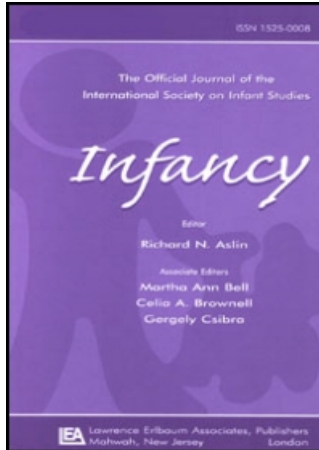


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Esther Thelen's Legacy: A Dynamic World That Continues to Reach Out to Others

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Esther Thelen's Legacy: A Dynamic World That Continues to Reach Out to Others

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On December 29, 2004 the field of developmental psychology lost one of its most prominent and influential scholars. Esther Thelen was known for her leading work on infants' perceptual motor development and for bringing dynamic systems theory into the mainstream of the field. At the core of her work was the notion that infants need to gain control of their body to acquire many functional skills such as kicking, stepping, walking, reaching, and solving perceptual-motor problems such as the A-not-B task. Thelen saw the processes of skill acquisition and problem solving as complex, contingent, and dynamic, in which many parts of the body and environment interacted mutually with one another, and where the brain needs to acquire and integrate the many physical properties of the body to learn, select, or remember specific response patterns. For Thelen, there were almost no forms of cognition that did not originate from the long history of perceptual and motor patterns performed by infants, children, and individuals over their life span. Thelen used the terms *embodiment* and *embodied cognition* in her later writings (e.g., Thelen, 2000; Thelen, Schöner, Scheier, & Smith, 2001) to capture and delineate her general theory of development and to apply it more broadly to the emergence of the mind.

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This thematic collection in *Infancy* is intended to honor her outstanding career and unique contributions to the field of developmental psychology. Since her death, a number of societies and journals have paid their respects to her and her achievements. Memoria written by her students, postdocs, and collaborators were published in *Infancy* (Adolph, Corbetta, Vereijken, & Spencer, 2005), the *Journal of Motor Behavior* (Smith, 2005), and *Developmental Psychobiology* (Galloway, 2005). The Society for Research in Child Development published an extensive retrospective of her work (Spencer et al., 2006) in *Child Development*. This thematic collection is aimed more specifically at acknowledging the impact that Thelen's vision had on the broad field of developmental psychology. The three empirical articles that are part of this issue represent just a few examples of how her ideas reached out to others. As illustrated by this set of articles, Thelen's ideas transcend early development, they apply to multiple domains of behavior, and they are relevant to researchers with disparate backgrounds who, collectively, have embraced Thelen's vision and approach to explaining developmental processes.

Robinson, Kleven, and Brumley (this issue) link Thelen's principles of developmental dynamics to early neural organization, a theme that was omnipresent in Thelen's writings since her earliest studies (i.e., Thelen, 1979, 1981b; Thelen, Ridley-Johnson, & Fisher, 1983). This article focuses on the impact of context and external constraints on the prenatal interlimb coordination of rodents, revealing a developmental trajectory of motor learning that depicts fetal responses to kinesthetic feedback. Ultimately, Robinson et al.'s data argue that coordination patterns are dynamic and emergent properties, not fixed or preset in the nervous system. This is an argument Thelen had made previously and supported with empirical data (Thelen, 1994), but Robinson et al.'s work is particularly exciting because of their extension of these data into the realm of the fetus and the use of very difficult experimental procedures to obtain such informative data.

Yoshida and Smith (this issue) focus on an important theme in Thelen's worldview of behavior: the need to understand that infants and children shape their own development through what they see, touch, and experience (Thelen, 2000). Through their methodology as well as their data, these authors make the compelling argument that the child's first-person view is quite different from the observer's third-person view. They stress the need to study children's attentional strategies and learning from the child's perspective by documenting what they attend to and what they do. At the same time, they carefully make the point that the learning context per se does not dictate what or how children learn, but rather enables a wealth of learning possibilities.

Finally, Smitsman and Cox (this issue) take on a more recent idea that Thelen elaborated on during her last years under the rubric of dynamic field theory (Thelen et al., 2001). Smitsman and Cox show that behavioral perseveration—the tendency to repeat the same action even though some parameters of the task have changed—is not unique to a certain situation (A-not-B), a specific age range (8- to

11-month-olds), or the lack of mental representations, insufficient memory, or any single factor; they show that behavioral perseveration emerges even in 3-year-olds, in tool-use tasks, and as the product of a number of contingencies such as the history of prior actions, task demands, and the preferred perceptual-motor biases or tendencies that the child brings to the task. As we learned from Thelen, multiple facets of the task and organism interact with each other at any given moment to give rise to particular forms of response, decisions, or cognitive processes that are grounded in real time.

An important contributor to Thelen's impact on the field of development comes from the fact that she had a knack for approaching old developmental questions from a different perspective. Several times during her career she went against the conventional wisdom about a given developmental problem to reveal a new account, a different process, or a different interpretation of what was being observed. Perhaps the best known example stems from her work on the disappearance of the newborn stepping reflex (Thelen & Fisher, 1982; Thelen, Fisher, & Ridley-Johnson, 1984). Thelen challenged conventional wisdom at the time that the stepping reflex disappears by design, due to an innate maturational mechanism. She showed ingenuity when she immersed babies in chest-high water at an age when stepping had disappeared in a terrestrial context. The reduced effect of gravity under water enabled stepping to reemerge, thus revealing that the reflex (response, as she later referred to it) was not, in fact, gone. She generated data to show that the disappearance of this leg pattern in the traditional elicitation context was due to the rapid accumulation of body fat without parallel increases in strength. These data ultimately formed the foundation for her arguments that all behavior (e.g., stepping) is contextual and influenced by multiple subsystems, from physiological factors to the history of cognitive, motor, and social experiences.

Another example comes from her work on infant reaching (Thelen et al., 1993). Around 4 months of age, infants begin to reach voluntarily for objects using very indirect, meandering hand paths to the target. Up to that time, the conventional wisdom was that those indirect trajectories were the result of infants' step-by-step visual guidance of the hand to the target. Thelen demonstrated that early trajectory inefficiencies were in fact more specifically related to infants' intrinsic levels of energy and their inability to control their arm motion purposefully. She observed that such indirectness in movement emerged especially when infants were active and moved their arm at high speed, whereas infants who were calmer at the onset of reaching were able to display much straighter trajectories. Thus, Thelen put a new spin on the development of this motor milestone. Learning to reach was not simply about learning to visually guide the hand to the target; it was also about figuring out how much movement speed needed to be generated to maintain arm control for the duration of the trajectory (see also Thelen, Corbetta, & Spencer, 1996). Here again, Thelen showed that patterns of behavior were not the result of a single factor (visual guidance), but rather the

product of a number of elements such as intrinsic activity level, experience at reaching, and the demands of the task.

A final example that marked her last battle, and maybe the one where she found the greatest resistance, was her work on the Piagetian A-not-B task. In a large number of published studies researchers documented that 8- to 11-month-old infants tend to fail to retrieve an object hidden under Location B after repeated searches and successful retrievals of an object hidden under Location A. The conventional wisdom was that infants failed to retrieve at B because of incomplete cognitive abilities (i.e., lack of object representations, lack of extended memory, etc.). Thelen revealed through careful manipulations that failure to retrieve the object at B was actually highly dependent on a number of contextual and experiential factors such as the number of prior reaches to A, the salience of the target locations, infants' reaching experience, attention to the task, and the distance between A and B locations. Not only was she able to show that in specific contexts 8- to 11-month-old infants perseverated on B trials, whereas in slightly different contexts they did not, but she also was able to make predictions as to the context in which infants would perseverate (Thelen et al., 2001). Furthermore, with Linda Smith, she demonstrated that the same patterns of response could be obtained without hiding an object, but just by cuing infants to specific visible locations (Smith, Thelen, Titzer, & McLin, 1999). This particular finding was important because it questioned the long-held belief that infants' retrieval patterns reflected states of their mental representations of hidden objects. More recently, she extended this work to the realm of infant habituation to highlight the contingent and dynamic properties of perceptual mechanisms (Schöner & Thelen, 2006). This work and the A-not-B work marked the apotheosis of Thelen's thinking. She moved into the cognitive domain by showing that mental and thinking activities are also the product of complex interrelational dynamic processes and began applying powerful modeling approaches (in particular dynamic field theory) to strengthen, test, and predict her theoretical assumptions beyond empirical testing.

It is clear from the preceding examples that Thelen was thinking outside of the box, a characteristic that most of her students and collaborators had been able to witness more closely during lab meetings, while discussing or writing a paper, or when brainstorming on a data set. If we look back at the beginnings of her academic career and from knowing her more personally, we can tell that the breadth of her ideas and divergent thinking had several origins. To begin, Thelen was not trained as a psychologist. She obtained her masters degree in zoology in 1973, by studying the repetitive grooming behavior of a wild and mutant strain of wasp called *Bracon hebetor* (*Braconidae: Hymenoptera*; Thelen & Farish, 1977). Then, while a graduate student in biology, she extended her observations from the grooming behavior of wasps to the study of rhythmical stereotypies in human infants. This led her to obtain her PhD in 1977 and publish this extensive work in several biology journals, such as in *Animal Behaviour*, *Ethology and Sociobiology*,

and *Behavioral and Neural Biology* (Thelen, 1979, 1980, 1981a; Thelen, Bradshaw, & Ward, 1981). Only in 1981 did she choose a different outlet for her work and published her first paper in *Developmental Psychology* (Thelen, 1981b). To add to her graduate training in zoology and biology, Thelen landed her first job in 1978 as an assistant professor in the Department of Family and Community Medicine at the University of Missouri Medical School, before finally joining the Department of Psychology in 1981 at the same university. Even though from that time on, psychology was her scientific home, Thelen continued to maintain a broad interest in varied fields of inquiry and scientific discoveries. She read neuroscience, medical science, and physics papers, along with developmental science. She worked with Nobel Laureate Gerald Edelman and acclaimed neurologist Oliver Sachs, who saw her as their peer and with whom she exchanged ideas. Thelen honed in on new work from different fields that linked in some ways to her own, and that served as catalyst for her growing view of the processes of change. Such breadth of knowledge and interest led her to expand her theoretical ideas over time, not morphing from one thing to another but by adding new elements and generating novel points of emphasis.

Thelen was also a thorough and deep thinker endowed with excellent writing skills. This allowed her to pass her new ideas on to others, express them clearly in her writings, and make them compelling so that they would appeal to scientists and practitioners within and outside of her field of inquiry. Because her ideas often challenged convention, she frequently confronted resistance from her peers. But this only pushed her to constantly redefine and reanalyze her thinking further, and also to rephrase her thinking in such a way that she could communicate to broad audiences such as expert scientists, students, or even parents. The breadth and impact of her thinking can easily be measured by the wide variety of people and groups who solicited her advice throughout her career. Thelen was regularly invited to give talks or keynote addresses in fields as varied as neuroscience, cognitive science, kinesiology, physical therapy, music, medicine, speech pathology, philosophy, and robotics.

To understand Esther's breadth and depth, yet focused approach to her scientific quest, one needs to understand her approach to life. She was a social and political activist, deeply committed to addressing inequities, to understanding and debating both their causes and solutions. She and her husband, Dave, contributed their time and resources to causes at local as well as international levels. To visit her home assured wonderful food, prepared by Esther, and even better conversation, ranging from opera to politics to babies. She loved to challenge conventional wisdom, not for the sake of argument, but for the sake of understanding and deriving the optimal explanation. Surely, Esther lived her life to the fullest, seeking and relishing new experiences, drawing from them ideas that she incorporated into her own way of thinking, her ever-assimilating and adapting worldview. To separate her professional life from her philosophy of life would be a mistake. She was truly an intel-

lectual in the most generous and profound manner. Her goals were always to make things better—whether those “things” were internal, in her own way of thinking and understanding, or in ways she could affect politics, social inequities, or theories of developmental science.

We think Esther would have appreciated the set of articles that follows because of the unique and diverse ways in which each of these scientists has integrated her ideas with their own.

We hope readers of this thematic collection will learn about some exciting research in the world of development as well as gain insights into the legacy that Esther Thelen left for us.

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