XVIII International Conference on Perception-Action

Proceedings

July 14 - 18 2015
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Proceedings

of the

XVIII International Conference on Perception and Action

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Organized by

Michael G. Wade and Thomas A. Stoffregen

Sponsored by

International Society for Ecological Psychology
University of Minnesota School of Kinesiology
University of Minnesota Center for Cognitive Sciences
University of Minnesota Center for Clinical Movement Science

Scientific Committee

Contents

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To all of these we offer our grateful thanks.

Daily Program

Tuesday, July 14

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Frederick R. Weisman Art Museum, Minneapolis

18:30 – 20:30 Opening reception
Frederick R. Weisman Art Museum, Minneapolis

Wednesday, July 15

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10:15 – 10:30 Break

10:30 – 12:00 Open Forum A Chair: Ludovic Marin

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The width of the multifractal spectrum
Zsolt Palatinus, Kinga Palatinus, Damian Kelty-Stephen, & Alen Hajnal
Function distance and negative hysteresis in human gait transitions
Mohammad Abdolvahab
Hybrid switching dynamical system: Toward understanding complex human behavior
Yuji Yamamoto, Akifumi Kijima, Motoki Okumura, Keiko Yokoyama, & Kazutoshi Gohara

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13:15 – 14:45 Smart perceptual instruments and perception of affordances
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The polar planimeter in us all
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Use your (smart) head! Cephalic perception of affordances of surfaces
Jeffery B. Wagman & Alen Hajnal
Locomotion through apertures as the person-plus-object system: When the body is off the center
Takahiro Higuchi, Maki Chiba, & Masashi Kusumi
Action experience facilitates recalibration to changing affordances when squeezing through doorways
John M. Franchak & Karen E. Adolph

14:45 – 15:15 Break

15:15 – 17:00 Open Forum B Chair: John Franchak

Geometric layout of shared space inspires shared intention in a stepping triad
Akifumi Kijima, Yuji Yamamoto, Hiroyuki Shima
Perceiving places
Harry Heft & Justine Hoch
Time, embedded meaning, and ecological science
Richard Schmidt
Embodied memory: The theory, evidence, and application
Jing S. Pan & Geoffrey P. Bingham
A peoples' history of embodiment
Thomas A. Stoffregen

17:00 – 18:30 Poster session I

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08:30 – 09:40 Ecological Principles in Design
Organizers: Bruno Mantel and Elise Faugloire

Designing and evaluating an interface for exploring distant places through mobile robot teleoperation
Bruno Mantel, Jean-Clément Devaux, Paul Nadrag, Philippe Hoppenot & Etienne Colle

Ecological Interface Design: Skilled Coupling of Perception and Action in Sociotechnical Ecologies
John Flach

Overview of the Increasing Use of Affordances in Engineering
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09:40 – 10:10 Break

10:10 – 12:00 Open Forum C Chair: Richard Schmidt

Sculpting the voice
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Social coordination dynamics and deception
MaryLauren Malone & Michael J. Richardson

Enhancing socio-motor competences: Impact of behavioural matching and behavioural synchrony
M. Gueugnon, R. N. Salesse, Benoit G. Bardy, Z. Zhao, Richard C. Schmidt, & Ludovic Marin

Mutual perception of the layout of affordances influences the control of joint actions
Tehran J. Davis

Playing PONG together: An experimental paradigm to study interpersonal coordination
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12:00 – 12:30 ISEP Business meeting

12:00 – 13:30 LUNCH

13:30 – 15:00 Open Forum D Chair: David Anderson

Focusing on transfer: Rehabilitation research from an Ecological perspective
Ludger van Dijk, Corry van der Sluis, & Raoul Bongers
Can flexibility of reaching movements be increased through training?
I. Tuitert, L. J. Mouton, M. M. Schoemaker, & Raoul Bongers
Not all is lost when ageing: Reaching flexibility doesn't decrease
Raoul M. Bongers, Christian Greve, & Tibor Hortobagyi
Does similarity promote social interaction in schizophrenia?
Ludovic Marin, R. N. Salesse, C. Bortolon, M. Gueugnon, Z. Zhao, S. Raffard, D. Capdevielle, Richard Schmidt, N. Schmitz, J. Henriques, D. Stricker, M. Di Bernardo, K. Tsaneva-Atanasova, P. Slowinski, C. Zhai, & Benoit G. Bardy

15:00 – 15:30 Break

15:30 – 17:00 Information and the prospective control of lateral interception: A new perspective

Organizers: Reinoud Bootsma and Frank Zaal

Reconsidering information for movement
Reinoud Bootsma, Simon Ledouit, Remy Casanova, & Frank T.J.M. Zaal
Reversal movements in the lateral interception of rectilinear ball trajectories
Simon Ledouit, Remy Casanova, Frank T.J.M. Zaal, & Reinoud Bootsma
Evaluating models for prospective control of lateral catching: What is the order of the information needed?
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Spatiotemporal domains of IOVD and CDOT for perceiving time-to-contact
Aaron J. Fath, Mats Lind, & Geoffrey P. Bingham
Perception of catchability of fly balls
Dees B. W. Postma & Frank T. J. M. Zaal
The initiation of running to catch fly balls
Frank T. J. M. Zaal, Harjo J. de Poel, & Gert-Jan Pepping
The art and science of the camera obscura
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Selecting the optimal strategy for the adaptive rhythmic auditory cueing of Parkinsionian walk
D. G. Dotov, S. Bayard, V. Cochen de Cock, B. Bardy, & S. Dalla Bella
Perception-action based intervention to reduce ACL injury risk
Michael A. Riley, Scott Bonnette, Adam W. Kiefer, Christopher DiCesare, and Gregory Myer

12:00 – 13:30 LUNCH

13:30 – 15:00 Advances in strong anticipation and complexity matching
Organizer: Drew Abney

Strong anticipation or good old-fashioned sharing of multifractal fluctuations
Damian G. Kelty-Stephen
Local interactions support complexity matching
Justin M. Fine, Aaron D. Likens, Eric L. Amazeen, Polemnia G. Amazeen
Global coordination and complexity matching in interpersonal movement coordination
Auriel Washburn, Charles A. Coey, Michael J. Richardson
Complexity matching and multiscale clustering of vocalizations during naturalistic infant-caregiver interactions
Drew H. Abney, Anne S. Warlaumont, D. Kimbrough Oller, Sebastian Wallot, Christopher T. Kello

15:00 – 15:30 Break

15:30 – 17:00 Dynamic touch: Emerging Themes, new developments
Organizers: Patrick A. Cabe and Jeffery B. Wagman

Perception by dynamic touch from head to toe: Riddles, wrists, and recalibration
Jeffery B. Wagman
The body's tensegrity architecture and dynamic (effortful) touch
Michael T. Turvey
Haptic distal spatial perception mediated by strings: Touch as a telemodality?
Patrick A. Cabe
Using an anchor system to haptically stabilize human postural control
Eliane Mauerberg-deCastro, Carolina Pailoi Tavares, Gabriella A. Figueiredo, Debra F. Campbell, and Renato Moraes

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08:30 – 10:00 Open Forum F Chair: Sarah Cummins-Sebree

Medium facilitates the perception of affordances for touch
Kiyohide Ito, Mamoru Sawada, Hiroyuki Mishima, Masashi Takiyama, & Yusuke Kikuchi
Possibilities for action stabilize the perception of multistable displays
Dobromir Dotov
Postural kinematics in support of affordance perception
Eric Haaland
Do multiscale interactions predict affordance perception?
Alen Hajnal, Zsolt Palatinus, Jonathan K. Doyon, & Joseph D. Clark

10:00 – 10:30 Break

10:30 – 12:00 Open Forum G Chair: Kiyohide Ito

Music-induced synchronization of biological systems
Benoit G. Bardy
Relationship between affordance and information from a semiotic perspective
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Medium perception robots
Miki Goan, Katsuyoshi Tsujita, Susumu Kihara, & Kenjiro Okazaki
Direct perception of uncertainty as a framework for urban design
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12:00 – 13:30 LUNCH

13:30 – 15:00 Open Forum H Chair: Tehran Davis

Distance-to-break in the haptic perception of compliant materials
Leah Hartman, Bliss M. Altenhoff, Christopher C. Pagano, Irfan Kil, & Timothy C. Burg
The influence of grip position on gaze and posture in handwriting
Yusuke Kikuchi
Wild bearded Capuchin monkeys crack nuts dexterously
Madhur Mangalam & Dorothy M. Fragaszy
The Gibsonian concept of information and its philosophical implications
Tetsuya Kono

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15:30 – 17:00 Open Forum I Chair: Audrey van der Meer

Perception of sex in point-light displays
Julie A. Weast, Sade McKenzie, Kevin Shockley, & Michael A. Riley
The visual control of walking over complex terrain
Bret R. Fajen, Jonathan S. Matthis, & Sean L. Barton
The visual coupling between neighbors in a virtual crowd
William H. Warren & Kevin W. Rio
Quantum-like issues at the ecological scale
Michael T. Turvey

19:30 – 21:30 Conference Banquet
Courtyard Hotel, Minneapolis (conference hotel)

Symposium Abstracts

Symposium

Dual affordances, effectivities, and their further theoretical implications

Organizer: William M. Mace

Dept. of Psychology, Trinity College, Hartford, CT

The talks in this symposium will present new ideas about the organization of affordances and effectivities. Even the ideas that are not so new (e.g. effectivities as process, not dispositions) have been "under the radar" and deserve more focal attention. The first talk by Mace will review the highlights of the new modifications in the framework. Saltzman will show how the new ideas facilitate his thinking about the coordinative structure graph. Jeffrey Kinsella-Shaw and Robert Shaw then will review a number of ways affordances have been described in the current literature. Finally, Robert Shaw and Jeffrey Kinsella-Shaw will present the affordance – effectivity duals with an emphasis on effectivity as process and affordance as disposition. They note that effectivities as well as affordances originally were described as dispositions. However, if both affordances and effectivities are dispositions, then there is no natural ecological concept to actualize an affordance goal. Their ideas address the question: What must happen for an action to actually occur?

The importance of duality in shaping a new view of affordances and effectivities

William M. Mace

Dept. of Psychology, Trinity College, Hartford, CT

In ecological psychology investigators have talked about affordances as opportunities for action and about the guidance of action, but have not developed natural ways to talk about the actualization of an act, or, as Robert Shaw and Jeffrey Kinsella-Shaw (Shaw and Kinsella-Shaw,1988; Shaw, 2001) have framed it in intentional dynamics, the realization of affordance goals. The symmetry inherent in the duality concept overarching the animal-environmental fit was taken to be a symmetry between potential actions (called effectivities) and the environmental circumstances (the affordances). Whatever "got an animal going" and the processes of selecting some actions over others were taken for granted as important for an overall psychology but the study of motivation and action selection seemed outside of the system. Meanwhile, as Shaw developed the ecological approach to goal directed behavior in his intentional dynamics, effectivities began to take on the process role that was missing before. The fact that this theoretical change was developing was not emphasized as a change and went somewhat unnoticed. Here are the highlights that have emerged in the most current thinking: Effectivities are process, affordances are dispositions. It must be recognized that animals have a repertoire of potential actions that ARE dispositional. Shaw and Kinsella-Shaw now argue that these too should be dubbed affordances (formerly effectivities). On this view, there now are affordances of the environment and affordances of the body. For example, the grasper capacities of the body as well as what is graspable in the environment are both dispositions and (it is proposed) *both* should be called affordances. The processes involved in the actualization of a real grasp would be an effectivity. A process of actualization, that is, from potential to actual, requires working down Shaw's cascade of ontological descent.

References

Shaw, R. & Kinsella - Shaw, J. (1988). Ecological Mechanics: A Physical Geometry for Intentional Constraints. *Human Movement Science, 7* 155 - 200.

Shaw, R. E. (2001). Processes, Acts, and Experiences: Three Stances on the Problem of Intentionality. *Ecological Psychology, 13*, 275 - 314.

On the emergence of functional activities from the dynamics of coordinative structures, affordances, and effectivities

Elliot Saltzman

Boston University, Boston, MA and Haskins Laboratories, New Haven, CT

The concept of coordinative structure (CS) has traditionally been used to refer to ensembles of muscles and joints that are recruited temporarily in a function-specific manner to perform a given task using an action type (e.g., locomotion) and movement form (e.g., running) that are consistent with the current set of organismic and environmental constraints (e.g., Turvey, 1990). When 'selected' and 'activated', such structures define the dynamical systems from which functional, goal-directed activities can emerge. These systems can be completely characterized according to three types of variables—states, parameters, and graphs (i.e. node-link architectures)—and their dynamics (Farmer, 1990). Recently, Saltzman & Caplan (2014) have focused on the coordinative structure graph (CSG) and extended the notion of coordinative structure beyond the traditional 'within-agent' graph for which body segments are nodes and task-specific intersegmental informational couplings are the links that create task-required patterns of end-effector motions. In their extended version, CSG's also span agent and environment. Nodes are identified with an agent's set of task-relevant end-effectors and the set of task-relevant objects, surfaces, and other agents in the environment; links are identified with the set of functional couplings between the nodes. Thus, CSG's can be used to formalize, not only the task-specific architectures of informational linkages among an agent's musculoskeletal degrees of freedom, but also the task-specific architectures of physical and perceptual/informational linkages that shape both physical interactions between agent and environment as well as social/communicative interactions between agents. In Saltzman & Caplan (2014), CSGs were used to provide a formalism for incorporating affordances into a dynamical systems framework of perception-action, in which the graph-dynamic creation, maintenance, and dissolution of links corresponding to affordance-effectivity coupling relations were posited to provide a basis for action selection and activation processes. In that formalism, affordances and effectivities were defined within the theoretical framework described in Shaw, Turvey, & Mace, 1982. The present contribution to this symposium will describe how the evolution of the Shaw, et al. (1982) framework into its present form, as detailed in the companion presentations in this symposium, has led to a more elegant and seamless formalization of the role of CSG's in action selection and activation. Further, this new framework has provided a basis for future work on affordances, effectivities, coordinative structures, and functional activities that is both 'cleaner' philosophically and more powerful scientifically.

References

Farmer, J. D. (1990). A Rosetta stone for connectionism. *Physica D, 42*, 153-187.

Saltzman, E., & Caplan, D. (June, 2014). Parallels between the dynamics of coordinative structures serving physical manipulation and social communication functions: Grounding agents in their environments, complex affordances, compositionality, and action grammars. Paper presented at the conference on *Finding Common Ground: Social, Ecological, and Cognitive Perspectives on Language Use*. University of Connecticut, Storrs CT, USA.

Shaw, R., Turvey, M., & Mace, W. (1982). Ecological psychology: The consequence of a commitment to realism. In W. Weimer & D. Palermo, (Eds.). *Cognition and the symbolic processes*. Hillsdale, NJ: Erlbaum Press. Pp. 159–226.

Turvey, M. T. (1992). Affordances and prospective control: an outline of the ontology. *Ecological Psychology, 4,* 173–187.

A heuristic taxonomy of the affordance concept usage

Jeffrey Kinsella-Shaw[1,2] and Robert Shaw[1]

[1]Center for the Ecological Study of Perception and Action
[2]Department of Kinesiology
University of Connecticut
Storrs, CT

While there is broad agreement concerning the value of Gibson's concept of affordance to the ecological enterprise, there is significant variation in the concept's usage in both experimental and theoretical contexts. For convenience we are going to employ a heuristic taxonomy, an affordance space, analogous to a semantic space (Osgood, Suci & Tannenbaum, 1957) defined over the following dimensions: (1) abstract-to-concrete, (2) general-to-particular, (3) potential-to-actual, & (4) invariant-to-variant. For illustrative purposes we locate examples of different treatments of the concept of affordance from a sampling of authors in this space. This is intended to be a representative sample only, not inclusive of all published perspectives, to encourage discussion of the usage of the affordance concept and its relationship to other concepts (e.g., effectivity, coordinative structure). We will focus on how different usages of the affordance concept confer upon it differing degrees of ontological stability. We will then examine what the potential utility is of these different treatments for an ecological theory that aspires to providing a sound scientific basis for an account of intentional actions consistent with task dynamics, as discussed in the previous talk. The requirements for this are explored in the next talk.

Reference

Osgood, C.E., Suci, G., & Tannenbaum, P. (1957) *The measurement of meaning.* Urbana, IL: University of Illinois Press

Dual organism-environment affordances potentiate actions and render the dual effectivity processes that actualize them

Robert Shaw[1] and Jeffrey Kinsella-Shaw[1,2]

[1]Center for the Ecological Study of Perception and Action
[2]Department of Kinesiology
University of Connecticut

What emerges from the semantic space approach introduced in the last talk is a different use of the affordance term than heretofore recognized. Also, we want to emphasize what we take to be the proper meaning of the term "effectivity" and point out how it differs from a popular current usage. In this talk, we revisit the mistaken claim introduced in one of our earliest papers that *affordances and effectivities are dual dispositions* (Shaw, Turvey and Mace, 1982). This claim is both right and wrong. It is right in claiming they are duals but wrong in claiming they are *both* dispositions. Affordances are indeed dispositions but effectivities most assuredly are not. The issue devolves on the realization that if both affordances and effectivities were dispositions, then no actions could take place. But, on the other hand, if they were not duals, then no actions could take place either.

We discuss three requirements for actions to occur: *First*, affordances and effectivities must "fit" one another (by being duals), that is, they must share a common basis (i. e., have *dimensional homogeneity*), or the degrees of freedom problem would not be solvable. *Second*, there must also be a process involved. As Aristotle taught us, it takes a process, an effective action (or, effectivity in our language), to change a potential into an actual. Otherwise, it would be like having two qualified candidates nominated for president but no election process taking place, so the office though potentially fillable is never actually filled. Or, it would be like having two sources of potential energy that might be used to do work but cannot actually be used to do so. For the work to be performed, there must be a dynamical process that transforms potential energy into kinetic energy. (Illustrated with several examples). More precisely, in keeping with task dynamics (analogous to the coordinative structure concept as discussed in the earlier talk), for any potential action to be realized, an effectivity must be a process of cascading constraints that squeezes out all redundant and irrelevant degrees of freedom or else the intended action remains forever dormant (Shaw and Kinsella-Shaw, 1988). The perceiving-acting cycle over the span of a task, as we shall show, is the effectivity process (a path propagator) that does this job. And *third*, for an intended action to be successful, the organism's own affordances, its abilities, must match affordance demands of its environment. That is, whenever an organism succeeds in performing a specific intended action, the organism's own affordances (i.e., its abilities) must become dually attuned to the relevant affordances (action opportunities) that its environment affords

To summarize: Analogically speaking, if an affordance is like potential energy, then an effectivity is like its dual, kinetic energy. One is the disposition for work-to-be-done, while the other is actually doing the work! And, as duals, like potential and kinetic energy, they also must sum to a conserved quantity (Shaw, et al, 1992). Finally, seeing a clear distinction between dispositions and processes, we can then appreciate that an affordance's role is to potentiate actions, while its dual effectivity's role is to actualize them. The actor is locked in a synergy with its environment so they adjointly co-author the dynamical process, or effectivity, that realizes the action mutually afforded by both the environment and the organism.

References

Shaw, R., Turvey, M. & Mace, W. (1982). Ecological psychology: The consequence of a commitment to realism. In W. Weimer & D. Palermo (Eds.) *Cognition and the symbolic processes II*. Hillsdale NJ: Lawrence Erlbaum Associates, Publishers.

Shaw, R. & Kinsella-Shaw, J. (1988). Ecological Mechanics: A Physical Geometry for Intentional Constraints, *Human. Movement Science.*, 7, 155.

Shaw, R., Kadar, E., Sim, M., & Repperger, D. (1992). The intentional spring: A strategy for modeling

Symposium

Smart perceptual instruments and perception of affordances

Organizers: Jeffrey B. Wagman[1] & Takahiro Higuchi[2]

[1]Department of Psychology, Illinois State University,
[2]Department of Health Promotion Sciences, Tokyo Metropolitan University

In what has become a classic paper in the ecological psychology literature, Runeson (1977) introduced the concept of 'smart perceptual instrument' as a model for understanding perceptual systems. Like perceptual systems, smart perceptual instruments measure higher order properties (such as affordances) directly without calculating and without information about lower order properties. The presentations in this symposium will explore this concept and explicitly make contact with a number of key features of smart perceptual instruments including: (a) task-specificity (b) measurement without calculation, (c) soft-assembly across animal and environment, and (d) recalibration with practice.

First, smart perceptual devices are task-specific. They are assembled with an intention to perceive a particular higher order property and are useful only for perceiving that particular higher order property. Brandon J. Thomas and Michael A. Riley will present experiments showing that a smart perceptual device assembled with the intention to perceive a given affordance (reach-with-ability) enables remembering a different affordance (heaviness) only when there is overlap in the informational bases of the two affordances. Second, smart perceptual devices are spontaneously assembled not only over the anatomical components of the organism but also over the components of the animal-environments system. Jeffrey B. Wagman, Alen Hajnal, & Katie L. Jameson will present experiments showing that perceivers can successfully perceive affordances for standing on an inclined surface when the surface is explored with an object attached to the head — a task that likely requires the spontaneous assembly of a unique smart perceptual instrument. Along these same lines, Takahiro Higuchi, Maki Chiba, & Masashi Kasumi will present experiments showing that perceivers successfully adapt both their exploratory and locomotory behaviors when passing through an aperture with an object attached to their body, even when the midpoint of the person-plus-object system is not coincident with the midpoint of the body. Finally, smart perceptual devices are tunable – they can be modified by means of practice measuring and practice doing. John M. Franchak and Karen E. Adolph will present a series of experiments showing that specific action experiences facilitate recalibration of perception of affordances for squeezing through doorways over the course of real and simulated pregnancy.

References

Runeson, S. (1977). On the possibility of "smart" perceptual mechanisms. *Scandinavian Journal of Psychology*, *18*, 172-179.

The polar planimeter in us all

Brandon J. Thomas & Michael A. Riley

University of Cincinnati
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Runeson (1977) compared the "smart" pick-up of perceptual information to the operation of the polar planimeter: A device that measures surface area directly, without computation based on lower-order variables. One prediction of perception as a polar planimeter is that an organism with a given intention picks up higher-order information that specifies a perceived object property, without the use of computation from lower-order primitives.

Two studies found that 1) perceived and remembered overhead reach-ability with an object do not depend on the perceived or remembered length of that object (Thomas & Riley, 2014), and 2) perceived jump-reach-ability does not depend on perceived jump-without-reach added to perceived reach-without-jump. Perception and memory of both affordances are experienced as such.

Another, less obvious, prediction from this view is that information picked up to fulfil one perceptual intention will only be useful for a different intention if the information specifying the intended properties overlap, just as a polar planimeter will only pick up information that partially specifies properties that co-vary contextually with surface area (e.g., length, width, etc.). Two experiments showed that perceived overhead reach-ability of an object by dynamic touch alone enables the partial ability to remember the heaviness of the object, while perceived overhead reach-ability by both vision and dynamic touch does not enable memory for heaviness (Thomas & Riley, submitted). Geometric, visual information about length does not inherently specify heaviness. Information picked up to perceive one property can be reused later to partially remember another property, but only if the properties correlate.

The findings of these three studies highlight important aspects of information for perception and memory. Information is specific to the intention of the perceiver-actor, irreducible to functionally neutral primitives, and can only be used to remember unintended properties when the information detected correlates with an intentionally perceived property. The results also have methodological and theoretical implications for the study of memory and perception as a single, graded phenomenon.

References

Runeson, S. (1977). On the possibility of "smart" perceptual mechanisms. *Scandinavian Journal of Psychology*, *18*, 172-179.

Thomas, B.T., & Riley, M. A. (2014). Remembered affordances reflect the fundamentally action-relevant, context-specific nature of visual perception. *Journal of Experimental Psychology: Human Perception and Performance, 40*, 2361-2371.

Thomas, B.T., & Riley, M. A. (submitted). The selection and usage of information for perceiving and remembering intended and unintended object properties. *Journal of Experimental Psychology: Human Perception and Performance.*

Use your (smart) head! Cephalic perception of affordances of surfaces

Jeffrey B. Wagman[1] **& Alen Hajnal**[2]

[1]Department of Psychology, Illinois State University
[2]Department of Psychology, University of Southern Mississippi

Two key properties of a smart perceptual device— flexibility and anatomical independence— are manifest in perception by means of wielded objects. In particular, affordances for standing on an inclined surface can be perceived when the object used to explore that surface is wielded by the preferred or non-preferred hand, by one or both hands, or by the preferred or non-preferred foot (Wagman & Hajnal, 2014 a, b). In all of these cases, perception of this affordance reflected the action capabilities of the perceiver and was generally unaffected by the (configurations of) anatomical components used to wield the object. Such results provide evidence of the task-specificity and anatomical independence of perception by means of a wielded object. Though the hands and the feet may not often be used to perform this particular perceptual task, they are often used to perform other haptic perceptual tasks. Therefore, stronger evidence would be provided if the same pattern of results were exhibited in a perceptual task that was (even more) likely to require the spontaneous soft assembly of a smart perceptual device.

In two experiments, we investigated the ability to perceive affordances for standing on an inclined surface when the object used to explore that surface was wielded by the head. Experiment 1 compared perception of this affordance by head and by hand. As expected, perception reflected the action capabilities of the perceiver and was generally unaffected by the (configurations of) anatomical components used to wield the object. There were no differences in perceptual boundary, discriminability, confidence, or response latency between the two limbs. Experiment 2 compared perception of this affordance by head and by vision. Again, there was no difference in perceptual boundary. However, participants were better able to discriminate inclinations that afforded standing on from those that did not, were more confident, and exhibited shorter response latencies when the surface was explored visually than when it was explored cephalically.

Such results provide strong evidence for the task-specificity and anatomical independence of perception of affordances within a given perceptual system. Moreover, the results suggest that such properties may also be manifest across perceptual systems and highlight that perceiving a given property is tantamount to creating task-specific detection units from potentially independent anatomical units.

References

Wagman, J. B., & Hajnal, A. (2014a). Task-specificity and anatomical independence in perception of surface properties by means of a wielded object. *Journal of Experimental Psychology: Human Perception & Performance, 40, 2372- 2391.*

Wagman, J. B., & Hajnal, A. (2014b). Getting off on the right (or left) foot: Perceiving by means of an object attached to the preferred or non-preferred foot. *Experimental Brain Research, 232: 3591-3599.*

Locomotion though apertures as the person-plus-object system: when the body is off the center

Takahiro Higuchi[1], **Maki Chiba**[1], **Masashi Kusumi**[2]

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Walking on to a subway train while carrying a suitcase or driving a car through a tunnel are examples of locomotion through an aperture by the person-plus-object system. In each of these cases, the midpoint of the body and the midpoint of the person-plus-object system are not coincident. The impact of this on locomotion through apertures is unknown. We conducted two experiments to investigate this issue. Participants walked while holding a long, horizontal bar (in Experiment 1) or while using a walker (a locomotor-assistance device (Experiment 2) and passed through a narrow aperture. We measured the kinematics of locomotor patterns and spatio-temporal patterns of eye movements both when the body midpoint was at the center (center condition) and when the body midpoint was off the center (always deviated to the right; off-center condition). Compared to the center condition, the off-center condition showed: (a) more frequent collisions on the left side (i.e., the far side), (b) no increase in the total number of collision (i.e., task difficulty did not increase), (c) more frequent fixations toward the right side (i.e., the near side), and (d) relatively less impact on kinematics, such as movement speed or head movement. Furthermore, more frequent collisions on the right side were observed during the center condition when participants initially performed this task during the off-center condition and then performed during the center condition, indicating the adaptation to the off-center condition. These findings suggest that participants were generally able to adapt to altered action capabilities even when the midpoints of the body and the person-plus-object system were not coincident

Action experience facilitates recalibration to changing affordances when squeezing through doorways

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Perceiving some types of affordances (e.g., walking through doorways, passing under barriers, stepping and sitting on risers) depends on intrinsic information about the body, such as height. Recalibrating to changing affordances for such intrinsically scaled actions does not depend on specific practice performing the action, because general experience with the body in motion specifies changes to the critical body dimension. Observers need only experience optic flow from normal postural sway to recalibrate to changes in height, thus facilitating accurate perception of height-scaled affordances. But how do observers recalibrate to changes in affordances when the critical information is not available to the visual system? We hypothesized that specific experience performing the action would be critical for recalibrating to changing affordances.

In a series of studies, we tested how observers recalibrate to changes in body size when squeezing through doorways. Affordances for squeezing through doorways depends on body compression, which is the result of body compliance relative to the doorway's compliance and how much force is applied when fitting through. As an emergent property, body compression is unlikely to be specified through visual information alone. Do observers require experience squeezing through the doorway to accurately perceive whether doorways are possible to navigate?

In Experiment 1, we tested women longitudinally over the course of pregnancy and found that they perceived affordances for squeezing through doorways as accurately as non-pregnant controls. Both groups made errors of only ~2 cm in magnitude. Moreover, pregnant women were equally accurate at each test session, suggesting that experience between test sessions facilitated recalibration. In Experiment 2, we tested non-pregnant adults who wore a "pregnancy prosthesis" to see how well observers could cope with a sudden change in body size. Without any experience squeezing through doorways while wearing the prosthesis, participants made errors of ~10 cm in magnitude. But after 20 trials of practice squeezing through, errors dropped to only ~2 cm. Taken together, these results suggest that when affordances depend on factors that are not accessible to the visual system, such as body compression, specific action experience may facilitate recalibration to changing affordances.

Symposium

Ecological Principles in Design

Organizers: Bruno Mantel & Elise Faugloire

Normandie Université, Caen, France
and
Centre d'Etudes Sport et Actions Motrices, Université de Caen Basse-Normandie, Caen, France

Our environment is full of man-made tools with which we interact on a daily basis. Not only do these tools impose specific constraints on perception and action, offering new opportunities to perceive and act, and withdrawing some others, but they also require designers to devise the specific layouts of constraints that will afford desired actions and specify these opportunities. Over the past thirty years, ecological principles have brought about important theoretical and methodological developments in the field of engineering design. These studies have not only resulted in successful applications, but have also raised specific questions (e.g., about specificity and ambiguity in the context of untraceable processes), pointed out new research directions (e.g., emergent features and configurality; inverse ecological optics) and proposed refinements of existing concepts (e.g., affordance nesting and its modelling). Yet, the engineering design and ecological communities mostly work and evolve in parallel, being only barely aware of what is achieved in the other field. The goal of this symposium is to foster this mutual awareness by establishing a dialogue between the two communities that, we believe, could be greatly beneficial to both and help ecological theory to move forward. John Flach will present the Ecological Interface Design framework, discuss its key concepts and their funding principles, and exemplify its use in concrete applications. Bruno Mantel will focus on the specific interface design issues raised by short-time human-like processes control such as locomoting in a remote environment using a mobile robot. Jonathan Maier will address the use and wide potentiality of the affordance concept in engineering design.

Designing and evaluating an interface for exploring distant places through mobile robot teleoperation

Bruno Mantel,[1,2,3] **Jean-Clément Devaux,**[3] **Paul Nadrag,**[3] **Philippe Hoppenot,**[3] **& Etienne Colle**[3]

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A robotic teleoperation platform can be viewed as a complex tool, mediating the operator's relation to the environment. This platform alters both what the operator can do (extending some capabilities and restraining some others) and the information he/she can access to. The latter is a major concern in human-robot interaction (HRI) research for it can have detrimental consequences on task performance and felt comfort (e.g., Woods, Tittle, Feil, & Roesler, 2004).

We designed and evaluated a computer interface for mobile robot teleoperation in a home environment. Following an ecological framework (Mantel, Hoppenot & Colle, 2012), we shifted the traditional HRI focus from *how* data should be presented to *what* data should be presented. The primary goal of the interface being to provide information that can be successfully used by the operator to control (the robot's) actions, we first reviewed existing constraints on the control of (wheeled) locomotion in a cluttered environment. We then used different approaches (anthropomorphism, augmentation of information, augmentation of action, delegation) to render this information to the operator –or to compensate for not doing so. This resulted in an interface offering two different modes of control. These modes were evaluated and contrasted with a former interface (which mainly involved a live video feed) during an experiment in which participants had to drive the robot (Lina, Droids Company, Buthiers, France) on three different routes, as fast as possible while hitting as little obstacles as possible.

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Ecological Interface Design:

Skilled Coupling of Perception and Action in Sociotechnical Ecologies

John Flach

Department of Psychology, Wright State University

Despite conventional wisdom that advanced technology would reduce reliance on the 'human factor' and that automation would lead to a deterioration of human skills, today we live in a sociotechnical world where satisfaction of many daily functions is not possible without the skilled use of technologies. These technologies can greatly extend perceptual capacities, specifying properties of the ecology that are not available to the unaided senses; and can greatly extend the field of possible actions, offering affordances not available to unaided motor systems. Thus, while it is clear that technology has changed the types of skills required for satisfying human experiences, it has not reduced the demands for a skilled coupling of perception and action. For this reason, it is essential that the design of sociotechnical systems be guided by theories of skilled performance. Over the last thirty years, Ecological Interface Design (EID) has been guided by theories of coordination and skilled performance that follow directions suggested by Gibson and Bernstein. The goal of EID has been to enrich the coupling of perception and action to reflect sociotechnical constraints on both information (degree of specificity) and action (degrees of freedom) in order to help people to skillfully achieve satisfying experiences.

Overview of the Increasing Use of Affordances in Engineering

Jonathan R.A. Maier

General Engineering Program, Clemson University

In this talk I will review how and why the concept of affordance is gaining popularity within the engineering design community, and suggest ways in which ecological psychologists and design researchers can and should collaborate. Gibson developed the idea of affordance to explain how animals perceive their environment. However, the idea of an affordance, that things in the environment afford behaviors to an animal, turns out to be more general, and more useful in other fields (such as engineering) than the revolutionary idea of direct perception itself. Whenever two (or more) systems interact, their structures together will afford behaviors that neither system is capable of exhibiting in isolation. Not only do animals in environments have affordances, so too do pairs of other organisms, and pairs of inanimate systems on length scales from the sub-atomic to the cosmic. The latter category includes situations in which perception is not even meaningful, but affordances of the general type I describe are clearly evident. In particular, affordances can be used in a descriptive mode, as a means of explaining emergent phenomena, in a predictive mode, as a tool for predicting what will happen when two systems are allowed to interact, and in a prescriptive mode (i.e., design), in order to tailor the structure of interacting systems to afford desired behaviors and to avoid undesired behaviors.

Symposium

Information and the prospective control of lateral interception: A new perspective

Organizers: Reinoud Bootsma[1], Frank Zaal[2]

[1]Aix-Marseille University, France, [2]University of Groningen, The Netherlands

Interceptive actions are paradigmatic examples of our behavioral interaction with dynamic elements of the environment. Yet, the functional organization of such actions is still largely debated, even in the simplest case of interception along a single horizontal dimension. Successful interception implies the use of information to guide the catcher to the interception location in time. Controversy remains, however, on the nature of the information used, with several candidate variables having been proposed for the prospective control of lateral interception. Some studies suggested that first-order information related to the future passing distance is used (e.g., Arzamarski et al., 2007; Dessing & Craig, 2010) whereas other studies showed that zero-order information with respect to current ball position is also implied under some conditions (e.g., Ledouit et al., 2013). Furthermore, within the paradigm of lateral interception, movement reversals have been reported for both curving (Casanova et al., 2015; Craig et al., 2011; Dessing & Craig, 2010; Lenoir et al., 2005) and straight (Montagne et al., 1999) ball trajectories, although the latter has so far not been replicated. To date, the rich variety of observed interceptive movement patterns has not been captured within a unified framework. This symposium will present a comprehensive account of the control of lateral interception, showing why and when movement reversals may be observed, and on the basis of which informational variable(s) lateral interception is controlled.

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Reconsidering information for movement

Reinoud J. Bootsma[1], **Simon Ledouit**[1], **Remy Casanova**[1], **Frank T.J.M. Zaal**[2]

[1]Aix-Marseille University, France, [2]University of Groningen, The Netherlands

Interception can be realized by moving the hand, the whole body or both. In this introductory presentation, we begin by examining the different informational variables available for controlling (i) movement of the hand and (ii) movement of the whole body to the final interception location within a prospective control scheme. We then demonstrate how information for hand movement (e.g., Dessing & Craig, 2010; Peper et al., 1994) is related to information for body movement (e.g., Chardenon et al., 2005; Michaels & Oudejans, 1992). Finally, we present a generic informational variable that, we suggest, may adaptively harness movement control according to the situation at hand.

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Reversal movements in the lateral interception of rectilinear ball trajectories

Simon Ledouit[1], Remy Casanova[1], Frank T.J.M. Zaal[2], Reinoud J. Bootsma[1]

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In a much-debated contribution to literature on lateral interception, Montagne et al. (1999) reported two main findings in favor of prospective control. The first finding was that rectilinear ball trajectories converging onto the same interception location (either 35 cm to the left or 25 cm to the right of the initial hand position) gave rise to trajectory-specific interception patterns (angle-of-approach effects). The second finding was that balls arriving at the initial hand position occasionally gave rise to reversal movements in which the hand first moved away from its initial position in the direction of the ball's departure position before reversing movement direction and finally intercepting the ball at the initial hand position. While the first finding was replicated in subsequent studies, the second was not (Arzamarski et al., 2007; Ledouit et al., 2013).

In the present contribution we demonstrate that movement reversals occur for rectilinear ball trajectories when movement tends to be initiated early on after onset of ball motion. Such early initiations were obtained by interlacing four different ball speeds. Using a set-up comparable to that of Ledouit et al., (2013) we analyzed interception behavior, under each of the four ball speeds, for 28 different ball trajectories resulting from the combination of four different ball departure positions and seven different ball arrival positions. Systematic angle-of-approach effects were observed, once again replicating Montagne et al.'s first finding. When the future interception point corresponded to the initial hand position, we observed a significant frequency of reversal movements, especially for the lower ball speeds, almost always directed towards the ball departure position, thereby also replicating Montagne et al.'s second finding. The relations between each participant's average moment of movement initiation, on the one hand, and the number and amplitude of movement reversals observed, on the other hand, will be discussed in the framework of the perspective on information-movement coupling presented in this symposium.

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Evaluating models for prospective control of lateral catching: what is the order of the information needed?

Remy Casanova[1], Simon Ledouit[1], Frank T.J.M. Zaal[2], Reinoud J. Bootsma[1]

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The prospective control of movement for lateral interception requires that the catcher establishes and maintains a relation with the ball that guarantees that s/he will arrive at the right time at the right place to intercept it. Different models of prospective control have proposed different informational variables, based on the ball's current position (Bootsma et al., 1997; Peper et al., 1994) or its current heading (Dessing & Craig, 2010). Ledouit et al. (2013) recently suggested that catchers rely on both, without providing an explanation of how this might come to be.

We systematically evaluated position, velocity, and acceleration-based models of prospective control of catching, testing their ability to capture the essential, qualitative aspects of the interception behavior demonstrated by experienced football players performing a goalkeeper's interception task within a virtual reality setting. Balls started their flight trajectory from one of two different initial positions and arrived at one of four different locations along the goal line. Each combination of ball departure and arrival position was presented with three different types of lateral spin applied to the ball (clockwise rotation, no rotation, counter-clockwise rotation). The factorial combination of (2) departure positions, (4) arrival positions, and (3) spin conditions gave rise to 24 different trajectories, presenting the full range of cases that we intended to consider: on the one hand, ball trajectories could be either straight or curving and, on the other hand, trajectories could remain to one side or cross to the other side of the goalkeeper's initial position. In this presentation we discuss the results of this modeling endeavor and demonstrate how a new, comprehensive perspective on the prospective control of lateral interception can account for the data.

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Getting to the right place for the N'th time

William H. Warren

Brown University

Dr. Warren will comment on the contribution of the perspective proposed.

Symposium

Theory in the service of clinicians

Organizers: Dobromir Dotov[1], Paula Lanna Silva[2]

[1]EuroMov, Movement to Health Laboratory, Université de Montpellier, France
[2]Graduate Program in Rehabilitation Sciences, Universidade Federal de Minas Gerais, Brazil,

An important test for the relevance and feasibility of a theoretical approach is its potential to inform solutions to real-world practical problems and to generate entirely new technologies. The ecological perspective to psychology and movement science has contributed to the applied sciences (human factors, kinesiology and physical therapy, occupational therapy, robotics, etc.). This contribution, however, is not always recognized. The purpose of this symposium is to present a selection of recent studies where the development of new clinical practices has a theoretical footing. The goal is not to perform an exhaustive survey but to bring us up to date with some of the recent work where progress is being made.

Something that is common among the talks to follow is that they address serious movement disabilities: Cerebral Palsy (CP) and gait-related symptoms in Parkinson's disease (PD), and point to solutions better identified at the level of task dynamics rather than in the anatomical or neurophysiological constraints. Task dynamics encompass the moving agent and the surrounding environment that simultaneously provides reactive forces to the agent's movement and a structured array making the information-based guidance of movement possible. The motor symptoms of the conditions in question are regarded as context-sensitive adaptations to flawed interaction with these environmental forces. Accordingly, addressing the disability should rely on correcting or compensating for the flawed interraction and not merely trying to forcibly reconstitute the form of the movement to its paradigmatic healthy state. Using technology to adjust the fit between task demands and individual action capabilities is a way to proceed with improving performance.

In the case of CP, the authors propose a tensegrity-based exoskeleton. This is in continuation with theoretical work on the function of the human musculo-connective-skeletal system. In the case of PD, the authors consider fixed rhythmical stimulation (a known method for improving gait in PD) and investigate different theoretically motivated methods for introducing good variability to the stimulation.

Context sensitivity of movement strategies supporting upper limb performance of teenagers with cerebral palsy

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When teenagers with hemiplegic cerebral palsy (CP) are compared to typically developing (TD) teenagers during the execution of upper limb tasks, worse performance and atypical movement strategies presented by the former are usually attributed to the presence or severity of their neural damage [1,2]. We aimed to verify the influence of other factors, such as task demands, contextual support and individuals' skills, that could be underlying the differences between teenagers with and without spastic hemiplegia during a reciprocal aiming task. Twenty participants (nine with hemiplegic CP and 11 with typical development) used a wooden rod to continuously hit two targets with maximum speed and accuracy. Task conditions were manipulated by changing the size of the targets, modifying tool properties and by switching between the preferred/non-affected and non-preferred/affected upper limbs. The results point to a strong sensitivity of the behavior of both teenagers with and without CP to task conditions. Even though participants from the CP group exhibited worse performance compared to those in the TD group, the magnitude of the differences between groups was more pronounced under more stringent task conditions. Task conditions not only affected performance but also joint kinematics. Teenagers with CP presented lower magnitude of elbow movements and increased magnitude of shoulder movements when performing the task with their less skilled upper limb. However, teenagers from both groups showed comparable increase in the magnitude of their trunk movements when facing more challenging task conditions. The overall pattern of results indicated that the joint kinematics employed by individuals with unilateral CP constituted adaptive responses to task requirements. Thus, the explanation of the effects of unilateral CP on upper limb behavior needs to go beyond a context-indifferent manifestation of the brain injury to include the interaction between task demands and action capabilities. The implication is that a comprehensive account of upper limb function of individuals with CP requires an understanding of how the reduced capabilities resulting from the brain injury interact with task demands in determining performance.

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Perception-action based intervention to reduce ACL injury risk

Michael A. Riley,[1] Scott Bonnette,[1] Adam W. Kiefer,[1,2]
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We present preliminary results of an anterior cruciate ligament (ACL) injury-prevention intervention that is based on the fundamental reciprocity between perception and action. Athlete movements are collected and analysed in near real time (~10-15 msec delay) and used to drive real-time feedback displays presented to the athlete on a wireless smart-glass display. Achieving proper exercise form results in a particular feedback stimulus shape, and deviations from proper form result in systematic deviations of the shape from the ideal. Thus, the athlete's task is to discover how to move in such a way as to control the shape of the feedback—to act so as to create a certain perceptual outcome. The brief, single-session training intervention resulted in positive biomechanical adaptations that are associated with "good form" and reduced ACL injury risk. Our ongoing work expands this preliminary study into a larger-scale clinical trial involving additional training sessions and a progression of exercise difficulty.

Selecting the optimal strategy for the adaptive rhythmic auditory cueing of parkinsonian walk

D.G. Dotov,[1] S. Bayard[1,2], V. Cochen de Cock[2,3], B.G. Bardy,[1,4] & S. Dalla Bella[1,4,5]

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Impaired gait in the middle stages of Parkinson's disease can be relieved to some extent by a a repetitive acoustic signal, the popular term for which is rhythmic auditory cueing [1]. Auditory cueing consists in asking patients to walk together with a rhythmic stimulus, such as an isochronous sequence or musical beat. The repetitive stimulus compensates for gait disorders by increasing speed and stride length, and by inducing healthier dynamics. Traditional auditory cueing involve stimulation in which stimuli are presented at a fixed time interval. This fails to take into account the intrinsic variability inherent in any motor activity. By forcing patients to perform steps with no variability one is placing too high demand on performance whereby every step the walker needs to overcorrect for the variability in the previous step.

One way to improve the effectiveness of auditory cueing is to adopt a stimulation embedding variability. Another way is to provide stimulation, which responds in real time to patients' motor performance. There are a number of possible adaptation strategies and which one is optimal has to be decided on the basis of empirical and theoretical considerations. If facilitating the walker's synchronization to the beat is the ultimate goal, then coordination dynamics has to inform the design of the assistive device.

In addition to searching to optimize auditory cueing techniques by incorporating coordination dynamics and variability in the stimulation, the current project expands the standard technique to a third dimension. Musical rhythm affords synchronization. Music offers an acoustic environment that is richer than a mere metronome by involving multiple embedded periodicities, thus being particularly well-suited to foster motor synchronization. Thus stimuli with different rhythmic complexity (e.g., a metronome vs. music) are examined.

In the first clinical study the statistical properties of the beat variability were addressed. The role of coordination dynamics was investigated in a second clinical study, in which variable and adaptive auditory cueing was provided to patients. Performance was quantified by way of the typical spatio-temporal gait parameters and a range of additional measures akin to complex systems. The central role of synchronization in inducing the beneficial effect of rhythmic auditory cueing its interaction with other aspects of gait variability are discussed.

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Symposium

Advances in strong anticipation and complexity matching

Organizer: Drew H. Abney

Cognitive and Information Sciences, University of California, Merced

Research on strong anticipation and complexity matching both entered the foreground in multiple fields of science at nearly the same time. Perception-action research extended the notion of strong anticipation (Dubois, 2003), by observing the matching of stimulus complexity from a metronome and behavioral complexity from finger tapping (Stephen et al., 2008), while work in the field of statistical mechanics advanced the framework of complexity matching for studying the complex coordination of interacting systems (West, Geneston, & Grigolini, 2008). Subsequent research on both strong anticipation and complexity matching have led to important questions about the local and global dynamics of coordination between human-environment and human-human interactions. The presentations in this symposium will explore the concepts of strong anticipation and complexity matching and attend to a number of issues and features relevant for both phenomena including: (a) multifractal fluctuations of behavior, (b) influences of local coordination patterns, (c) influences of global coordination patterns, and (d) applications to naturalistic settings.

There are strong conceptual connections between the concepts of strong anticipation and complexity matching. This symposium will begin with the initial perception-action research investigating strong anticipation. First, Damian Kelty-Stephen will review the early work that sparked interest in strong anticipation and offer a proposal that multifractal fluctuations might serve as the link between complex systems. Second, complexity matching was initially considered as a global coordination of systems across multiple temporal scales. Justin Fine, Aaron Likens, Eric Amazeen, and Polemnia Amazeen consider the hypothesis that global coordination observed across systems is not distinct, and might very well emerge, from the local patterns of coordination of interacting systems. Third, the study of complex coordination patterns necessitates the utilization and combination of innovative methods and analyses. Auriel Washburn, Charles Coey, and Michael Richardson further explore the dynamics of local and global coordination patterns using a variety of methods and analyses, and provide evidence that global coordination patterns are not entirely dependent on local coordination patterns. Finally, research on strong anticipation and complexity matching extends past the laboratory and into the wild. Drew Abney, Anne Warlaumont, D. Kimbrough Oller, Sebastian Wallot, and Chris Kello will present analyses from a longitudinal study of infant-caregiver vocal interactions consisting of nearly 9,000 hours of recordings over the first two years of life, showing evidence for the global coordination between the complex structure of infant and caregiver vocalizations.

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Strong anticipation or good old-fashioned sharing of multifractal fluctuations

Damian G. Kelty-Stephen

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Perception and action must proceed in the face of grave uncertainty—or rather, in the face of a fundamental inability to predict. Ecological psychology is wary of any prediction from internal model or, rather, any internal stipulation at all that does not have to do with context. Perception-action without explicit prediction would be a non-starter without the context to shape organismic fluctuations. Furthermore, we are not behaviorists, hoping to build action out of reactions to punctate, fleeting stimuli. The sharing of fluctuations is absolutely crucial to get the perceiving-acting cycle out of the behaviorist's bind. The stimuli to which we respond and that we learn to anticipate and to coordinate with have as much statistical texture as our own bodies. The rich fluctuations on either end extend beyond any sort of immediate snapshot and scaffold one another across time, out into the scales of "learning" and "memory." To illustrate these points, I review work that began with asking participants to entrain to chaotic metronomes, that is, asking participants to predict what was mathematically unpredictable. I found a matching of stimulus complexity with behavioral complexity in terms of multifractal fluctuations (Stephen, Stepp, Dixon, & Turvey, 2008; Stephen & Dixon, 2011). Here was an exciting existence proof of coordination by sharing multifractal fluctuations: if multifractal fluctuations are allowed to flow between one system and another, then this sharing of multifractal fluctuations might serve as the substrate for coordination of perception and action. Multifractal fluctuations might serve to wrangle motor degrees of freedom into synergies and to weave separate sensory modal streams into coherent perceptions (Stephen et al., 2012; Kelty-Stephen & Dixon, 2014). My work has dived inwards, away from the metronomes, up through the hand, and into the motor system, but the expectations are largely the same: everywhere we had once thought that predictive models would organize behavior, we will instead find the collision of multifractal fields.

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Local Interactions Support Complexity Matching

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Movement variability is often characterized by a non-random, temporal structure (i.e., long-range correlated or fractal). However, minimal information is known regarding the effects of such complexity on the coordination between agents (or environmental stimuli). Recent studies have demonstrated complexity matching, in which people match the movement complexity of another person or stimulus. A general conclusion is that this matching represents a distinct coordination process. At issue is the supporting mechanism for such matching across a variety of coordination tasks. It is thought to involve tuning into another system's *global* statistical structure. Tuning is assumed to operate independent of *local* state matching (e.g., relative phasing). This hypothesis was tested using a rhythmic interpersonal coordination task. Dyads coordinated frequency detuned pendulums. Increased detuning revealed decreased complexity matching between participant's period series and shifts in relative phase. The implication is complexity matching is not distinct from local state coupling during rhythmic coordination. However, these results raise concern about their generalizability to more complex interactions. The potential for complexity to operate as a top-down constraint on coordination will also be discussed.

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Global coordination and complexity matching in interpersonal movement coordination

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Recent empirical work examining the occurrence of behavioral complexity matching during joint-action tasks has been shown to provide valuable information about the underlying coordinative processes that support complex interpersonal interaction (e.g., Abney, Paxton, Dale, & Kello, 2014; Delignières & Marmelat, 2014). This both complements and extends the understanding gained through analyses of local, short-term coordination between interacting individuals (e.g., Delignières & Marmelat, 2014; Marmelat & Delignières, 2012). The current authors have employed such complexity matching measures in order to characterize the global coordinative processes involved in 1) the behavioral anticipation of a co-actor's chaotic movement behaviors and 2) finger-tapping performed in syncopation with variously structured sequences of taps produced by another individual. These studies also allowed us to further examine the relationship between the local and global coordinative processes associated with successful performance in these interpersonal coordination tasks, as it has not yet been clearly demonstrated that anything other than short-range coupling and adaptation processes are responsible for the emergence of global coordination phenomena (Marmelat & Delignières, 2012; Torre et al., 2013). A variety of distinct measures aimed at identifying complexity matching were used to examine the three joint-action behaviors outlined above. Some of these analyses were selected based on the nature of the task and resulting data, while other measures were used along with previously established analyses of complexity, such as detrended fluctuation analysis (DFA) and power spectral density (PSD) analysis, in order to determine their utility as measures of complexity matching. For instance, the use of a box counting analysis for identifying the fractal structure of 2-D visual images was well-suited to provide a measure for the structural similarity of the 2-D patterns produced by co-actors during the chaotic anticipation task. In the evaluation of complexity matching for syncopated joint-tapping behaviour, however, detrended cross-correlation analysis (DCCA) measures were applied and found to provide a similar pattern of results to that obtained from DFA assessments of complexity matching. Additional analyses used to identify local coordination further allowed us to establish that for the joint-action tasks considered here, the degree of complexity matching observed within a given trial was not entirely dependent on the level of local or synchronous behavioral coordination achieved. Ultimately this work provides a basis for the use of a variety of analyses in examining the occurrence of global coordination and complexity matching in interpersonal interaction, as well as an empirical motivation to further examine the relationship between such long-term behavioral similarity and that produced on shorter timescales.

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Complexity matching and multiscale clustering of vocalizations during naturalistic infant-caregiver interactions

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Prelinguistic vocalizations produced by infants, although not yet bounded by linguistic structure, show precursors of mature language through the multiscale clustering of vocal events. We quantified multiscale clustering in the acoustics of infant prelinguistic vocalizations during the first two years of life, and the relationship between clustering in infant and caregiver vocalizations, for fifteen infant-caregiver dyads. Infant vocalizations exhibited clear multiscale clustering, ranging from timescales of seconds to over one hour, throughout the first two years of life. While infant vocalizations were slightly but reliably less clustered than adult vocalizations, infant and caregiver vocalizations were found to converge in terms of their degrees of clustering similar to what has been observed in adult vocal interactions (Abney, Paxton, Dale, & Kello, 2014). Evidence for convergence in terms of complexity matching could not be explained by similarities in the volubility of infant and caregiver speech, and greater complexity matching was found for infant speech-like vocalizations relative to non-speech vocalizations. We discuss complexity matching in terms of the development of hierarchical organization in speech, and the broader role of complexity matching in infant development and infant-caregiver interactions.

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Symposium

Dynamic touch: Emerging themes, new developments

Organizers: Patrick A. Cabe[1] and Jeffrey B. Wagman[2]

[1]Department of Psychology, University of North Carolina at Pembroke;
[2]Department of Psychology, Illinois State University

Gibson (1966, p. 109) described dynamic touch as "…the skin and joints together…stimulated in combination with muscular exertion," but the empirical study of dynamic touch phenomena gained primary momentum from the publication of the work of Solomon and Turvey (1988). That research used startlingly simple apparatus and elegant physical-mathematical analysis to elaborate the informational bases for perceptual performance. Inspired in many respects by the ground-breaking work of Solomon and Turvey, in the more than two decades since, investigators around the world have extended and expanded the scope of dynamic touch research in dozens of studies. As a consequence, dynamic touch has taken a prominent place as one of the most active research themes in the ecological perception-action literature. This symposium – linking empirical work to novel theoretical perspectives – aims to explore recent trends in both research on, and thinking about, dynamic touch.

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Perception by dynamic touch from head to toe: Riddles, wrists, and recalibration

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Dynamic touch has been a highly productive area of research in ecological psychology for well over twenty-five years. Research on dynamic touch has provided a principled understanding of perception of geometric and functional properties of wielded objects (see Turvey & Carello, 2011 for a review). Perhaps more importantly, however, such research has also provided a principled understanding of perception-action in general. Dynamic touch has been useful in this respect because it is a perceptual system (a) with no centralized sensory organ, (b) in which perception and action are inextricably linked, and (c) in which the boundary between organism and environment is blurred, if not eliminated entirely. This talk will provide an overview of recent work on dynamic touch focusing on research on perception of heaviness, perception of affordances by means of wielded objects, and (transfer of) recalibration of properties of wielded objects. Such research advances not only the understanding of perception by dynamic touch, but the ecological approach to perception-action in general, by further elucidating (a) a principled understanding of so-called perceptual illusions (b) perception-action as the assembly of a smart perceptual device, and (c) learning as a self-organized process.

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The body's tensegrity architecture and dynamic (effortful) touch

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To understand the functional design of the body, one must put connective tissue on a par with muscles and nerves. Connective tissue, comprising ligaments, tendons, cartilage, and (particularly) fascia, provides the mechanically supportive and regulatory framework for contraction and conductance. The organizing of movements and the perceiving of the body and attachments to the body are to be understood in terms of the muscular-connective tissue-skeletal (MCS) system, not the musculoskeletal system of textbooks. A working hypothesis is that the MCS system is an indefinitely nested organization of tensegrity systems with tensegrity icosahedra as a specific example (Turvey & Fonseca, 2014). These are self-similar mechanical objects each constituted by tensioned (T) and compressed (C) components where a T or a C component at one level is constituted by both T and C components at the level below. It is argued that each tensegrity system at every scale is an adjustive-receptive unit and that the array of tension differences across all tensegrity systems is analogous to Gibson's (1979) optic array. It is information about the body and its attachments. As optical solid angles assume their forms and intensity differences specific to the layout of environmental surfaces, tensegrity systems assume their forms and tension differences specific to the layout of the body and its attachments. The presentation will explicate and elaborate these notions in the context of experiments on dynamic (effortful) touch and the related phenomena of phantom and impossible limbs.

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Haptic distal spatial perception mediated by strings: Touch as a telemodality?

Patrick A. Cabe

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Telemodalities (von Fieandt, 1966) are sensory systems capable of picking up information about objects, surfaces, substances, and events spatially displaced from an observer and consequently from immediate contact with the relevant receptors. Telemodalities therefore require a medium, the structure of which is causally connected to the environmental features of interest and which is accessible to relevant perceptual systems. Essentially uniquely among the panoply of sensory modalities, touch has traditionally not been regarded as a telemodality. However, some recent work (Cabe, 2011, 2013; Cabe & Hofman, 2012; Kinsella-Shaw & Turvey, 1992; Mauerberg-deCastro et al., 2014) suggests that there are circumstances – specifically, when touch receptors are in contact with strings connected to displaced spatial features – under which touch might function as a telemodality. I will examine some of the physical-mathematical underpinnings of touch as a telemodality, focusing on the potential information available for distal spatial features via force relationships (nominally mediated by strings) that could serve to support haptic perception of those (unseen) distal spatial features.

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Using an anchor system to haptically stabilize human postural control

Eliane Mauerberg-deCastro[1,2], Carolina Paioli Tavares[1], Gabriella A. Figueiredo[2], Debra F. Campbell[1], Renato Moraes[2]

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The purpose of this presentation is to introduce concepts and applications of a non-rigid *anchor system* tool—a string connected to a load with a given mass (a resistive probe), which remains in contact with a support surface (i.e., the floor)—to illustrate how individuals integrate haptic information for the purpose of postural stability (Mauerberg-deCastro, 2004). The anchoring context requires an individual, while performing a balance task, to haptically explore alternatives for postural stabilization by lightly pulling on the string of "anchors," one held in each hand, and to feel the resistance of their load masses, but not lift either of them from the surface. By integrating mechanical properties from the anchor system (string tension and mass resistance of the probes, or loads), individuals haptically acquire useful information about the support surface in order to stabilize their bodies. Therefore, a (never quiet) postural system and a (deliberate, effortful, and dynamic) haptic information pick-up system become functionally tied. The dynamic interplay during the anchoring task requires various levels of energy patterns (i.e., torque, thrust, and drag) to be comprised as information for the behavioral solution (i.e., postural stabilization). We demonstrated the effective use of the anchor system in a variety of groups in various experimental settings (for a review, see Mauerberg-deCastro *et al.*, 2014). Those groups included normally developed adults, as well as individuals with impaired balance (e.g., due to intellectual disability, cerebral palsy, advanced age). Regardless of balance or developmental status, these groups demonstrated their haptic use of the reference frame created by the exploratory activity using the anchor system. The anchor system, therefore, functionally expanded their body's perimeter of support relative to the surface. Postural stabilization occurs during haptic anchoring even when the distal source of contact is moving: for example, a person holding the leash of a dog that is walking on a treadmill. By holding the dog's leash, individuals stabilize their posture by selectively and distinctively weighing the relevant variables that continually arise from the dog's walking motion. In such a context, the haptic perceptual system requires fine tuning and the elimination of redundancies from the task array. From a conceptual point of view, haptic anchoring—as a dynamic system, which relies on (deliberate) exploratory activity—is a subservient subsystem to the postural control system (automatic and involuntary). From an applied perspective, by observing groups with special needs or developmental challenges, and by testing the effects of practice, as well as by implementing intervention protocols with the anchor system, we intend to preliminarily demonstrate the technological potential of the anchor system in the field of rehabilitation.

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Open Forum Abstracts

Open Forum A

Wednesday, 10:30 – 12:00

End-directedness and Context-Sensitivity in Non-living Dissipative Systems

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The extensive study of self-organizing, thermodynamically open, non-equilibrium systems has revealed that biological phenomena such as clocking, pattern formation, and chemotaxis may also be found more generally in non-living (e.g., chemical) systems. We show that another fundamental biological phenomenon, end-directedness, also appears in non-living systems. We present a non-living dissipative system that exhibits end-directed processes in seeking and drawing the energy needed to form and maintain its structure. In addition, the system can become sensitive to its context, defined as gradients other than its primary energy source, and use those gradients in the service of achieving an end. Implications for an epistemological approach to biological systems will be discussed.

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The width of the multifractal spectrum

Zsolt Palatinus[1], Kinga Palatinus[2], Damian Kelty-Stephen[3], Alen Hajnal[1]

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In recent years multifractal spectral analysis became one of the fancy new methods to apply on noisy psychological data. The number of published research using some form of multifractal analysis is steadily rising in various subfields of psychology. Without aiming at completeness here, behavioral questions addressed this way include visual Fitt task (Eddy & Kelty-Stephen, 2014) visual recognition of human point light displays (Palatinus, 2013), length perception, intention (Palatinus, 2014) conversation dynamics (Ashenfelter et al., 2009), anxious phobic disorders, (Dick et al., 2012) team coordination (Likens et al, 2014), decision making (Ross, 2014), executive function (Anastas et al., 2014) schizophrenia, (Takahashi, 2008). The apparent advantage spectral analyses provide over most traditional methods is the promise of being able to conceptualize psychologically relevant events in the interaction or ongoing processes inside and outside an organism in some concise and substantive way.

Most of these studies use the width of the MF spectrum to summarize their findings. There is no general consensus, however, about the exact psychological "meaning" of spectrum properties. For example, it is understood that the width of the spectrum is an index for heterogeneity in the cascade that produced the time series (Kelty-Stephen et al., 2013). However, translating this description into psychological knowledge in particular cases remains enigmatic and there is no general consensus on the principles that would allow such translation. Clearly, more coordinated empirical and theoretical work is needed.

Here we invite researchers to join a collaborative effort we've already started. We discuss a set of basic psychophysical studies aimed at the interpretation of spectrum properties and encourage colleagues extend or shorten our to do list.

Functional distance and negative hysteresis in human gait transitions

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Center for the Ecological Study of Perception and Action

"Functional distance" is defined as the degree to which a perceiver is engaged in exploratory activities to base perceptual judgments. By increasing the functional distance, or in other words decreasing the action-relevant information for perception available to a participant, bi- or multi-stability of perceptual modes emerges. In the context of behavioral transitions, it is known that increasing functional distance results in early switchings or negative hysteresis when using ascending and descending method of limits. Classically, in human gait transitions on an accelerating treadmill, it is known that the transition speed for walk-to-run transitions is higher than for run-to-walk transitions on a decelerating treadmill. In the present study, it was attempted to empirically increase the functional distance between the perceiver and the environment at two levels. At one level, walking or running participants had to *anticipate* their upcoming gaits in the scenario of increasing or decreasing speed. At another level, "passive" participants, while standing off the treadmill, had to report the gait they would use if they were on the treadmill (Abdolvahab, 2014). It was aimed, by virtue of increasing the functional distance, to induce early switchings or negative hysteresis. Accordingly, compatible with the findings in other behavioral transitions paradigms, for instance as in Fitzpatrick et al. (1994) or Lopresti-Goodman et al. (2009), it was observed that as the functional distance increased, the amount of (positive) hysteresis for "active" participants, engaged in the exploratory activities, reduced to lower values and eventually negative hysteresis.

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Hybrid switching dynamical system: Toward understanding complex human behavior

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Complex human behavior, including both interlimb and interpersonal coordination, have been studied from a dynamical system perspective (Kelso, 1995), especially with regard to the synchronization of coupled oscillations. Because this approach has examined rhythmic and cyclic movements to understand the dynamics of movements, a computational perspective would not regard these complex human movements as inclusive of a cognitive domain. Real life, especially sporting activities, requires instantaneous decision-making and the instantaneous execution of an action corresponding to environmental demands and changes. As a result, such actions cannot be regarded as rhythmic and/or cyclic movements. In contrast, we examined the complicated striking actions and/or interpersonal coordination in real sports settings from a dynamical system perspective that considers temporal input (Yamamoto & Gohara, 2000; Yamamoto et al., 2012). This hybrid switching dynamical system model represents a feedback linkage between a discrete dynamical system and a continuous dynamical system, which correspond to the brain and the body, respectively. Because the brain can process a symbol extracted from continuous sensory input under anatomical and neuronal constraints, this system can be regarded as a discrete and/or symbolic dynamical system. Thus, the efficiency of the processing performed under temporal constraints would increase. However, human movement can be regarded as a continuous dynamical system. The human body has innumerable degrees of freedom at the neuronal, muscular, and articular levels (Bernstein, 1967). Additionally, human movement is affected by the constraints imposed by gravity and inertia. We propose a hybrid switching dynamical system to understand complex human behavior, including interpersonal and collective phenomena.

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Open Forum B

Wednesday 15:15 – 17:00

Geometric layout of shared space inspires shared intention in a stepping triad

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The self-organizing behavior in crowds is frequently exhibited in natural environments, but it has rarely been experimentally investigated. In the present study, we performed a triad-stepping experiment using rubber hoops and revealed that the geometrical layout of the hoop chain greatly influenced the formation of shared intention among people. We arranged six rubber hoops (f = 0.6 m) in a circular pattern on the floor with both sides touching the adjacent hoop. Participants were grouped into triads, and each member of the triad stood in one of three alternately aligned hoops. Each triad member was asked to jump either to the left or right according to a metronome beat (20 bpm; 3-s interval). The members had to step in the same direction as they were forbidden to jump into hoops that were already occupied by other members. They were instructed to return to the initial position when the members failed to coordinate. One hoop was removed each time a triad successfully stepped 20 times. Therefore, the hoop chain layout was sequentially altered from hexagonal to pentagonal, rectangular, and triangular (all equilateral); we terminated the trial when the number of hoops became less than three. The lag between each member's takeoff time was detected with a motion capture system. We found in the hexagonal and triangular layouts, three members simultaneously initiated stepping. However, in the pentagonal layout, one followed two, and, in the rectangular layout, two followed one. Similar triad coordination patterns have been observed in football drills (Yokoyama & Yamamoto, 2012). We also performed dyad-stepping experiments, and spontaneous switching in a rotational direction was observed in rectangular and triangular layouts, which contrasted with the triad-stepping in which the members rotated counter-clockwise almost constantly. Our results indicate that geometric restriction causes shared intention and spontaneous synchronization in the collective movement of people.

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Perceiving places

Harry Heft[1] and Justine Hoch[2]

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In his "A Nomenclature for Surface Layout," Gibson (1979) includes 'place' which he defines as a location in the environment, an extended surface layout, rather than a point in space. Among the examples he offers are "sleeping places, eating places, meeting places, hiding places, and falling-off places . . ." (pp. 240-241). Although this definition and list of examples is a start, it fails to highlight the distinctive character of places that are primarily found in human habitats. I refer to places that are meaningful in the context of particular sociocultural practices, places such as classrooms, lecture halls, restaurants, and churches. Each of these places afford a delimited range of socially normative activities. Barker (1968) and his colleagues devoted several decades to the study of such places ("behavior settings") as predictors of everyday action. Conceptualizing places as affordances for activity, it would be expected that places qua affordances are perceivable. In three studies to be reported, it was hypothesized that the identity of a setting is specified by the dynamic action patterns generated by setting participants. To test this hypothesis, the point light display technique was adapted, with computer animations generated based on observed, collective actions in everyday settings. Two experiments assessed whether individuals could accurately perceive the identity of the settings displayed, and a third experiment indirectly examined this question by asking participants to evaluate how appropriate particular actions would be in each setting displayed. The results demonstrated some support for the hypothesis while also pointing to several directions for refining our conceptualization of place from an ecological perspective. The findings suggest that most settings vary in their normatively permissible actions or degrees of freedom, and for this reason, the pattern of action specific to a setting may *initially* specify a "family" of settings that will be differentiated with on-going action.

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Time, embedded meaning and ecological science

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Theorists (Clark, 1997; Wilson, 2002) have criticized the ecological theory of meaning for not being sufficiently general to explain the apprehension of meanings when the present environment has nothing to do with the current psychological state. Ecological research on perceiving and acting has focused instead on how currently available perceptual information (e.g., rate of optical expansion) can be used to guide on-going actions (e.g., hitting a baseball). However, the examples of perception and action used in this research are generally studied out of context of real life. Hitting a baseball, for example, occurs within a time at bat, which occurs within a game in which a team is winning or losing, which occurs within a team's/player's season in which is going well or not. Research has shown that such factors can constrain the act of hitting a baseball over and above the visual information being picked-up by the actor. For example, batters use the history of previous pitches as a basis for controlling their swing (Gray, 2002). The traditional conclusion drawn from such research is that (direct) perception is not enough—one needs cognitive processes that rely on mental representations of the past. The question for ecological science is whether it can provide an account of all meaning making in a way that avoids such a representational account. To address this question, I have argued (Schmidt, 2007a; 2007b) that what is missing from psychological theories of knowing is countenancing the 'process' nature of our epistemic reality and an 'ecologizing' of the notion of time. The traditional way of conceiving time in terms of past, present, and future needs to be replaced with an alternative that views time as consisting of the hierarchically nested events at different scales of the complex system being observed—the "time as conflict" perspective (Fraser, 1978).

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Embodied memory: The theory, evidence and application

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In 3D environments, there are two sources of optical information: image structure and optic flow. Surfaces in the world project image structure that is weak in specifying spatial relations, but enduring. Relative motion between observers and surfaces generates optic flow that powerfully specifies spatial relations, but vanishes when motion stops. Normally, the two interact and compensate for one another's weaknesses. With on-going motion, optic flow carries one image to the next and spatiotemporally calibrates them. After motion stops, calibrated image structure remains and preserves spatial relations specified by optic flow. Image structure provides embodied memory for situated, active observers.

We designed two studies, where targets were on a separate depth plane from distracters. We manipulated the availability of optic flow and image structure, and tested embodied memory for visual targets that were occluded (Pan, Bingham & Bingham, 2013) or camouflaged (Pan, Bingham & Bingham, submitted). Converging evidence showed that observers successfully identified targets when optic flow was on-going, or when optic flow and image structure coexisted. With response delays of up to 25s, large numbers of targets were identified only if optic flow-calibrated image structure was continuously available. Therefore, like memory, perception is a dynamic process that entails stability and persistence; and like perception, memory is an active process that entails interaction between observers and world structures.

Embodied memory was applied to studying event perception with low vision (Pan & Bingham, 2013; Pan et al, submitted). Macular degeneration patients failed to identify events using static blurry images but succeeded when these images were played in motion. Thereafter, events continued to be perceivable with static blurry images. Weakened image structure in low vision was calibrated by unimpaired optic flow, and preserved the spatiotemporal information in optic flow. This synergy allowed low vision observers to perceive, remember and potentially interact with events.

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A people's history of embodiment

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Embodied cognition, or embodiment is an idea that enjoys growing popularity. Expositions of the concept often appeal to real-world or real life situations, but within the behavioural sciences these tend to be focused on activities that can or might be brought into the laboratory for controlled study. In the present contribution I take a broader view. My view is based less on phenomena that might be subjected to laboratory testing, and more on how embodiment may have unfolded over human history. That is, I attempt to describe how historical changes in embodiment may be related to historical changes in human activity, human society, and human thought for ordinary people in daily life. To keep things manageable, I focus on the history of embodiment as it relates to physical movement from place to place. Many of the historical facts that I review are well known; my aim is to place these facts into a broader context that may help to illuminate the place of the mind within the world.

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Open Forum C

Thursday 10:10 – 12:00

Sculpting the voice

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Vocal sounds are sculpted by humans and other animals by the movements of the vocal articulators – lungs, vocal folds (syrinx in birds), larynx, velum, jaw, tongue and lips. Therefore, understanding how vocalizations are generated and controlled requires understanding how the movements of the vocal articulators are generated and controlled. A theory of vocalization needs to be expressed within a general theory of movement - just as Kepler's laws of planetary motion are expressed within Newton's general laws of motion. We present a perceptuomotor theory of voice, based on General Tau Theory (Lee, 2009). The theory proposes that, in skilled vocalization, the motion-gaps in the articulator movements and in the resulting sound pressure waves are all tauG-guided, and therefore follow a specific mathematical formula. Spatiotemporal coordination of the tauG-guided movements of the articulators produces, through tau-coupling, the pattern of tauG-guided movements in the sound pressure wave. Quantitative tests of the theory will be presented, taken from human adult speech and singing, infant pre-speech, and animal vocalizations.

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Social coordination dynamics and deception

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Detecting deception is an important skill for therapists, health professionals, lawyers, salespeople, parents and teachers. Recognizing dishonesty can also aid military and law enforcement professionals in maintaining public safety. Despite decades of research, however, it remains unclear how the behavior of liars differs from the behavior of truth tellers. Current major challenges in deception research today include identifying the behavioral processes or cues involved in lying and lie detection, modeling their interplay, and determining their modulation by situational factors.

Evidence from social psychology and applied social research points to interactional synchrony as a useful measure for detecting deception, emphasizing the link between social coordination, interpersonal affiliation, and emotional intelligence (Dunbar et al., 2011; Wojciechowski, Stolarski, & Matthews, 2014). A particular need has also been identified for the examination of temporal patterns in deceptive behavior (Burgoon, 2006), yet few, if any, systematic studies of rapport, interpersonal synchrony, or social skill have examined the time-evolving effects of social coordination on deception and vice versa.

Motivated by the social coordination dynamics approach to perception and action (Oullier et al., 2008; Schmidt & Richardson, 2008), we argue that deceptive interactions should exhibit different patterns of coordinated behavior than truthful interactions, and moreover, that the relationship between measures of interpersonal coordination and lie detection accuracy may be mediated by social-psychological variables such as social aptitude and rapport.

In contrast to previous studies in which researchers have investigated the discrete characteristics of intrapersonal deceptive behavior or deception detection, we use a dyadic approach to examine the social coordination dynamics that emerge during truthful and deceptive interactions. We discuss the theoretical and methodological implications of examining deception from a social dynamics perspective, as well as the practical applications of our findings.

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Enhancing socio-motor competences: Impact of behavioural matching and behavioural synchrony

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The goal of this study was to investigate the acquisition of socio-motor competences. Several studies showed a beneficial effect of similarity and temporal organization between movements (*behavioural matching* (BM) and *behavioural synchrony* (BS) respectively) on social competences such as pro-social behaviours, connectedness or cooperation between interactants (Marsh et al., 2009; Valdesolo et al., 2010; van Baaren et al., 2004). However, no study investigated the impact of BM and BS on the acquisition of motor competences. In this vein, we believed that both parameters could promote improvement of these competences. Motor competences were evaluated through a mirror game task where performance could be increased with expertise (Noy et al., 2011).

48 dyads were split in a between-groups two-by-two experimental design. They performed unintended interpersonal coordination tasks in which BM and BS were manipulated (BM: Similar or Dissimilar amplitude; BS: Easy or Difficult movements). Before and after each unintended coordination step, all groups performed a mirror game task in which either a leader was designated (Leader-Follower rounds: LF) or not (Joint Improvisation trials: JI). Motor competences were evaluated using movement precision and richness of movements performed during the mirror game. Social competences were evaluated by asking interactants to rate the connectedness towards each other before and after the experiment.

Dyads from Similar groups and from Easy groups improved their motor and social competences whereas Dissimilar groups and Difficult groups only improved social competences. Analyses on unintentional interpersonal coordination steps revealed that dyads from Similar and Easy groups exhibited more unintended synchronization. Altogether, results suggest that the use of BM and BS during unintended motor coordination task appears relevant to improve social and motor competences. These findings have strong implications for understanding the mechanisms that contribute to increasing social interactions and in paving the way for studies in rehabilitation of social pathologies.

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Mutual perception of the layout of affordances influences the control of joint actions

Tehran J. Davis

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James J. Gibson offered his theory of affordances (1986) to address how animals select and control actions in complex environments. Briefly, an environment, by virtue of its structure and constitution, provides a manifold of opportunities for specific kinds of actions to specific kinds of animals. In the present talk I will discuss recent work demonstrating how the perception of this "layout of affordances" influences goal-directed behavior and shapes the online execution of action. In particular, I highlight work that focuses on joint actions, where an actor must often consider both the affordances that are available to himself as well as those that are available to another, including the constraints and limits of collaboration. In such situations, one's actions may rejigger and restructure the environment in ways that have consequences for others, and may serve to guide, invite, or inhibit certain behaviors. In this regard, joint action may be understood as a reciprocal process where individuals continuously perceive and exploit the opportunities for action that their combined efforts create for one another, and the mutual perception of affordances may serve to align the intentions and actions of co-actors, facilitating better prediction, coordination, and task success.

Playing 'PONG' together: An experimental paradigm to study interpersonal coordination

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Typically, studies into interception have considered how individual participants perform an interception task. In various (sports) situations, however, individuals have to coordinate their interceptive movements with respect to others (e.g. a serve reception in beach volleyball). This begs the question if and how an individual's interception is affected when cooperation is demanded to achieve a common goal. To our knowledge, no study has considered the influence of the presence of static or dynamic cooperating agents on an individual's interceptive behavior. To address this issue, we adapted the well-known game 'PONG' to develop an experimental paradigm to study interpersonal coordination in a cooperative manual interception task. Participants had to return virtual balls, moving downward across a large computer screen, with an on-screen paddle that was directly linked to lateral hand movements along a rail. All participants (N = 24) took part in three consecutive sessions in which they intercepted balls: 1 - Individually; 2 - Individually but accompanied by a static agent (covering approximately ¼ of the screen); 3 - As a member of a dyad (both with their own paddle). In all sessions the paddle could move across the full width of the screen; that is to say, in session 2, it could move freely across the static agent, and in session 3, both paddles could pass over or under the other paddle. Preliminary analyses have focused on the differences in paddle kinematics among the three conditions. These differences indicate an interaction between the control aspects of the task (knowing how to arrive at the interception location in time) and the affordance aspects of the task (participants knowing who will intercept the target, as well as the timing thereof). We believe that this experimental paradigm provides a powerful tool to explore the (inter)personal coordination during individual and cooperative interception tasks.

Open Forum D

Thursday 13:30 – 15:00

Focusing on transfer: Rehabilitation research from an ecological perspective

Ludger van Dijk, Corry van der Sluis, Raoul Bongers

University of Groningen, University Medical Centre Groningen

In order to bring ecological considerations to the field of rehabilitation, this talk examines the perspective that is currently at the heart of rehabilitation research. It will take its examples from our recent studies on using computer games to improve prosthetic use in activities of daily life (ADL). The dominant "body-oriented perspective" in rehabilitation explains motor learning as determined by improvements in underlying body-functions, such as range of motion or step length. It is argued that this perspective views technological innovations, such as using computer games for rehabilitation, as fostering the use of the same body-functions implicated in ADL. Therefore rehabilitation tends to adopt novel training tools in order to improve body-functions, and focuses on measuring these body-functions at the expense of studying transfer of practice to ADL. By contrast we articulate an ecological "task-oriented perspective". This perspective explains motor learning as the ability to learn to coordinate the body towards a goal. From this perspective computer games and virtual environments provide novel and essentially different tasks. It is shown how this perspective inherently favours a focus on the study of transfer to ADL. We argue that in order to understand if and how virtual training benefits transfer to ADL, research therefore needs to adopt a task-oriented perspective. We end this talk by outlining how the task-oriented perspective bears on current research methods in rehabilitation. By taking an ecological, task oriented perspective, rehabilitation research can make strong headway in designing training programs that transfer skills from (virtual) rehabilitation environments to ADL activities.

Can flexibility of reaching movements be increased through training?

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The current study examined whether flexibility of a reaching movement over an obstacle can be increased through a variable practice intervention. Flexibility in motor behavior is defined as accomplishing the same action goal with different joint coordination patterns. The question was whether practicing the use of different joint coordination patterns in an intervention resulted in more flexibility after the intervention. The pretest, on day 1, and the posttest, on day 3, consisted of 30 trials of 30cm reaching movement over an obstacle (height: 10cm, placed at one third of the movement distance). The intervention, on days 1 to 3, consisted of 200 reaching movements per day over one of 10 different obstacles (heights: 5-9cm and 11-15cm, steps of 1cm) in quasi random order. The pretest, intervention and the posttest were analyzed with the UCM method. With the UCM method we partitioned variability in joint angles over repetitions of reaching movements in two types of variability: a) goal equivalent variability (GEV): variability that does not affect the goal, which we call flexibility and b) non goal equivalent variability (NGEV): variability that results in movements away from the goal. Results showed that during the intervention both GEV and NGEV decreased while comparison of pre- and posttest did not show significant differences. This implicates that flexibility did not increase when training emphasized the use of different joint coordination patterns. These findings challenge learning theories that have the assumption that flexibility increases when variability during training is promoted. To further understand how the intervention affected flexibility, future analyses will concentrate on variability in joint angles used and individual differences in learning paths.

Not all is lost when ageing: Reaching flexibility doesn't decrease

Bongers, Raoul M., Greve, Christian, Hortobágyi, Tibor

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Coordinating limb segments in different ways while the goal of the task is achieved over repetitions of the same task is coined flexibility. This paper focuses on whether the capacity of flexibility varying joint angles differs between young and old adults. Flexibility is operationalized using the Uncontrolled Manifold (UCM) method. In the UCM analysis it is assumed that the neuromuscular system acts in a state space of elemental variables (e.g. joint angles) and makes use of all available degrees of freedom to ensure stable but flexible control of task important performance variables. The method allows distinguishing variability of elemental variables in stabilizing and de-stabilizing variability. The ratio between the two is an indicator of flexibility. In a reaching task with just young adults we manipulated dexterity demand by changing target size and physical demand by increasing external resistance to reaching. We found no effects of dexterity demands on UCM variables. With larger physical demands we found a proportional increase in stabilizing and destabilizing variability without the change in the ratio of the two variability components. We propose that the larger de-stabilizing variability as a function of physical demands originated from larger sensorimotor noise in the neuromuscular system. The larger stabilizing variability with larger physical demands is a strategy employed by the neuromuscular system to counter the de-stabilizing variability so that performance stability is maintained, we suggest. In a new experiment young and old adults were examined under variations of dexterity and physical demands. Overall we found more stabilizing variability than destabilizing variability but no effect of age, dexterity demand, and physical demand. Our findings that old were not less flexible than young challenges findings of other studies that report declines in performance when aging. It also points to possibilities to develop interventions that foster flexibility.

Does similarity promote social interaction in schizophrenia?

L. Marin,[1] R.N. Salesse,[1] C. Bortolon,[2] M. Gueugnon,[1] Z. Zhao,[1] S. Raffard,[2] D. Capdevielle,[2] R.C. Schmidt,[3] N. Schmitz,[4] J. Henriques,[4] D. Stricker,[4] M. Di Bernardo,[5] K. Tsaneva-Atanasova,[6] P. Slowinski,[6] C. Zhai,[5] & B.G. Bardy[1]

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Schizophrenia is often characterized by nonverbal communication deficits that directly impact patients' everyday life and often induce stigmatization. Although clinicians have developed several interventions and training sessions for these patients, paradoxically, these interventions are not focused on social motor interaction. The goal of this presentation is to propose lines of inquiry that could enhance socio motor competences in schizophrenia based on the concept of similarity. In several fields, two similar systems exchanging information tend to synchronize together. For instance, in social psychology, social exchanges were increased when two people unintentionally mimicked each other (Chartrand & Bargh, 1999); in physics, two oscillators moving at the same frequency synchronize to each other as long as they are in contact (Von Holst, 1973). Several other examples could be found showing that similarity promotes synchronization. In such a context, we propose that using similar avatars (that look and behave like the participants) in a joint-action task should enhance social interactions.

In this presentation, we will compare patients suffering from schizophrenia to healthy participants facing an avatar similar or dissimilar to them during several exposures. Participants' task was to horizontally move in synchrony a handle attached on a string at the shoulder height while facing the avatar.

The main results showed that although all participants were always more synchronized with a similar avatar than with a dissimilar one, after some exposures to the dissimilar avatar, patients increased their motor coordination performance.

From a clinical perspective, our results highlight two potential therapeutic pathways: first, similarity could be used in protocols requiring high level of interaction from patients, second, dissimilarity could be envisaged in protocols involving social interaction learning. These findings are of particular interest to any rehabilitation protocols in schizophrenia in particular but also in psychiatry in general

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Open Forum E

Friday 8:30 – 10:20

Invisible tension behind cooperative skills in team sports

Keiko Yokoyama[1], Hiroyuki Shima[2], Noriyuki Tabuchi[3], Yuji Yamamoto[4]

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Team sports, such as soccer, require dynamic inter-personal interactions among many players within spatiotemporal constraints controlled by rules. We previously investigated the dynamics of cooperative interaction among three players using a 3-on-1 ball-possession soccer task (Yokoyama & Yamamoto, 2011). The results showed that expert players behaved in a rotational pattern, whereas intermediate players behaved in a partial anti-phase pattern, which was predicted from symmetric Hopf bifurcation theory (Golubitsky & Stewart, 2002). This theoretical approach has been used to predict several synchronized patterns among oscillators using only the geometrical symmetry of the system. Therefore, specific synchronized patterns corresponding to skill levels were identified, even though we could not describe the invisible interactions among the three players. Here, we describe and clarify the invisible interactions among three players using cooperative interaction modeling. The invisible links among players were imagined to be the physical spring tension that depends on inter-personal distance in a spatial relationship. Two different linkage patterns as interactions of the three players were defined, such as two players were connected by one spring or three players were connected by a common spring. The difference between the two patterns is the number of interactions affected by the pull force generated by displacing the spring; the first pattern affects two interactions connected directly, whereas the second pattern affects all interactions, including those indirectly connected to the interactions. The simulation and experimental results showed that the common-spring linkage pattern was associated with a high skill level. The experts pulled each other simultaneously and indirectly using invisible tension. We not only constructed a model depicting the inter-personal interactions among three players but also suggested a practical tool for acquiring cooperative skills.

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Spatiotemporal domains of IOVD and CDOT for perceiving time-to-contact

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The optical variable τ has been studied for perception of time-to-contact of approaching objects. This τ information is available monocularly, but most human vision is binocular, so there may also be contributions from information like interocular velocity differences (IOVD) and changes in disparity over time (CDOT). IOVD results from comparison of two monocular flow (MF) fields. Binocular disparity results from comparison of two monocular image structures and CDOT characterizes how this disparity evolves. There is evidence that CDOT-based stereomotion perception is a slower process than IOVD-based perception (Shioiri, Saisho, & Yaguchi, 2000). If so, CDOT should be an inferior source of information for fast-moving objects, but is there a domain in which CDOT is superior? Ten participants were presented with displays that depicted two squares approaching from different distances at different constant velocities yielding different times-to-contact. Squares disappeared during approach and participants judged which square would have contacted them first. One display type was dynamic random-dot stereograms that isolated CDOT by rerandomizing points each frame (CDOT-only). Another was evolving (i.e., without rerandomization) random-dot configurations (MF+IOVD) in which disparity did not specify approach. The third was evolving random-dot stereograms, so motion was defined by MF, IOVD, and CDOT (COMBINED). For all three displays, in half of the trials, the squares moved at speeds ranging 26–32 cm/s. In the other half, speeds ranged 73–127 cm/s. For fast stimuli, performance as measured by proportion correct was comparable for MF+IOVD and COMBINED trials, but CDOT-only trials were significantly worse. Performance with slow stimuli was comparable for CDOT-only and COMBINED trials, but MF+IOVD trials were significantly worse. Optimal performance levels were similar for both speed conditions. To yield invariant performance across speeds, it appears the visual system primarily uses CDOT to perceive motion of slower objects, but MF and IOVD for faster objects.

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Perception of catchability of fly balls

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The Chapman strategy (1968), also known as the Optical Acceleration Cancellation (OAC) strategy, holds that zeroing out optical acceleration will lead to successful interception of a projected fly ball. Although the Chapman strategy has proven to be quite successful in explaining the locomotor patterns of fielders running to catch a fly ball, any affordance aspects of running to catch fly balls does not appear to be part of the strategy (cf. Fajen, 2007). The current study examined what optical information fielders might use to perceive the affordance of catchability. Semi-professional baseball players were to catch fly balls projected along their sagittal plane. Some fly balls were projected within the players' locomotor reach, whereas others were projected beyond their locomotor reach. Participants were instructed to call 'no' at the instant they realized that a ball would be uncatchable. Using an HD-camera, positioned perpendicular to the plane of ball projection, we captured kinematics of both the ball and the participant's (head) movement. From this, we computed a number of optical variables (cf. Zaal and Michaels, 2003). The analyses considered variables and their fractional derivatives. Preliminary analyses suggest that optical velocity (i.e. a variable of about a first-order derivative of optical position) is the most promising candidate variable predicting the participants' judgments of catchability. We hope that the present findings will provide an entry into understanding running to intercept fly balls from an affordance-based control perspective.

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The initiation of running to catch fly balls

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According to the optical acceleration cancellation (OAC) strategy, optical acceleration informs catchers to change their running speed appropriately to arrive at the interception location in time. Relatedly, optical acceleration informs these catchers to start moving in the correct direction (forward or backward). We report results of analyses of running initiation times of running to catch fly balls. We had participants run to catch fly balls, projected at them from a ball-launching machine. Launching distances were 17 to 23 m, balls reached peak heights of 6 to10 m relative to average initial eye height, and passed at distances up to 6 m in front or behind the participants' initial position. Because the delivery of the balls from the launching machine was quite variable, we could not use repeated-measures ANOVAs to analyze the running initiation times. Instead, we applied linear mixed-effects regression (LMER), a technique that can be seen as repeated-measures multiple regression. The results of the LMER analyses indicated that running initiation times were affected by ball height and ball passing distance in a way that would be predicted from the use of optical acceleration: participants started running later for balls flying higher trajectories and for balls passing at longer distances from the initial position of the participant. We were not able to also show an effect of launching distance. In sum, the timing of running initiation to catch fly balls was consistent with the use of optical acceleration.

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The art and science of the camera obscura

Rebecca Krinke

University of Minnesota

The camera obscura is an ancient device that was the forerunner of photography and the camera. They were - and even still are - used as an aid to making drawings by painters and scientists. Camera obscura means "dark chamber" in Latin, and it is via darkened enclosures and principles of light/optics that an image of the outside can be captured and projected onto a facing surface. My talk will use my *Black Box Camera Obscura* that I designed and constructed last year as a temporary project on campus - with the help of two of my graduate students - as a case study to outline how the camera obscura works and how being inside the camera obscura impacted the visitors' perceptions of the outside world. The *Black Box Camera Obscura* generated much conversation about perception, and I will reflect on that in my talk and make comparisons to the intentions and experiences with other camera obscuras, such as geographer Patrick Geddes' camera obscura in Edinburgh, and artist Abe Morrell's work of creating and photographing camera obscuras in rooms all over the world.

Open Forum F

Saturday 8:30 – 10:00

Medium facilitates the perception of affordances of touch

Kiyohide Ito[1], Mamoru Sawada[2], Hiroyuki Mishima[3], Masashi Takiyama[1], & Yusuke Kikuchi[3]

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At ICPA 16, Mishima et al. reported when two persons held both ends of a rod, one person was able to identify the person solely through haptic perception. This result suggested that the physiological tremor of each person's fingers propagated through the rod. Also at ICPA 16, Ito et al. reported the findings from an experiment where participants without vision and audition were asked to stop prior to contacting a wall. They reported that the physiological tremor of the participants' fingers increased as they approached the wall. This finding suggested that participants perceived affordances of contact with the wall via their fingers. Based on these studies, we investigated the role that media (solid or gas) plays in humans perception of the affordances used for contacting objects. Therefore, in this study, we set two experimental conditions: a solid medium and a gas medium. In the solid medium condition, participants held one end of a rod, the other end of the rod contacted objects that varied in pressure. Participants without vision and audition took part in this experiment. The participants were required to report the strength of the contact with the objects. In the gas medium condition, participants were asked to extend their arms forward and to stop prior to contacting the objects. Then they were asked to report the specific material of the objects without touching them. In this case, the air was the medium provided information about the objects. From the findings of both experimental conditions, we will present the argument that different mediums, namely solid and gas, facilitate humans' perception of the same affordances a unique action.

Possibilities for action stabilize the perception of multistable displays

Dobromir Dotov

EuroMov, Movement to Health Laboratory, Université de Montpellier, France

A typical experiment in ecological psychology would investigate the perception of a single affordance or a single information variable specifying something. The world, however, is a vast field of potential but not actualized possibilities for action. How do some of these turn into solicitations? A classic method of studying the appearance of a single affordance is by way of a gradual parametric modulation of a control parameter that determines the layout of the optic array and the feasibility of the action. Such paradigms usually lead to hysteretic behavior characteristic of nonlinear phenomena. Here we show how a classical affordance boundary paradigm has been extended to study the switching between different perceptual modes or between different actions. The experimental procedure consisted of judging (classifying, open perception-action loop) or bodily interacting with (tracking, closed perception-action loop) the two possible perceptual modes of an apparent motion phenomenon while a control parameter was being incremented gradually. In the tracking condition the two perceptual modes were embedded in an object tracking game and implied two different kinds of actions. Therefore, the current could be thought of as an "ecologized" Gestalt phenomenon. Several important results were obtained. First, a rarely reported phenomenon of negative hysteresis was reliably observed in the classifying condition whereas normal hysteresis was observed in the bodily interaction condition. Second, applying a previously proposed formal account of these two kinds of dynamical regimes revealed that the alternative modes were subject to low competion between each other and high self-inhibition when they did not support action (classifying condition) and high competion and low self-inhibition when they supported action (tracking condition). Together these inform a general principle of operation of perceptual systems. When not complementing an action, a perceptual system is poised in a dynamically unstable state. Dynamical stability is a property of the complete perception-action loop.

Postural kinematics in support of affordance perception

Eric Haaland

School of Kinesiology, University of Minnesota

A quarter century ago, a set of experiments conducted by Mark et al (1990) suggested that certain postural movements were necessary for making accurate judgments about ones' maximum sitting height. Constraining or amplifying postural sway by manipulating task constraints reduced the participants' abilities to make accurate affordance judgments as well as learn new affordances. In their manuscript, the authors casually remark that participants made head and body movements in the main axes of the body (p. 335) and that increasing the angle of the feet during stance appeared to be correlated with increased uncontrolled movements (pg. 347). However, no movements were analysed and stance angles were not controlled.

This study was conducted to investigate the patterns of movement performed by participants while they make judgements of their maximum sitting height. Using an electromagnetic tracking system, I gathered movements of the head and trunk in AP and ML axes during and between judgment trials while participants stood with heels 17 cm apart (McIlroy & Maki, 1997) in two conditions: 1) with a 14° and 2) 110° difference in the long axis of the feet. Judgment performance was assessed across 12 trials in each condition. Movements in the AP and ML axes from each condition will be analysed in terms of spatial magnitude, spatial variability, as well as temporal complexity. The findings of this research may provide insight into the types of motor control necessary for the accurate perception of affordances.

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Do multiscale interactions predict affordance perception?

Alen Hajnal, Zsolt Palatinus, Jonathan K. Doyon, Joseph D. Clark

Department of Psychology, University of Southern Mississippi

In recent years considerable attention has been devoted to action measures during affordance tasks, such as motion tracking of relevant body parts. Nonstationary movement patterns ought to be as informative about affordances as perceptual judgments are. Given how central the notion of the unity of perception-action is among ecological psychologists it is surprising that this hypothesis has not become more popular sooner.

In the present contribution we recorded head motion with a single wireless marker attached to the back of the head (Vicon Motion Systems Ltd., Oxford, UK) during quiet stance. Participants visually inspected sloped ramps of various geographical slants for 15 seconds in order to estimate whether they would be able to stand on the surface. Verbal affordance judgments were also obtained. Participants were not allowed to attempt standing on the ramp on any trials. We hypothesized that multiscale fluctuation patterns in bodily movement during visual observation would predict perceptual judgments. Similar hypotheses have been successfully supported in recent dynamic touch investigations (Stephen & Hajnal, 2011; Palatinus et al., 2014).

Mixed effects logistic regression was used to predict binary affordance judgments by using geographical slant angle, standard deviation of head motion, ellipsoid volume capturing 95% of motion (derived via principle components analysis following Duarte and Zatsiorsky, 2002), and multifractal spectrum width (derived by the MFDFA algorithm of Ihlen, 2012) as predictors.

Results showed that multifractal spectrum width and ellipsoid volume were the strongest predictors of affordance judgments. Specifically, increased spectrum width was associated with decreased odds of a "yes" answer. Similarly, increase in ellipsoid volume was associated with decreased odds of a "yes" answer. Interestingly, standard deviation was not a significant predictor, reinforcing the hypothesis that traditional measures of variability are not suitable for describing nonstationary time series, and in turn do not contribute significantly to multiscale interactions in perception-action systems.

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Open Forum G

Saturday 10:30 – 12:00

Music-induced synchronization of biological systems

Benoît G. Bardy

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Music is known to boost motor performance. Running while listening to rhythmic music is not only pleasurable, but propels people to run longer and more efficiently. Yet, it is unclear where this ergogenic power of music comes from. It can be merely due to music's tendency to drive attention away from people's feelings of fatigue. Alternatively, music may foster efficient coupling of biological rhythms that are key contributors to performance, such as locomotion and respiration. Here, we show that running with music enhances performance (i.e., it lowers motor and respiratory variability), increases the coupling between locomotor and respiratory rhythms, and reduces energy consumption (Bardy et al., 2015, Hoffmann et al., 2012). Music is more efficient than a simpler rhythmic stimulus (i.e., a metronome), which is itself more efficient than silence. This beneficial effect of music is equivalent to reducing by 3 min the time to complete a marathon, and is associated to lower perceived effort. The propensity of auditory rhythms to entrain biological systems, and stabilise their synchronisation, is thus a key factor in increasing motor performance. This finding is robust and extends well beyond the science of running, with consequences for rehabilitation of movement disorders, efficiency in daily work, and the development of new music technologies.

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Relationship between affordance and information from a semiotic perspective

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The aim of this study is to analyze the relationship between the concepts of affordance and (ecological) information, with regard to specification in particular. This would to the continued development of the field of ecological psychology.

Since J. J. Gibson coined the term "affordance," it has been used in a number of fields, including ecological psychology. However, even in the field of ecological psychology, the term has several different definitions.

Though there is some discussion of the concept of (ecological) information in the field of ecological psychology, there is little continuing debate in other fields. This leads to the misinterpretation of results, due to (ecological) information being confused with Shannon's information. As a result, research in ecological psychology is frequently misinterpreted.

Consequently, ecological psychologists sometimes classify some definitions of affordance (Chemero, 2003; Withagen et al., 2012), and clearly show the difference between (ecological) information and Shannon's information (Kelso et al., 1987; Yates, 2012).

Classifying and arranging the concepts of affordance and (ecological) information has led to much study of these concepts, which has in turn, contributed to the field of ecological psychology. However, few studies have investigated the relationship between affordance and (ecological) information. In many cases, ecological studies follow Gibson's definition: "the affordances of things for an observer are specified in stimulus information" (Gibson, 1979/1986), and do not define "specification" well. Furthermore, one ecological study (Withagen et al., 2012) uses the term "non-specifying information," which seems to be self-contradictory.

In this study, I survey the classification of affordance and (ecological) information. Then, I analyze the relationship between the two terms, especially with regard to specification, and suggest new, standard definitions of the terms from a semiotic perspective. This analysis will improve the study of learning affordance and (ecological) information.

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Medium Perception Robots

Miki Goan[1], **Katsuyoshi Tsujita**[2], **Susumu Kihara**[3], **Kenjiro Okazaki**[4]

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In order to verify the way of emotional communication in visual art, we developed medium perception robots to display the relative movement between subject and medium during drawing. In this presentation, we introduce the experimental study using the following two types of the robots' systems.

First one is an automatic drawing computer program using a simulation algorithm based on the coiling patterns of heteromorphy ammonoids (Goan et al., 2014). In this program, the plotting point on the computer view window is determined by two components. One is the position of the mouse cursor, which is manipulated by a human operator at every moment and gives the center position for the plotting point in the view window. The other is based on the coiling pattern of heteromorph ammonoids, and gives fluctuation and a coiling pattern to the plotting point in the view window, depending on the movements of the mouse cursor.

Second one is a parallel link-type robot which played the role of medium, combining the following two kinds of consciousness which arise in the process of creating pictures (Yabuki et al., 2014). One is the consciousness that one is trying to draw a picture. The other is the consciousness that one is made to draw a picture while facing various material resistances. In this research, the parallel link-type robot which plays the role of medium, combining them. The experimental system was as follows. Participant #1 draws a free line on a tablet computer. Participant #2 only holds the pen to a moving board on the robot. When the robot moves the drawing board under the pen, the line drawing is recreated on the board. By doing this, each agent verifies how he or she is trying to regain subjectivity in the drawing act.

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Direct perception of uncertainty as a framework for urban design

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Navigating in a built environment requires road users to attend not only to information about immediately visible static objects but also to information about potential future hazards. Pedestrians attempting to cross a road must be aware of things like cars that are not in their immediate field of vision but which may nevertheless appear from round a corner before they reach the other side of the street. In assessing whether it is safe to cross, what the pedestrian perceives is not empty space but a relation between their own prospective path across the road and a prospective state of the world. Where vision is impeded by traffic and other opaque objects the pedestrian directly perceives uncertainty about whether it is safe to cross.

A popular school of thought has arisen in urban design known as the shared space approach. This holds that the most effective urban spaces are those in which artificial structures such as signs and kerbs and traffic signals are removed and individual road users are forced to interact with one another directly. This approach can work well but relies on designers making common sense considerations about what will work in a given setting. What the designers lack is a watertight account of how individual pedestrians perceive their environment. The ecological approach provides the appropriate tools, though there is work to be done to spell out exactly how to apply them in the urban setting. The concepts of prospective control and direct perception of uncertainty are invoked in analyzing some existing shared spaces and are used to motivate some heuristics for effective design.

Open Forum H

Saturday 13:30 – 15:00

Distance-to-break in the haptic perception of compliant materials

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In minimally invasive surgery, where interactions with a patient's tissues are through hand-held tools, surgeons face several perceptual challenges due to the remote interaction. Nonetheless, accurate perception of haptic information is critical in order to apply the appropriate amount of force against soft tissue, with the aim of minimizing tissue trauma. Force perception in minimally invasive surgery involves dynamic touch, with the surgeon's administration of force against a tissue revealing information about the nature of the tissue and about the effects that ongoing manipulations are having upon the tissue. Surgeons must perceive, for example, when they are about to break a tissue that they are pushing or pulling against with the tool. Haptic perception during minimally invasive surgery is further complicated by the presence of friction caused by the trocar, the device that the tool must pass through at the incision site. Forces applied, and felt, are a function of both the trocar friction and the tissue manipulations. We discuss an invariant relationship between applied force and material deformation rate that specifies the distance remaining until a tissue will fail. This invariant provides a haptic analog to optical time-to-contact, and we refer to it as haptic distance-to-break. We review a series of experiments that utilized a haptic simulator developed at Clemson University. These experiments demonstrate that perceivers are sensitive to distance-to-break when manipulating simulated tissues, that the ability to perceive distance-to-break can be enhanced through feedback training, and that distance-to-break can be attuned to even in the presence of varying amounts of simulated trocar friction.

The influence of grip position on gaze and posture in handwriting

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The design of writing implements is important to handwriting because it affects not only the control of hand movement but also eye gaze and body posture [1]. In this study, I manipulated the position or availability of a rubber grip for participants writing Japanese Hiragana or Arabic letters, and analyzed eye gaze and head posture during the task. Four right-handed adults (2 men and 2 women) participated in this experiment. Each participant was asked to sit behind a desk and trace examples of Arabic or Hiragana letters. An eye tracker (EMR-9, nac Image Technology) was placed on the participant's head to record eye gaze, and 12 infrared cameras recorded their head orientation. The fixation point in Arabic moved along the letter, whereas the fixation point in Hiragana was on the center of the letter. A letters (Arabic/Hiragana) × grip position (bottom/center) × availability of rubber grip (with/without) ANOVA for head orientation was performed. Participants' heads seemed to be rotated more to the left in writing Hiragana letters when the grip was in the center position compared with the bottom grip position. Gaze and head posture seem to be influenced by the design of writing implements.

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Wild bearded capuchin monkeys crack nuts dexterously

Madhur Mangalam, Dorothy M. Fragaszy

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Dexterous tool use is likely to have been crucial in the evolution of human percussive technology (Byrne, 2005). According to Newell (1986), 'dexterity' refers to the ability of an organism to make goal-directed corrections in movements that optimize physical effort. Dexterity develops during the later phases of refining a motor skill as the actor becomes sensitive to the outcome of the preceding movement, or to its modulation. It might be revealing to know how individuals of nonhuman species modulate their percussive movements to accommodate (or do not accommodate) specific requirements of the percussive tool-using task into the broader schema of cognition and control. In the present study, we examined how wild bearded capuchins monkeys, *Sapajus libidinosus* at Fazenda Boa Vista (Piauí, Brazil), that routinely crack palm nuts using stones by placing the nuts on rock outcrops, boulders, and logs (collectively termed anvils) (Fragaszy, Izar, Visalberghi, Ottoni, & de Oliveira, 2004), modulate their percussive movements while processing a single tucum, *Astrocaryum campestre* nut. The monkeys cracked tucum nuts by repeatedly striking them with less force, rather than by forcefully striking them once, and modulated the force/work parameters of the current strike on the basis of the condition of the nut following the preceding strike (i.e., the development of any fracture/crack). Repeatedly striking the nuts with less force is energetically less costly than forcefully striking them once and reduces the likelihood of crushing the kernel. Thus, wild bearded capuchin monkeys crack tucum nuts dexterously. We conclude that certain aspects of the psychophysical phenomenon of manual dexterity in hominids, such as modulating striking movement, are common to other primate taxa, and discuss several plausible questions stimulated by our observations, pertaining to the kinematic modulation of the percussive movements and the precise control of heavy stones, and the underlying perception-action systems.

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The Gibsonian concept of information and its philosophical implications

Tetsuya Kono

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This paper seeks to clarify the Gibsonian concept of information and draw some philosophical and metaphysical implications from it. Recently, there have been some important works which cast doubt on the Gibsonian conception of information as specification and propose alternative conception of perceptual information based on developmental systems theories (Chemero, 2009; Withagen & Chemero, 2009; Withagen & van der Kamp, 2010). However, I would like to focus on the Gibson's claim that information is simply there where the perceptual object exists. According to Gibson (1979), information is not conveyed inside the body including brain, but, it is out there to be perceived. Luminous, mechanical or chemical energy can be a medium for perception, but information itself cannot be conveyed by them. Information is detected thorough mediums while the information is out there. If so, what is the difference between the object itself and the information of it, or between existence and information? We should interpret this Gibsonian concept of information as a concept with the original meaning of "giving form" "organizing" or "teaching". Information is *Eidos* in the sense of Greek philosophy, the structure of the environment. Gibson does not distinguish, by intention, knowing from existing, and ontology from epistemology. The form or structure of the environment is an existing real property of the world, and at the same time, it is information which organizes and guides animal behaviours. It is an animal who begins the perceptual exploration, but it is information which guides the exploration. Therefore, information is ontological and epistemic at the same time. The most radical, philosophical implication of the Gibsonian concept of information suggests the abolishment of the dichotomy between knowing and existing and the new ontology which sees information as another ontological principle in addition to causality, natural laws, or energy transmission.

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Open Forum I

Saturday 15:30 – 17:00

Perception of sex in point-light displays

Julie A Weast[1], Sade McKenzie[2], Kevin Shockley[1], & Michael A Riley[1]

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The evolution of the human visual system has resulted in perceptual sensitivity to human motion (Johannson, 1973). Observers are able to identify many characteristics of a moving actor even when perception is constrained, such as when the biological motion of the human body is displayed as a point-light video; these characteristics include the identification of the walker's sex (Kozlowski & Cutting, 1977), age (Montepare & Zebrowitz-McArthur, 1988), and emotional state (Dittrich, Troscianko, Lea, & Morgan, 1996; Kozlowski & Cutting, 1977). While previous research has identified cues in biological motion patterns that are useful for sex classification, it is unclear whether classification is possible when the movements of certain parts of the body are occluded. In the current study, we evaluated accuracy in the sex classification of point-light walkers after viewing movements of the whole body, the upper body only, and the lower body only. Results revealed differences in the accuracy of sex classification between video types, suggesting movements of different parts of the body are relevant for the perception of each sex.

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The visual control of walking over complex terrain

Brett R. Fajen[1], **Jonathan S. Matthis**[2], **Sean L. Barton**[1]

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When humans walk over flat, obstacle-free terrain, they achieve remarkable energetic efficiency by exploiting the passive mechanical forces inherent to bipedal locomotion. However, little is known about how these principles govern the control of walking over complex terrain containing obstacles and irregularly spaced safe footholds. Inspired by the dynamic walking perspective on human locomotion (Kuo, 2007), we proposed that when humans walk over complex terrain, they select footholds that allow them to exploit their inverted-pendulum-like structure to the benefit of efficiency and stability. Such a strategy suggests that visual information about each foot target is primarily used just prior to initiation of the step to that target, but is not needed to continuously guide the foot throughout the swing phase. To test this hypothesis, we developed a novel experimental paradigm in which subjects walked over a field of randomly distributed virtual obstacles or irregularly spaced target footholds that were projected onto the floor by an LCD projector while their movements were recorded using a full-body motion capture system. Walking behavior was compared across different visibility conditions in which the virtual objects did not appear until they fell within a visibility window centered on the moving subject or were initially visible but disappeared before the subject reached them. The findings from a series of studies (Matthis, Barton, & Fajen, in press; Matthis & Fajen, 2013, 2014) suggest that visual information about each foot target is most essential during the latter half of the preceding step, and is used to initialize the upcoming step so that the body can follow a natural, ballistic trajectory to the next target. By using information during this critical phase, walkers can choose footholds that allow them to walk over complex terrain much like they navigate flat, obstacle-free terrain -- that is, by exploiting their inverted-pendulum-like structure.

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The visual coupling between neighbors in a virtual crowd

William H. Warren, Kevin W. Rio

Brown University

Pedestrians in a crowd use visual information to coordinate walking speed and heading direction with their neighbors. Previously, we characterized the strategies used to control these behaviors in pairs of pedestrians (Rio, Rhea, & Warren, 2014; Dacher & Warren, 2014). Here we investigate how a participant combines the influence of multiple neighbors, providing a bridge from individual behavior to crowd dynamics. In two experiments, a participant (N=10 per experiment) was instructed to "walk together" with a virtual crowd of 12 simulated humans presented within the FOV of a head-mounted display (90˚ H). On each trial, a subset of virtual neighbors changed their walking speed or heading direction mid-way through the trial. We manipulated the number of neighbors in the subset (0, 3, 6, 9, or 12, equivalent to 0%-100% of the crowd), their distance from the participant (1.5m or 3.5m), and the density of the crowd (interpersonal distance of 2.5m or 5.5m). Change in the participant's walking speed and lateral position were measured relative to baseline control trials, when all neighbors maintained a constant speed and direction. The results support three main conclusions: First, neighbor influence is additive. Participant responses increased linearly with the number of neighbors in the subset ($p<.001$), for both speed and heading. Second, neighbor influence is weighted by distance. Responses were significantly weaker when the subset was far than near ($p<.001$), for both speed and heading. Third, the neighborhood structure appears to be metric (fixed radius) rather than topological (N nearest neighbors) (Ballerini et al., 2008). Responses depended on crowd density ($p<.01$), for both speed and heading, contrary to the topological hypothesis. Thus, a pedestrian in a crowd is visually coupled to at least 12 neighbors in the FOV and coupling strength decays rapidly with metric distance, placing strong constraints on models of collective behavior.

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Quantum-like issues at the ecological scale

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The theory of perception-action encounters two quantum-like problems. Given visual entities *here* (e.g., in the mind), how are they experientially situated *there* (in the environment) coordinate with the entities to which they belong? This is the *outness problem*. Its foundation is the principle of local causality: no action at a distance. Given that everyday objects offer different action possibilities for different organisms (observers) simultaneously, how can they be classified in classical mechanical terms independently of context? This is the *observation problem*. Its foundation is the traditional conception of macroscopic objects as non-superpositional. Ecologically motivated steps to addressing the two problems are presented and the significance of doing so for a theory of perception-action encompassing all organisms is emphasized.

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Posters

Poster Session I

Alphabetical order by 1st author

1. Whole-body semantic decision making

Mohammad Abdolvahab, vahabmo@gmail.com
Michael Turvey

2. High-density EEG study of cortical activity in response to visual motion perception: Longitudinal comparison of preterm and full-term infants

Seth Agyei, agyei@svt.ntnu.no
Ruud van der Weel
Audrey van der Meer

3. Observations of block play: Communication as a way to control encounters

K. Aoyama, aoyamakei@hotmail.com
K. Suzuki
M. Sasaki

4. Parsing memory and anticipation using analysis of head motion data

Thomas Brooks, thomas.brooks@uconn.ed
James A. Dixon

5. Quantifying survivability: An Ecological analysis of soldier performance

Michael A. Busa, mbusa@kin.umass.edu
Christopher J. Palmer
Richard E. A. van Emmerik

6. Auditory information for, and perception of, shape from motion

Patrick A. Cabe, patrick.cabe@uncp.edu
John G. Neuhoff

7. Effects of age and task constraints on intercepting a moving traffic gap in a virtual environment

H. C. Chung, hcx0001@gmail.com
G. J. Choi
M. Azam
M. H. Jin
W. Y. Cho

8. Head-sway multifractality carries optical nesting to visual and haptic perception

Charles L. Eddy
James A. Dixon
Damian G. Kelty-Stephen, keltysda@grinnell.edu

9. Perceiving movement synchronization differences in autism

Paula Fitzpatrick, pfitzpat@assumption.edu
Katherine Schmidt
Veronica Romero
Joseph Amaral
Michael J. Richardson
R. C. Schmidt

10. Response in delayed control system

Yuto Fujita
Shigeru Sakuazawa
Kiyohide Ito, itokiyo@fun.ac.jp

11. Rhythmic self-sustained motor activities: How to go beyond the harmonic case with the canonical-dissipative approach

J. M. Gordon, jason.gordon@uconn.edu
S. Kim
T. D. Frank

12. Stride foot movement does not correlate with head movement during the baseball swing

Samuel J. Haag, haag@csp.edu

13. Detecting structure in activity sequences: Exploring the hot hand phenomenon

Taleri Hammack, hammack.2@wright.edu
John Flach
Joseph Haupt

14. Actions are selected according to mutually scaled π-numbers

Henry S. Harrison, henry.harrison@uconn.edu
Tehran J. Davis

15. Creating and validating point-light displays as a tool to study anticipation in penalty kicks

Alfredo Higueras-Herbada
David Travieso, david.travieso@uam.es
David M. Jacobs

16. Differentiating the hit-able affordance of sound through perceptual modalities and practice types

Chia-Pin Huang, magichcp32@gmail.com
Chih-Mei (Melvin) Yang

17. Reduced surface for postural control of reading in moving room

Chia-Chun Huang, tetsu69bass@me.com
Chih-Mei (Melvin) Yang

18. Dimensions of geometric object and information patterns in aperture-passing-through task

Chia-Sheng Huang
Chih-Mei (Melvin) Yang, melvin@ntnu.edu.tw

19. Auditory perception of shaking event

Kiyohide Ito, itokiyo@fun.ac.jp
Masashi Takiyama

20. Eye-head-knee coordination and optic flow in Kendama

Mariko Ito, itomarik@aoni.waseda.jp
Hiroyuki Mishima

21. Hiroshige's use of linear perspective: Mistakes or artistic license?

Endre E. Kadar, kadar_e@yahoo.co.uk
Judith Effken

22. Perceptual learning through brain computer interface in young infants

Mina Khosravifard, minak@stud.ntnu.no
Mahboobeh Harandi
Audrey L. H. van der Meer
F. R. (Ruud) van der Weel

23. Human odometer on inclined surfaces

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Till D. Frank
Tehran J. Davis

24. Preliminary tau analysis of infant arm movements as a detection method for cerebral palsy

Amy Mitchell, amym@stud.ntnu.no
Lars Adde
Audrey L. H. van der Meer

25. The horizon affects postural sway in older adults on land

Justin Munafo, munaf002@umn.edu
Michael Wade
Thomas Stoffregen

26. The horizon affects postural sway in older adults at sea

Justin Munafo, munaf002@umn.edu
Michael Wade
Nick Stergiou

27. An infant walking in his home

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Kei Aoyama
Masato Sasaki

28. Where is the dog? An analysis of stage performer's gestures and utterances

Yuki Sato, yuki.satou@gmail.com
Kei Aoyama
Masato Sasaki

29. Perceiving affordances with a sensory substitution device

David Travieso, david.travieso@uam.es
Luis Gomez-Jordana
Alex Diaz
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David M. Jacobs

30. Identifying individual traits with a medium perception robot

Katsuyoshi Tsujita, tsujita@bme.oit.ac.jp
Kouhei Yabuki
Miki Goan
Susumu Kihara
Kenjiro Okazaki

31. Development of optic flow perception in infants: A high-density EEG study of speed and direction

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Ruud van der Weel
Audrey van der Meer

32. A theoretical study on the genealogy of "medium": From Heider to Gibson

Hiroe Yamazaki, mathiroe@gmail.com
Masato Sasaki

33. Effect of a state and locomotion change by chemical reaction on macro pattern formation

Ayano Yoshida, g3114003@fun.ac.jp
Shigeru Sakurazawa

Poster Session II

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Mohammad Abdolvahab, vahabmo@gmail.com

35. Exploration in information space during affordance perception

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Brandon J. Thomas

36. Social perception of culprits and victims by witnesses of minor food theft

Thomas R. Alley, alley@clemson.edu
Kaitlyn A. Kooi

37. Connecting the dots in perception of affordances for stepping

Jiuyang Bai, jbai2@ilstu.edu
Aja Carten
Jeffrey B. Wagman
Peter J. K. Smith
Brian M. Day

38. The perceived preferred critical boundary as an example of Gibson's margin of safety

Brian Day, bday@clemson.edu
Leah S. Hartman
Christopher C. Pagano

39. The Oculus Rift is sexist

Med Diedrick
Zachary Polhkamp
Justin Munafo
Thomas A. Stoffregen, tas@umn.edu

40. Visuomotor training improves proprioceptive function and transfers to an untrained motor task

Naveen Elangovan, naveen@umn.edu
C. Krewer
Leonardo Cappello
Joshua Aman
Lorenzo Masia
Juergen Konczak

41. Exploring the behavioural and neural processes underlying social synchronization of individuals with and without social deficits

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Teresa Mitchell
Jean Frazier
C. Coleman
R. C. Schmidt

42. Multifrequency coordination in dyads

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Polemnia G. Amazeen

43. Spontaneous dynamic interpersonal postural coordination

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R. N. Salesse
B. G. Bardy
A. Coste
Z. Zhao
R. C. Schmidt
L. Marin

44. Catastrophe theory and pattern formation: Comparing two approaches for understanding hysteretic grasping transitions

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45. Modality effects in training haptic distance-to-break in a simulated minimally invasive surgery task

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Brian M. Day
Christopher C. Pagano
Irfan Kil
Timothy C. Burg

46. Coordinative dynamics: The role of task difficulty during interpersonal coordination

Justin A. Hassebrock, hassebja@miamioh.edu
Henry Cook IV
L. James Smart

47. Detecting the hit-able affordances of auditory information through same- and extra-modality practice

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Chih-Mei (Melvin) Yang

48. An affordance-based model of the relationship between environmental surfaces and perceived spaciousness

Makoto Inagami, inagami@enveng.titech.ac.jp

49. Wedge-prism adaptation involves prompt changes in shoulder orientation

Endre E. Kadar, kadar_e@yahoo.co.uk
Georgina Torok
Nam-Gyoon Kim
Juhan Kim

50. Schizophrenic' Impaired capacity to perceive affordances

Hakboon Kim
Geonho Shin
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51. Sex and task differences in pre-motion sickness postural control

Frank C. Koslucher
Eric Haaland
Thomas A. Stoffregen, tas@umn.edu

52. Does age change joint proprioceptive activity?

Carmen Krewer, ckrewer@umn.edu
Naveen Elangovan
Joshua E. Aman
Leonardo Cappello
Sara Contu
Sanaz Khosravani
Jurgen Konczak

53. Tablet computers: Sex differences in body sway and motion sickness

Ruixuan Li
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54. Joint navigation on the virtual table

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55. Haptic contribution to human postural stabilization during dog walking

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Renato Moraes

56. The influence of individual postural demands on role in interpersonal coordination

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Tehran J. Davis

57. Comparing solo and joint syncopation shows dyadic facilitation

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58. Expertise speeds up dynamics of interpersonal-distance maneuvers in Kendo

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59. Circadian influences on bimanual coordination

Chulwook Park
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60. Learning to intercept a moving target by launching a simulated ball

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61. Relationship between physiological tremor and haptic perception

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Arashi Noto
Kiyohide Ito

62. Flip this rod! Changing grasp position can recalibrate perception of length by dynamic touch

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Jeffrey B. Wagman
Drew H. Abney

63. Critical sizes induce handwriting movement pattern transition: Handedness and writing direction effects

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Melvin Chih-Mei Yang

64. Perceiving affordances while passing through one aperture among multiple co-existing apertures

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Hiroyuki Mishima

65. Muscle activity and lifting kinematics combine in the perception of weight by dynamic touch

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Eric L. Amazeen
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66. Build your own tool: The what, why, and how of a nested tool-making task

Jeffrey B. Wagman, jbwagma@ilstu.edu
Thomas A. Stoffregen
Sarah Caputo

67. Behavioral dynamics of a joint-action object movement and passing task

Auriel Washburn, washbual@mail.uc.edu
James Evans
Maurice Lamb
Rachel W. Kallen
Steven J. Harrison
Michael J. Richardson

68. The development of proprioceptive acuity and the susceptibility to muscle vibration in typically developing children

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Jessica Holst-Wolf
Juergen Konczak

69. Development of simple model system consisting of molecular state change and movement

Ayano Yoshida, g3114003@fun.ac.jp
Shigeru Sakurazawa

70. How you look like matters: Impact of physical attractiveness on interpersonal coordination

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Mathieu Gueugnon
Richard C. Schmidt
Ludovic Marin
Benoit G. Bardy

Most of the posters presented at ICPA XVIII appear in the "poster book":

Studies in Perception & Action XIII
J. Weast-Knapp, M. Malone & D. Abney (Eds.)

Below are abstracts for posters that do not appear in the poster book

Poster session I

Auditory information for, and perception of, shape from motion

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Past studies have demonstrated that humans can perceive a variety spatial and material properties of objects using acoustic information, primarily from impacts. Perception specifically of object shape from acoustic information has been documented in several other studies, also typically using impact-generated sounds. Research in the visual perception literature shows that optical patterns associated with object motion can inform visual perception of both solid and outline/boundary shape. However, apparently no studies document auditory perception of shape from motion in ways that parallel visual perception of shape from motion. We derived a physical analysis that implies the existence of information in the acoustic array to support 2-D shape judgments, where the acoustic information is friction-generated. We then examined human listeners' ability to make shape judgments of ellipses varying in shape (defined by minor-to-major axis length ratios between .4 and 1.0), when presented with recordings of such ellipses rotating against a contactor. The frictional contact produced a rasping sound varying in modal frequency and intensity as a function of ellipse shape. Group average shape judgments correlated strongly ($r = .95$) with actual shape for ellipses. Individual correlations showed substantial variability across participants (judged vs. actual shape correlations ranged from near zero to $> .9$). The results indicate a novel means by which shape information is available to, and can be picked up by, human listeners.

Poster session I

Effects of age and task constraints on intercepting a moving traffic gap in a virtual environment

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The present study investigated pedestrian age related to behavior while crossing the road in a virtual reality environment. To cross the road safely the pedestrians were required to actively control movements based on the flow of incoming vehicles.

Method

Participants consisted of three groups: 16 children (M = 12.18 yrs, SD = .83), 16 students (M = 22.75 yrs, SD = 2.56), and 13 aged (M = 54.18yrs, SD = 4.93) who were required to intercept moving gaps between two incoming vehicles in a virtual reality. We varied the gap size, vehicle types, vehicle velocity, and starting position relative to the time of arrival of the traffic gap at the interceptive point. We evaluated the position of the participants at the central point of the gap (PCP) and their speed.

Results and Discussion

PCP was influenced by the manipulation variables, including the initial starting position with respect to the time of arrival of the traffic gap at the interceptive point. The mean PCP was systematically varied dependent of initial starting position and age. Initial starting position influenced the participants' velocity during their approach of the interceptive point. Patterns of velocity control were similar among the three age groups, although mean speed was lowest among children and greatest among the aged. The
results demonstrate that the coupling of participants' crossing behavior with incoming motion was modulated by the manipulation of task constraints.

Poster session I

Eye–Head–Knee Coordination and Optic Flow in Kendama

Mariko Ito, Hiroyuki Mishima

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Visual perception involves eye, head, and whole body movement (i.e., posture). When we see a moving object in motor tasks, the eyes, head, and body are tuned to the object. Whereas the object's motion affects the local property of optic flow, posture affects the global property. Since optic flow guides goal-directed behavior, eye–head–body regulation could support motor task achievement. Hence, the coordination of eyes, head, and body movement relative to the optic flow is key for motor tasks.

Several studies have examined eye–head coordination in motor tasks, but little is known about eye–head–body coordination. On the other hand, our previous study revealed that head movement of kendama experts strongly coupled with the moving ball, and head–ball coupling was supported by knee movement in Swing-in, one of the tricks of kendama. The results suggested that the head–ball coupling supported by knee movement could stabilize their vision. However, eye movement was not examined in that experiment.

The aim of this study was to reveal the characteristic of visual perception regulated by eyes, head, and body. An expert and a novice kendama player participated in the experiment, and eye, head, and knee movement was recorded. We will report eye–head–knee coordination in expert and novice kendama players relative to the optic flow generated by a moving ball with rotation in Swing-in.

Poster session I

Perceiving affordances with a sensory substitution device

David Travieso, Luis Gómez-Jordana, Alex Díaz, Lorena Lobo & David M. Jacobs

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The objective of this study is to test if Perception through sensory substitution devices can be described under the view of the theory of affordances. Testing affordances implies obtaining objective behavioral tests of body-scaled or action-scaled informational variables. Body-scaled affordances refer to the perception of properties that are scaled to anthropometric dimensions.

In our study, we test the well-established stair climbing affordance (Warren, 1984) in two groups of tall and short participants. In order to do so, we tested if participants were able to estimate the *climbability* of risers according to the climbability affordance π-number founded for visual perception.

As dependent variable, participants were asked to estimate if they could climb the riser in front of them in a bipedestrian manner, perceived through the SSD. This vibrotactile SSD allows active exploration and lawfully related sensorimotor contingencies, and it is based on distance information delivered to the torso via vibratory effectors.

Results showed that the differences in the riser height that they perceive as climbable can be explained when scaling riser height to leg length. Moreover, participants show a π-number, the dimensionless number that describes the affordance, similar to that founded for regular visual perception. We conclude that our sensory substitution device allows the perception of affordances and that this research approach can shed light on sensorimotor theories and the usability of these devices.

Poster session II

The Oculus Rift is sexist

Med Diedrick, Zachary Polhkamp, Justin Munafo, Thomas A. Stoffregen

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Background. Motion sickness is more common among women than among men (e.g., Lawther & Griffin, 1988). Motion sickness is increasingly common among users of contemporary interactive technologies. When these technologies were used primarily for entertainment the sex difference was, arguably, of little significance. However, interactive technologies are increasingly important in a wide variety of non-entertainment settings, including clinical interventions (Camporesi et al., 2013), and work (e.g., Kurtzberg, 2014). Given the pervasive use of interactive technologies, sex differences in their tendency to induce motion sickness may negatively impact women's access to technology related interventions and careers, such that the technologies would be sexist in their effects.
One of the most widely heralded interactive technologies is the virtual reality headset, a device—worn on the head—that excludes vision of the physical surroundings, such that users can see only what is presented through the device. Perhaps the best-known example of this technology is the Oculus Rift. Widespread anecdotal reports of motion sickness among users of the Oculus Rift have been confirmed by the manufacturer. However, no existing research has evaluated possible sex differences in the tendency of this technology to induced motion sickness.
Method. Seated participants played a game presented via an Oculus Rift. Using a handheld controller, together with the device's built-in head tracking functionality, users navigated a virtual world, moving from room to room and from floor to floor of a virtual building. Participants played for a maximum of 15 minutes.
Results. Motion sickness was reported by 33% of men, and by 78% of women; the difference was significant, $\chi^2 = 7.20$, $p = .018$.
Conclusion. Virtual reality headsets are compelling technologies that have justly garnered widespread public attention and excitement. Unfortunately, our results indicate that this technology is sexist in its effects.

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Kurtzberg, T. R. (2014). Virtual teams: Mastering communication and collaboration in the digital age. Berlin: Prager. ISBN-10: 1440828377

Poster session II

Visuomotor training improves proprioceptive function and transfers to an untrained motor task

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BACKGROUND: When acquiring a new visuomotor skill, we face the challenge of aligning visual feedback with proprioceptive feedback in order to generate accurate motor commands. Here we evaluate, if a training that relies on visual cues for learning will result in measurable changes in proprioceptive acuity, and whether such sensory changes will translate to motor function. We engaged healthy adults in a visuomotor training protocol to identify whether this training improves proprioceptive acuity, and to evaluate if proprioceptive changes translate to motor performance of an untrained non-visuo motor task.

METHOD: Training involved tilting a virtual surface to position a virtual ball on a target by performing small amplitude wrist flexion movements using a haptic robot. Proprioceptive acuity was measured as wrist position discrimination thresholds using controlled passive motion. In an untrained motor task, movement precision errors was measured as the difference between a target wrist position and participant achieved wrist position.

RESULTS: Improvements in proprioceptive thresholds were found in all participants (N = 20; Age: 19-65 years; mean: pre/post = 2.1° ± 0.4°/ 1.4° ± 0.6°; a 33% improvement). Movement precision error improved in 82% of healthy participants (mean: pre/post = 3.1° ± 2.4° / 2.2° ± 2.4°; a 22% improvement).

DISCUSSION: This study demonstrates: First, improvements in proprioceptive acuity are observable even after brief training. Second, enhanced motor performance in an untrained non-visuomotor task indicates that such proprioceptive improvements translate to motor performance. Results provide a scientific basis to apply such training in patients with proprioceptive impairments.

Poster session 2

Schizophrenic' Impaired Capacity to Perceive Affordances

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The present study was inspired by Sass and Parnas' (2003) contention that schizophrenia is essentially a disorder involving impaired selfhood or self-experience. Setting aside what self means, Gibson argued that self can be perceived, stating that "to perceive the world is to co-perceive oneself." If schizophrenics' sense of self is disturbed, their ability to perceive affordances (information specifying environmental properties taken with reference to the perceiver's action capabilities) also should be disturbed. To test this hypothesis, two experiments were conducted. Participants (26 schizophrenics and 23 normal controls) were presented with an artifact on the computer and asked to determine its affordance (for which the artifact was not expressly designed) in a 2-alternative forced choice task (Experiment 1). Schizophrenics were less accurate (84%) and slower (1.52s) than controls (95% and 0.75s). However, when asked to identify physical properties of the artifacts (color, shape) (Experiment 2), schizophrenics were as accurate as normal controls (95% vs 97%) and their reaction time was faster (0.86s) than in Experiment 1, although still slower than normal controls (0.6s). These results provide further evidence that schizophrenia is an illness that impairs individual's sense of selfhood, as Sass and Parnass claimed. Importantly, this impairment also affects schizophrenics' capacity to perceive affordances (information providing functional meanings of objects and events), thus depriving schizophrenics of the practical meanings offered by their environment.

Poster session 2

Does Age Change Joint Proprioceptive Acuity?

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Background: Ageing is associated with sensory loss in multiple modalities, negatively impacting on perceptual precision and on motor systems that rely on sensory information to control balance or the fine-motor actions of the hands. The time course for age-related sensory loss has been well mapped for vision and audition. In contrast, the effects of ageing on proprioception and haptics have received far less attention. To understand the age-related changes in proprioceptive function, this study seeks to establish normative data on proprioceptive acuity of the wrist joint in adulthood.
Methods: 44 healthy adults participated: 1) 20 younger adults (aged 18-35 years), 2) 16 middle-aged adults (aged 35- 55 years), and 3) 8 elderly adults (aged 55- 75 years). Using a 2 response forced –choice paradigm, subjects were asked to discriminate between two different flexion/extension wrist positions generated by a haptic robot. Psychometric acuity functions were obtained at the end of testing and individual proprioceptive discrimination thresholds were extracted.
Results: Mean proprioceptive thresholds were: 2.05° (SD: 0.60°) for young adults, 1.64 (SD: 0.61°) for middle-aged, and 2.04° (SD: 0.50°) for elderly adults. Pearson correlation revealed a non-significant low correlation coefficient between age and the proprioceptive threshold (r=-.096; p=.480).
Conclusion: Our results indicate no age-related decline in proprioceptive acuity of the wrist within the age range from 18 to 75 years. These normative data can be used to determine possible proprioceptive deficits due to pathology.

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Poster session 2

Tablet Computers: Sex Differences in Body Sway and Motion Sickness

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Background. Motion sickness is increasingly common among users of contemporary interactive display technologies. Several studies have demonstrated that motion sickness is preceded by distinctive patterns of postural activity (Stoffregen, 2011). Stoffregen, Chen, & Koslucher (2014) showed that tablet computers can give rise to motion sickness and that such sickness is preceded by distinctive patterns of postural acitivity.
Many studies have shown that motion sickness is more common among women than among men (e.g., Lawther & Griffin, 1988). In addition, there are characteristic sex differences in quantitative measures of standing body sway (e.g., Sullivan et al., 2009). Given the pervasive use of tablet computers in contemporary life, a sex difference in motion sickness relating to these devices could have discriminatory effects. In the present study, we asked 1) whether women and men differ in their propensity to experience motion sickness while using a tablet computer, and 2) whether motion sickness would be preceded by distinctive patterns of body sway, and 3), whether patterns of body sway relating to motion sickness might differ between women and men.
Method. We measured standing body sway while participants performed simple visual tasks. Each task was performed while standing with the feet together, and again with the feet apart.
Next, participants played an "off the shelf" video game on a tablet computer, while seated.
Results. The overall incidence of motion sickness was 22% (8/36). Motion sickness was more common among women (6) than among men (2). Before playing the game, patterns of standing body sway differed between women and men, and between participants who later reported motion sickness and those who did not. There were also statistically significant interactions involving sex and motion sickness.
Conclusions. In terms of motion sickness, tablet computers are sexist in their effects. The sex difference may be related to sex-specific patterns of postural activity.

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Poster session II

Learning to intercept a moving target by launching a simulated ball

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The direct learning theory of Jacobs and Michaels (2007) states that learning entails attuning to more useful informational variables and becoming appropriately scaled to that information (i.e., calibration). Usefulness of a variable refers to how well it relates to a top-be-perceived environmental property or how well it constrains an evolving action. The potential variables for some perceptual or action task constitute an information space, so learning involves moving through the space to a better locus. The majority of applications of the theory have asked participants to make reports of perception; in the present experiment, we apply it to an interception task, in which participants use a mouse to launch a virtual "ball" to hit a target traversing a computer screen. The "ball" displacement matched the mouse displacement until it crossed a visible horizontal line; from there, the ball traveled at a constant velocity to the interception zone. Two target onset positions and seven target velocities were used. The participants performed five blocks of 56 trials (four trials per target position-velocity combination), totaling 280 trials. The task was difficult, but all participants improved. Analyses of various action characteristics and their relations to information variables revealed that participants differed in how they performed the task: Some individuals matched ball and target times-to-contact by employing a high release-velocity and release point near the interception point and others by modulating ball velocity in proportion to target velocity. We asked whether direct learning could account for the differences in learning.

Poster session 2

Perceiving affordances while passing through one aperture among multiple co-existing apertures

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Several studies on affordance perception for aperture crossing (Higuchi et al., 2004; Higuchi et al., 2011; Toyota at al., 2008; Wagman and Taylar, 2005; Warren and Whang, 1987) showed that the consistency of the actions involved in each situation is clarified by a intrinsic action scaled ratio (e.g., aperture-width to actor's shoulder-width ratio), the pi number (Warren, 1984). However, previous studies have mainly focused on "single-aperture situations," whereas we live in cluttered environments and, therefore, will encounter "multi-aperture situations." In this study, we investigated aperture-crossing actions with a baby stroller around the line of automatic ticket-gate machines as an example of a "multi-aperture situation." Participants were asked to walk through the most comfortable aperture among four differently sized apertures constructed by ticket-gate-simulated cardboard boxes with a baby-stroller-simulated pushcart. The widths of the four apertures and their arrangement (aperture width of 850 mm, 550 mm, 400 mm, 700 mm, from the participant's left to right) were changed randomly in each trial. Additionally, there were three conditions in terms of pushcart's width (450 mm, 550 mm, and 650 mm), and two conditions in terms of the pushcart's mobility, which was adjusted by the degrees of freedom of each wheel. The movement trajectories of the pushcart in each condition were analyzed and their characteristics are discussed in terms of pi numbers.

Poster session 2

The development of proprioceptive acuity and the susceptibility to muscle vibration in typically developing children

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Development of human limb proprioception is not well mapped. In adults a systematic shift in the perception of limb position can be elicited by muscle vibration. The responsiveness to muscle vibration in children examines the integrity of the developing proprioceptive system. **AIMS:** 1) Map the development of proprioceptive acuity during childhood, 2) Determine the effect of muscle vibration on position sense during development. **METHOD:** Elbow proprioceptive acuity and the response to biceps brachii vibration were evaluated in children (N = 112, 5-16 y/o) and adults (N = 20, 19-26 y/o). Participants were seated at a bimanual manipulandum. Embedded encoders recorded elbow angular positions. The non-dominant arm was passively moved horizontally from a starting position of 30° elbow extension to one of three target positions at 40°, 60°, or 90°. The participant moved the dominant arm to match the position of the reference arm. Five trials for each target position were presented in pseudo-random order for each of the three conditions: before vibration (baseline), during vibration of the reference arm and after vibration. Mean and standard deviation of matching position error characterized the bias and precision of proprioceptive acuity respectively. **RESULTS:** At baseline adults and children had similar levels of bias, but children were more variable. Children were less responsive to muscle vibration. **DISCUSSION:** The development of proprioception is characterized by an improvement in precision and an increase in susceptibility to muscle vibration. Both may be explained by the development of the central nervous system.

Poster session 2

Development of simple model system consisting of molecular state change and movement

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Perception processes in nerve system is based on an initial movement of molecules caused by physical stimulus and subsequent pattern formation caused by cascading chemical reactions and movement of molecules. From such a viewpoint, it is thought that perception is synergetic processes consisting of molecular state change due to chemical reaction and molecular movement. And also, body action caused by the perception processes consists of cascading chemical reactions and movement of molecules in effector organs. Given these perspective, it can be said that theoretical frame work of the perception-action cycle is based on coupling of molecular state changes and molecular movements. Therefore, we need a simple model system consisting of state change and movement to investigate the nature of the perception-action cycle. For this purpose, in this study, we developed a self-oscillating microgel system in which microgel particle's movement is induced by state changes resulting from a chemical reaction.

To examine availability of the model system developed here, pattern formations in diffusion processes of microgel particles were observed with comparing between two cases with and without state changes. As a result, temporal pattern was formed only in the diffusion processes with the state change. The model system developed here is available for the future research to reveal the basis of perception-action cycle.