome for each instrument was calculated from the tap-pressure data. Using the vertical displacement extracted from the 3D motion data, continuous relative phases of the right wrist-7th cervical vertebra, the right wrist-right shoulder, the right wrist-right elbow were calculated. We found the followings: as for the synchronization error, the higher the tempo, the smaller the error. Meanwhile, the tapping preceded the metronome at all of the tempi for every instrument. There were various patterns in the relative phase for 60 bpm and 120 bpm. For example, some relative phases (e.g., the wrist-C7) kept approximately 90 degrees, while others (e.g., the wrist-elbow, the wrist-shoulder) exhibited different patterns. At 180 bpm, however, the relative phases under discussion were in the in-phase mode for every participant. That is, at the fastest tempo in this study, the body parts were synchronized along with the vertical axis. Although the task of playing the drum-set at 180 bpm only with the wrist may be extremely difficult even for professional drummers, they may have achieved this by employing the entire body parts coordinated along with the vertical axis. In the future, we will acquire more data to enhance the robustness of the present findings.

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Equipment specifically designed to physically-couple players influence interpersonal triadic coordination in football

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Interpersonal triadic coordination is an important skill for promoting the self-organization of collective sports. In a previous study, we clarified that expert and novice triadic coordination skills could explain the different types of synchronization patterns of three-coupled oscillators, in a three-versus-one ball possession task in football (Yokoyama & Yamamoto, 2011). These skill differences could explain the symmetry degree of coupled oscillators. Moreover, we revealed that “social forces” depending on the interpersonal distance were related with the emergence of expert type of synchronization called as rotation pattern. Such “social forces” could be induced by a specifically-designed equipment to physically-couple the three players by elastic bands (Yokoyama et al., 2018). The aim of the present study was to test two types of equipment to physically-couple players, which present different degrees of coupling symmetry. These tools were ``one-band tool” connecting the triad of players by one long elastic band and ``three-bands tool” connecting the players with three separated elastic bands. 16 male elemental school students were split into 4 groups. All groups performed three trials in each of the three conditions: one-band condition, three-bands condition and control condition without band. Infrared cameras captured two-dimensional coordinate positions of participants. Three inner angles of a triangle composed by players were applied to the synchronization analysis. Three conditions were compared by using two dependent variables, ball passing frequency and the time of rotation pattern. Statistical analysis of ball passing frequency showed no significant difference among three conditions (p = 0.35), but the time of rotation pattern showed marginally difference (p = 0.085). These results suggest that the equipment tested in this study do not immediately improve the performance such as ball passing skill, but may influence the synchronized movement during interpersonal triadic coordination. However, we could not confirm the clearly difference between one-band and three-bands’ equipment. This means that the difference in symmetry degree do not influence the novice child players. To develop this equipment for increasing the “social forces”, further research is needed, including a bigger sample, more age groups, and conditions for learning.

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Multiple affordances on playground: Differential effects in kindergarten children

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The playgrounds in educational centers have the function of providing a space that allows children to carry out recreational activities. These areas can promote physical activity, play and socialization, among others. The playground, therefore, suppose a natural space for the observation and identification of multiple affordances. The objective of this study was to identify the affordances and the modes of action according to the kindergarten grade of the children. Four groups were videotaped: Toddler, Beginners, Grade 2, and Grade 3, with ages between 3 to 6 years. Each group was videotaped for 10 minutes, then a focal observation was made to record the different behaviors of the children, which were determined based on Heft (1988)’s taxonomy, which is a functional classification of the affordances for playground. The categories of analysis allowed to identify in each structure of the environment, the affordances, and the different modes of action. A differentiated use of the structures according to the kindergarten grade was observed, that is, the older children preferred larger structures (e.g., stairs, large sliders, bars), while smaller children preferred walk and run around fixed objects, as well as the use of smaller structures (stairs and small sliders). The results allowed to identify different patterns and distributions in the use of the affordances according to the kindergarten grade of the children. These structures for the development of the child from an ecological perspective is highlighted.