



THE ADAPTABILITY OF LANGUAGE-MOTOR CONNECTIONS IN DANCE AND ACTING

A Coordination Dynamics Experiment

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Abstract

This study examined the strength of language-motor connections in dance and acting through a dynamical coordination experiment. It was designed to achieve a higher degree of precision and discipline-specificity than provided by past applications of action-based language theory to the fields of dance psychology and cognitive performance studies. The study revealed that language-motor connections are dependent on training and artistic discipline. It also found that while these connections attract behavior, task-oriented attempts to counter this effect produce implicit adaptation or creation of new language-motor connections. These discoveries are considered in terms of their utility and potential application to gesture-based memorization, choreographic reflection, and improvisational feed-back systems in dance and theatre.

Keywords:

dance, theatre, language-motor coordination, cognitive dynamics

The advent of embodied language and performance research

In 2009, when the experiment I discuss here was first conceived, several theories on the activation of neural motor systems for the comprehension of language were capturing the imagination of scientists, scholars, and artists working on or within dance and theatre. In neuroscience, Vittorio Gallese and George Lakoff were proposing a radical action-based theory of language drawing upon Gallese and his colleagues' discovery of the mirror-neuron system (Gallese and Lakoff) and Gerald Edelman was arguing with Giulio Tononi that the evolution of language stemmed from physically-based concepts (Edelman and Tononi 174). Despite issues of methodological incompatibility, such theories supported key notions of embodiment in branches of phenomenological philosophy, inspired theories of the embodied, enactive, embedded, and extended mind (4E), and gave rise to a new wave of cognitive philosophy (see Thompson; Noë). Due to its degree of abstraction, cognitive 4E philosophy could be, and was, applied to the study of the performing arts as pure theory.

As I discussed in an article published in 2008 (Hansen and Barton 132-135), these generalized, theoretical constructions of neurobiologists or philosophers made it easier to take explanatory leaps when applying discoveries about cognition in creative contexts and performance research. Yet, such leaps could not address the methodological problem of using reductive experiments that tested neurological activity in the motor cortex during the perception of very simple movements to explain far more complex forms of empathy and affect in dance and theatre without sufficient support in empirical evidence. At the same time, scientists with an interest in the very specialized skills in embodied perception of performing artists were using them as research subjects, but there was little awareness of how the codified training of specific approaches to and contexts of creative expression rendered somewhat naïve attempts to generalize findings from experiments with a specific group of artists. As the semiotician Charles Sanders Peirce pointed out in his arguments for a third form of inference—abduction—novel research begins with a period of making associative and not yet qualified nor tested leaps and guesses (Minnameier 78). In this vein, I consider speculative leaps made in the mid 2000s (e.g., McConachie and Hart; Grove, Stevens, and McKechnie) an important precondition for subsequent epistemological developments in the field (e.g., Shaughnessy; Bläsing, Puttke, and Schack; Hansen with Bläsing).

From 2011-12, I conducted experiments into language-motor interactions in contemporary dance and theatrical devising practices. These experiments were small-scale attempts to pursue my interest in action-based and embodied language theory with careful steps, new experimental evidence, practice-based application solutions, and artistic specificity. They included a choice of taking departure in empirical studies instead of the broader theories. In this article, I am both reporting

on the findings of one of these experiments and interpreting them with reference to subsequent developments in a field that in many ways has advanced past the challenges described above.

Seeking precision in application

There was and is ample evidence for the role of the primary motor cortex (or regions adjacent to it) in the perception of both movement and action words (see Pulvermüller; Fischer and Zwaan), which can inform hypotheses about audience reception. However, in order to look into the effect of language-motor connections on dancers' or actors' performance, we need to advance from studies of perception to studies of movement and language production. It is technically impossible to conduct an fMRI study of moving and talking subjects, but behavioral research methods provide useful tools and measures. Perhaps the most convincing study of movement and language production to date was conducted by the research team of the cognitive psychologist Amy Rodriguez. They tested both gross and fine motor responses to motor-related words (semantic motor representations). In practical terms, the research team first tasked subjects to produce words from semantic categories with either high or low motor connotation while analyzing changes in the subjects' posture, measured as center of pressure (COP) displacement. Then subjects were tasked to tap their fingers while producing terms with either high or low motor connotation. In this experiment, rates of finger tapping and language production were measured. From these measures it was concluded that the production of words with higher motor connotation does significantly increase COP displacement and facilitates finger tapping (Rodriguez et. al. 1-8). Where the neuroscientists Arthur Glenborg and Vittorio Gallese continue to argue that all language acquisition, comprehension, and production is action-based and thus embodied using broad strokes (Glenborg and Gallese 919-920), Rodriguez and her team help us distinguish between words with higher or lower motor connotation at the concrete level of effect.

These results give arguable support to recent advances in cognitive performance studies and dance psychology. They align with Rick Kemp's suggestions for a gesture-based method of 'actioning' and memorization in acting (Kemp) in that the link between words with high motor connotation and physical actions hypothetically could strengthen memorization of lines in ways that remain alive and responsive to the reciprocal effect instead of merely coming across as rehearsed. Rodriguez's results can furthermore be used to add verbalization of semantic-motor terms to David Kirsh's influential analysis of gestural marking and motor imaging as choreographic tools of reflection. Kirsh concludes that the practice of marking and imaging movement provides the dancer with the media needed to hold two external and internal

versions of a choreography up against each other simultaneously (Kirsh 27-28). Rodriguez's findings open up the possibility of using semantic-motor terms that are connected to and affect movement as a third medium of choreographic reflection.

However, the measures Rodriguez tested (posture and finger tapping and the generic motor-representative words) do not and cannot help us factor in the variables of training and usage of words and movement that are specific to the disciplines of dance and acting. Without considering those factors, the utility of these findings is limited for our field and remain theoretical. Utility was and is a priority equal to that of methodology in my research. I am aware that my choice of research method depends on which kind of knowledge I wish to produce, and also that my results will be recognized as knowledge by specific disciplines with reference to both methodology and the extent to which they contribute something useful.

Coordination dynamics as a discipline-specific, experimental solution

In response to these considerations, I returned to Kelso's early coordination dynamics findings, as described in Esther Thelen and Linda B. Smith's account of Dynamical Systems Theory applied to complex human development and interaction (Thelen and Smith 65). In 1985, Kelso and his colleagues discovered a human tendency to self-coordinate, or self-organize, otherwise seemingly chaotic behavior. One of his first, and simplest, experiments required subjects to flex and stretch their index fingers in-phase and antiphase. He discovered that, at an accelerated speed of execution, the subjects who started in antiphase would transition; that is, the antiphase would break into disorder and finally shift back to in-phase. This analysis of dynamically self-organized behavior—patterns that are attracted by shifting control parameters and that funnel in and out of phase transition—has been applied to a vast variety of social, natural, and cultural phenomena since Kelso's early work.

In 2009, I reasoned that the simple version of the coordination experiment would provide a useful measure of more discipline-specific language-motor affects. Backed up by Rodriguez research, I found it likely that reciprocal connections between more discipline-specific speech and movement phrases could be as strong as the connections between the movements of individual limbs that Kelso studied. If this hypothesis holds, then sets of associated speech and movement that are performed in reorganized antiphase order would begin to transition at accelerated speed and eventually enter a phase shift back to the original, associated in-phase sets. Results from the experimental psychologist Catherine Stevens and her colleagues' research into established dancers' memorization methods include the observation

that inner verbalization—the naming of the different moves in a sequence—is often relied upon for recall (Stevens et. al. 244). With reference to this observation, reorganized antiphase sets of otherwise associated speech and movement separates the verbalization from its movements, and thus should be significantly harder to recall correctly than the associated in-phase sets.

Experimental procedure

In our tests of these hypotheses, the Canadian dancer and choreographer, Ame Henderson, of Public Recordings and the actor/devisor and director, James Long, of Theatre Replacement served as research subjects. Both were established artists, working full-time in their art form and deeply invested in artistic inquiries that would push their perceptual practice and capacity. In other words, they shared my interest in discovering more about the implicit dynamics of performance, which could further their artistic practice. Each subject recalled sets of closely associated speech and movement sequences. The dancer was tasked with choosing sets of movement phrases and the descriptive terms she had used to name them when the phrases were memorized. The sets had to differ in quality and amount of movements. The actor was tasked with choosing or creating paired sequences of gestures and speech acts that differed in terms of meaning. These tasks were designed to match each performer's individual memorization and recall techniques, knowledge of which was derived from personal interviews in the research design phase. During the experiment, the performers were asked to perform two sets in-phase (in associated order), rotating them back to back for six minutes. A metronome accelerating from twenty to fifty beats per minute over six minutes was used to indicate speed. In the second round, the experiment was repeated with the only difference being that the sets were performed antiphase (pairing movement phrases and speech from the original sets, but in a new order). A third and fourth round was executed using the same parameters, but asking the two performers to work on one another's sets. After each experiment, the performers were asked to describe first person experiences from their performances. All rounds and reflections were video recorded for qualitative analysis.

Taking the hypotheses previously described as a point of departure, the recordings were first coded and analyzed with attention to fluctuations in the repeatability of speech and movement under each of the four experimental conditions. Then dynamic phase transitions or shifts from antiphase to in-phase were identified with attention to control parameters that attracted the observed patterns of behavior.

Accuracy of repetition and adaptation

In all four rounds, each performer was able to sustain accurate repetition of the material in the sets that was closest to their discipline, even at high speed. The dancer's repetition of movement and gesture sequences was accurate, so was the actor's repetition of speech acts and movement terms. However, when working in antiphase or on each other's sets, neither of them accurately repeated the material that was more foreign to their discipline. These findings support Stevens and her colleagues' observation about the reliance on vocalization for recall. My subjects' memorization and recall performance decreased due to our separation of the vocalization used and the movement to which it referred. The additional insight we gained concerns the discipline-specific impact described above and relates to the kinds of 'forgetting' that took place when performing either in antiphase or with material from an unfamiliar discipline. Both performers adapted the material that did not match their discipline. The actor's adaptation of movement established new meaningful associations, as described in the following examples: a flat-handed gesture of petting a horse was changed to the gesture of running fingers through something when paired with the line, 'comb the hair.' Two separated gestures were merged into one when a phrase of five gestures was paired with a four-part speech sequence. The dancer had difficulty remembering her disassociated terms and the actor's speech acts. Working on the primer, she attempted to re-associate the antiphase terms as more abstract descriptions of movement. In parallel to the actor, she inadvertently dropped a term when pairing a five-term description with a sequence of four movements in the antiphase experiment. When faced with the challenge of recalling the actor's lines, she tried to make meaningful connections, but failed, and was only able to perform some of the material with fluency when allowing the speech act and the gestures to be performed simultaneously, but as abstract dual tasks.

Motor-language effects indicated by control parameters

The discipline-specific adaptation discovered becomes particularly interesting when analyzing the data as a dynamical system. The subjects' in-phase performance of their own sets was, as predicted, stable; even at high speed, they did not transition. However, when working in antiphase, they initially paused while trying to remember material that did not match the primary mode of expression within their discipline; they made mistakes performing that material and corrected themselves; the aforementioned adaptations occurred; and, it took them approximately four minutes to achieve fluency of performance. At increased speed, the sequences of material that matched each performer's discipline began to lose distinction and merge into one, longer choreography or speech. Shortly thereafter, the actor shifted to antiphase and the dancer stopped speaking and performed the movement alone.

The influence of discipline-specific connections between movement and speech that match memorization techniques stands out as a clear control parameter. This influence attracted adaptation, of which the performers were only partially aware. They reported on the difficulty experienced when first performing the antiphase sets and their attempts at staying on task, but they rarely noticed the actual adaptation taking place. This brings me to the second control parameter discovered, namely that of task-oriented, conscious control and adjustment of behavior. In a recent article, Kelso discusses the impact of conscious control on the self-organization of task-oriented behavior. As most creative work in dance and devised theatre is task-based, this discussion is relevant both for the analysis of my data and for the utility of results. Drawing upon a body of experiments, Kelso concludes that the release of intentional control is necessary to shift from the less stable antiphase to the more stable in-phase (Kelso 910). This conclusion corresponds with my data: the actor who did shift to in-phase reported that he let his mind wander when he achieved fluency; while the dancer who pushed past her breaking point reported on her ongoing awareness of performance challenges, she remained on task and only began to transition at the point when speed hindered execution. However, the performers' usage of conscious control to remain on task resulted in the implicit effect of adaptation; the adaptation made staying on task possible without shifting to the in-phase sets.

Motor-language effects indicated by multistable system dynamic

Kelso's discussion of control is positioned within a larger project of defining the behavioral characteristics of multistable systems; that is, systems which either oscillate between two different phases of self-organized behavior or largely remain in transition between such phases. This development in Kelso's research is timely. In the case of my study, the actor oscillated between the stable in-phase and a version of the antiphase, which had become more stable through adaptation. The dancer mostly remained in transition between the two phases. The control parameter of discipline-specific connection between speech and movement attracted performance of the in-phase sets, but it was the additional control parameter of task-orientation that led to adaptation and re-association of the antiphase sets and thus produced a second semi-stable phase. This adaptation privileged familiar discipline-specific material and produced discipline-specific associations. The training of the performer therefore had a greater impact on the types of terms that were motor-salient than on general categories like action-terms. Motor connotation had neither become semantic in a general way nor vaguely associated with general types of movement; rather, it remained anchored in specific, ongoing practices.

Utility

This study had internal validity: the experiments were kept simple, and variables that could provide competing causal explanations were eliminated. No attempt was made to achieve external validity; specificity of artistic practice and training was valued over a sample size that could provide statistically generalizable results. Our findings are true for Ame Henderson and James Long and could in theory be true for artists with comparable practices. This choice of method renders the experiment a pseudoscientific pilot that would require more testing for scientific verification. However, it also makes the study far more precise in its ability to factor in both degrees of motor connotation, like Roriguez did, and discipline-specific types of motor-semantic connections. It is this level of precision and specificity that makes the results directly useful in the context of creative practice.

It can help discover more precise and impactful applications to for example Kirsh and Kemp's suggestions. In the case of Kemp's gesture-based technique for the memorization of dialogue in acting, it may prove productive to work with discipline-specific and trained motor-language connections instead of general motor-semantic categories. These connections can be pre-established or they can be generated in rehearsal through the kinds of adaptation discovered in our study. In the context of choreographic reflection and development (as discussed by Kirsh) our findings can be applied with different purposes. The previously suggested use of vocalization with strong motor connotation as a medium to render external a version of a choreography is still valid, but an additional possibility of working against established movement descriptors, using language that facilitates adaptation, now holds creative potential that can be explored.

On that note, I would like to draw attention to an exploration of practical application that I facilitated with Ame Henderson and James Long in the aftermath of our experiments. Our ideas were presented as a performance for an invited audience of directors and choreographers at the Theatre Centre in Toronto in November 2011. We worked with a version of 'the lie line,' a system of performance generation in which performers steal from each other's autobiographical stories. While taking turns to 'tell' their stories, the witnessing performer would copy gestures and movements from the telling performer and use them to manipulate him or her. In turn, the story teller was tasked to anticipate and realize his spectator's movements. The dramaturgical strategy behind this idea was to inhibit the telling performer's ability to rely on memorization techniques for recall, increase the amount of effort demanded, and generate a physical feedback dynamic between the performers that paralleled the story feedback produced by stealing and incorporating story components from each other. We aimed to allow a complex, multistable, rather than singular, form of compositional self-organization to occur on stage.

Bibliography

Books

- BLÄSING, Bettina, Martin PUTTKE, and Thomas SCHACK, Eds. *The Neurocognition of Dance: Mind, Movement and Motor Skill*. Hove and New York: Psychology Press, 2010.
- EDELMAN, Gerald and Giulio TONONI. *A Universe of Consciousness*. New York: Basic Books, 2000.
- GROVE, Robin, Catherine STEVENS, and Shirley MCKECHNIE, Eds. *Thinking in Four Dimensions: Creativity and Cognition in Contemporary Dance*. Melbourne: Melbourne University Press, 2005.
- MCCONACHIE, Bruce and Elizabeth F. HART, Eds. *Performance and Cognition: Theatre Studies and the Cognitive Turn*. London and New York: Routledge, 2006.
- NOË, Alva. *Action in Perception*. Cambridge, Mass.: MIT Press, 2004.
- SHAUGHNESSY, Nicola, Ed. *Affective Performance and Cognitive Science: Body, Brain, and Being*. London: Bloomsbury Methuen, 2013.
- THELEN, Esther and Linda B. SMITH. *A Dynamical Systems Approach to the Development of Cognition and Action*. Cambridge, Mass.: MIT Press, 1996.
- THOMPSON, Evan. *Mind in Life: Biology, Phenomenology, and the Sciences of Mind*. Cambridge, Mass.: Harvard University Press, 2007.

Forthcoming Books

- HANSEN, Pil with Bettina BLÄSING, Eds. *Performing the Remembered Present: the Cognition of Memory in Dance, Theatre, and Music*. London: Bloomsbury Methuen, 2017 (forthcoming).

Forthcoming Chapters

- KEMP, Rick. Action, Memory, and Meaning: Embodied Cognition and the Fictional Present. In: HANSEN, Pil with Bettina BLÄSING, Eds. *Performing the Remembered Present: the Cognition of Memory in Dance, Theatre, and Music*. London: Bloomsbury Methuen, 2017 (forthcoming).

Articles

- FISCHER, Martin H. and Rold A. ZWAAN. Embodied Language: A Review of the Role of the Motor System in Language Comprehension. *The Quarterly Journal of Experimental Psychology*, v. 61, n. 6, p. 825-850, June 2008. doi: 10.1080/17470210701623605

- GALLESE, Vittorio and George LAKOFF. The Brain's Concepts: The Role of the Sensori-Motor System in Conceptual Knowledge. *Cognitive Neuropsychology*, v. 22, n. 3, p. 455-479, May 2005. doi: 10.1080/O2643290442000310
- GLENBERG, Arthur M. and Vittorio GALLESE. Action-based Language: A Theory of Language Acquisition, Comprehension, and Production. *Cortex*, v. 48, n. 7, p. 905-922, 2012. doi: 10.1016/j.cortex.2011.04.010
- HANSEN, Pil and Bruce BARTON. Research-Based Practice: Situating *Vertical City* Between Artistic Development and Applied Cognitive Science. *TDR: The Drama Review*, v. 53, n. 4, p. 120-136, Winter 2009.
- KELSO, J. A. Multistability and Metastability: Understanding Dynamic Coordination in the Brain. *Philosophical Transactions of the Royal Society B*, v. 367, n. 1591, p. 906-918, April 2012. doi: 10.1098/rstb.2011.0351
- KIRSCH, David. How Marking in Dance Constitutes Thinking With the Body. *Versus: Quaderni Di Studi Semiotici*, Bombiani, Milan, n. 113-115, p. 179-210, 2011.
- MINNAMEIER, Gerhard. Peirce-Suit of Truth: Why Inference to the Best Explanation and Abduction Ought Not to be Confused. *Erkenntnis*, Netherlands, v. 60, n. 1, p. 75-105, January 2004. doi: 10.1023/B:ERKE.OO0005162.52052.7f
- PULVERMÜLLER, F. Brain reflections of words and their meanings. *Trends in Cognitive Sciences*, v. 5, n. 12, p. 517-524, December 2001. doi: [http://dx.doi.org/10.1016/S1364-6613\(OO\)01803-9](http://dx.doi.org/10.1016/S1364-6613(OO)01803-9)
- RODRÍQUEZ, Amy D., Matthew L. MCCABE, Joe R. NOCERA, and Jamie REILLY. Concurrent Word Generation and Motor Performance: Further Evidence for Language-Motor Interaction. *PLoS ONE*, v. 7, n. 5, p. e37094, May 2012. doi: 10.1371/journal.pone.0037094
- STEVENS, Catherine, Jane GINSBORG, and Garry LESTER. Backwards and Forwards in Space and Time: Recalling Dance Movement from Long-term Memory. *Memory Studies*, v. 4, n. 2, p. 234-250, 2010.

Biography

Dr. Pil Hansen is an Assistant Professor of Dance and Drama at the University of Calgary, a founding member of Vertical City Performance, and a dance/devising dramaturg. Her empirical and PaR experiments examine cognitive dynamics of memory and perception in creative processes. She developed the tool-set “Perceptual Dramaturgy” and, with Bruce Barton, the interdisciplinary research model “Research-Based Practice.” Her award-winning creative work has toured nationally and internationally and her scholarly research is published in *Performance Research*, *Journal of Dramatic Theory and Criticism*, *Theatre Topics*, *TDR: The Drama Review*, *Canadian Theatre Review*, *Peripiti*, *Koreografisk Journal* and a series of essay collections on dramaturgy, PaR, and research methods. Hansen co-edited the essay collections *Dance Dramaturgy: Modes of Agency, Awareness and Engagement* (Palgrave, 2015) and *Performing the Remembered Present: The Cognition of Memory in Dance, Theatre and Music* (Bloomsbury Methuen, 2017).